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NOTES:

1. The Brown County West Landfill Transfer Station is located in T24N, R19E, Section 35, Brown County, Wisconsin. The street address is 3734 West Mason Street, Hobart, WI 54313.

2. Aerial Imagery obtained from Brown County. Date of Photography - April 2017.


4. Site Coordinate System is the Brown County Coordinate System.

5. Site Coordinate System is the Brown County Coordinate System.

6. Vertical Datum is referenced to U.S.G.S. Mean Sea Level (M.S.) Datum (NAVD 1988 Adjustment). The contour interval is two feet.

7. Site is located adjacent to a closed municipal solid waste landfill. Contractor shall prepare and follow health and safety plan for potential hazards, including but not limited to potential for presence of landfill gas and vehicle traffic hazards.

8. Existing Blower located inside Blower Control Building.

9. Existing Blower and Flare will be abandoned in place and isolated from active system.

10. Blower/Flare Replacement will be part of a pre-packaged skid.

11. Blower/Flare Skid Layout is approximate.

12. Existing Infrastructure locations estimated, field verification required prior to start of construction.

13. Existing Blower and Flare system will remain in operation throughout construction. Appropriate safety precautions should be taken.

14. Contractor to remove and replace fencing as required.

**Legend**

- Existing Building
- Existing Topography
- Existing Fence
- Existing Limits of Waste
- Existing Landfill Gas System
- Existing Gas Header Riser Pipe
- Existing Cleanouts
- Replacement Blower
- Proposed Header Connection Pipe

**FIGURE 1**

Flare Skid Design

Brown County Port and Resource Recovery Department
NOTES:

1. INFORMATION OBTAINED FROM DRAWINGS BY ROBERT E. LEE & ASSOCIATES, GREEN BAY, WI. DRAWINGS TO BE USED FOR REFERENCE ONLY. CONTRACTOR TO VERIFY ALL EXISTING EQUIPMENT AND UTILITY LOCATIONS PRIOR TO BEGINNING CONSTRUCTION.

2. BLOWER/FLARE SKID LAYOUT IS APPROXIMATE.

3. BLOWER/FLARE SKID POWER DISTRIBUTION AND CONTROL PANEL TO BE MOUNTED AT ACCESSIBLE LOCATION ON SKID. POWER DISTRIBUTION PANEL TO INCLUDE BREAKER BRANCHES TO FEED ALL SYSTEM LOADS, PER SPECS.

4. EXISTING PROPANE SYSTEM CONTROL PANEL AND SUPPLY LINE TO BE ABANDONED AND REMOVED. TWO EXISTING 100 LB PROPANE TANKS TO BE MOUNTED ON SKID AND CONNECTED TO SUPPLY PILOT ASSEMBLY.

5. CONTRACTOR TO REMOVE EXISTING 12" HEADER PIPE AND REMOVE AND DISCONNECT EXISTING BUTTERFLY VALVE IN BLOWER CONTROL ROOM. CONTRACTOR TO INSTALL FLANGE ON PIPE CONNECTING TO BLOWERS AFTER VALVE IS REMOVED. CONTRACTOR TO PATCH BUILDING WALL.

LEGEND

- **ADDITIONS TO SYSTEM**
- **ELECTRICAL**
- **CONDENSATE LINE**

**NEW BLOWER/FLARE**
**DISCONNECT SEE DETAIL**

**SEE DETAIL**
**SKID FOUNDATION**
**BLOWER/FLARE**

**AND CONTROL PANEL.**
**POWER DISTRIBUTION**
**AND CONTROL PANEL.**

BLOWN/FLARE SKID FOUNDATION
SEE DETAIL

HORIZONTAL COORDINATES BASED ON UTM ZONE 16 NORTH.
HORIZONTAL DATUM BASED ON NAD 1983.

NOT TO SCALE

FIGURE 2
BLOWER/FLARE SKID DESIGN
AND EXISTING CONDITIONS

BROWN COUNTY PORT AND RESOURCE
RECOVERY DEPARTMENT

DATE: MARCH 2020

DRAWN BY: TRN
CHECKED BY: SMB2
PROJECT: 208029.10
CONNECTION FROM EXISTING LFG HEADER TO BLOWER/FLARE SKID

1. CONTRACTOR SHALL SUPPORT THE NEW HDPE LANDFILL GAS PIPE WITH THE PIPE SUPPORTS AND TREATED 2" x 4" LUMBER UNDERNEATH THE PIPE.

2. CONTRACTOR SHALL VERIFY LOCATIONS OF ALL EXISTING UTILITIES PRIOR TO BEGINNING CONSTRUCTION.

PROPOSED BLOWER/FLARE BASE

CONDENSATE REMOVAL CONNECTION TO EXISTING CLEANOUT
NOTES:
1. MAIN BREAKER TO BE INSTALLED IN EXISTING MAINTENANCE BUILDING AS INDICATED IN DETAIL. EXISTING DECOMMISSIONED MSA M5300 METHANE-MONITORING EQUIPMENT TO BE REMOVED AND DISPOSED OF PROPERLY. NEW 100 AMP MAIN BREAKER TO BE INSTALLED ADEQUATELY SIZED FOR FULL OPERATION OF BLOWER/FLARE SKID AND COMPONENTS.

2. CONTRACTOR TO INSTALL CONDUIT AND ELECTRICAL CONNECTION FROM NEW MAIN BREAKER TO IN MAINTENANCE BUILDING TO SKID. CONDUIT TO INCLUDE COMMUNICATIONS BETWEEN EXISTING AUTO DIALER ALARM SYSTEM AND ADDITIONAL ETHERNET CABLE FOR FUTURE REMOTE DISPLAY OPTION.
SECTION 01 10 00

SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. References
   2. Specification Formats and Conventions
   3. Work Covered by the Contract Documents
   4. Work Sequence
   5. Use of Premises
   6. Work By Others
   7. Owner-Furnished Products
   8. Partial Owner Occupancy

1.2 REFERENCES

A. Definitions
   1. The term "approved," when used to convey Engineer’s action on Contractor's submittals, applications, and requests, is limited to Engineer’s duties and responsibilities as stated in the General Conditions of the Contract.
   2. The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

B. Industry Standards
   1. Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
   2. Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.
   3. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement.
   4. The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements.
   5. Each section of the specifications generally includes a list of reference standards normally referred to in that respective section. The purpose of this list is to
furnish the Contractor with a list of standards normally used for outlining the quality control desired on the project. The lists are not intended to be complete or all inclusive, but only a general reference of standards that are regularly referred to.

6. Each entity engaged in construction on the Project shall be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards are needed to perform a required construction activity, obtain copies directly from the publication source and make them available on request.

1.3 SPECIFICATION FORMATS AND CONVENTIONS

A. The Specifications are organized into Divisions and Sections using the 50-division format and CSI's "MasterFormat" numbering system.

B. The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.

1.4 WORK COVERED BY THE CONTRACT DOCUMENTS

A. Project Identification
   1. Project Location: Brown County West Landfill, Hobart, WI
   2. Owner: Brown County Port & Resource Recovery Department
   3. Work will be performed under the following prime contracts:
      a. Contract: WLF Blower/Flare Skid Replacement

B. The Work includes:
   1. Contract: WLF Blower/Flare Skid Replacement
      a. Blower/Flare Skid Foundation/Base
      b. Blower/Flare Skid Installation
      c. Piping
      d. Electrical/Controls Installation
      e. Start-up and Commissioning
      f. Existing Flare and Blower System Disconnect
      g. Restoration

1.5 WORK SEQUENCE

A. Conduct the Work in phases.
   1. Contract: 20B029.10 WLF Blower/Flare Skid Replacement
      a. Blower/Flare Skid Foundation/Base
      b. Blower/Flare Skid Installation
      c. Piping
      d. Electrical/Controls Installation
      e. Start-up and Commissioning
f. Existing Flare and Blower System Disconnect

g. Restoration

Note: All work must be coordinated with the operations of the landfill and scheduled to prevent any disruption to daily operations.

1.6 USE OF PREMISES

A. Contractor shall have full use of the premises for construction operations, including use of the Project Site, as allowed by law, ordinances, permits, easement agreements and the Contract Documents.

B. Assume full responsibility for protection and safekeeping of material and products stored on or off premises.

C. Move any stored material or products which interfere with operations of Owner or other Contractors.

D. Obtain and pay for use of additional storage or work areas needed for operation.

E. Use of Site
   1. On-site work shall be limited to between the hours of sunrise to sunset Monday through Saturday. Work on Sundays shall not be allowed unless approved in writing by Owner.
   2. Owner shall provide contractor two keys to the landfill gate if necessary. Keys shall not be duplicated, and shall be returned to Owner at completion of the work. Contractor shall be responsible for locking gate if leaving after 3:30 p.m.

1.7 OWNER-FURNISHED PRODUCTS

A. Products furnished by Owner and installed by Contractor:
   1. Soil materials from on-site stockpiles.

1.8 PARTIAL OWNER OCCUPANCY

A. Contractor provide:
   1. Access for Owner’s personnel.
   2. Prior to occupancy, execute Certificate of Substantial Completion for designated areas.
   3. Access for Engineer to perform all necessary inspections.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 01 22 01

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. General Work Items
2. Blower/Flare Equipment Skid and Installation
3. Piping, Heat Trace, and Insulation (gas, condensate)
4. Electrical/Controls Installation
5. Start-up and Commissioning
6. Abandonment of Existing Equipment
7. Restoration

B. Unit Prices include:
1. Defined work for each Unit Price Item which will provide a functionally complete Project when combined with all Unit Price Items. If there are specific work items which the Contractor believes are not identified in any Unit Price Item, but is required to provide a functionally complete Project, then the identified specific work items shall be included in the appropriate Unit Price Item.
2. The method of measurement for payment.
3. The price per unit for payment.

C. Lump Sum Prices include:
1. All work items which will result in a functionally complete project in accordance with the specifications and figures.

1.2 GENERAL WORK ITEMS

A. Include with the appropriate Proposal Item the following work items which are common to the Proposal Items for this Section.

B. If there is a specific Proposal Item for any of the following items, then the work item shall be included with that specific unit price item.
1. All costs associated with the mobilization and demobilization of equipment and personnel.
2. All costs associated with providing temporary facilities required to complete the work.
3. Maintenance, protection, replacement and/or repair of damaged facilities outside the area identified for payment in a separate Unit Price Item.
4. All necessary building and regulatory permits.
5. Dust control.
6. Traffic control.
7. Erosion control construction.
8. Right-of-way requirements.
9. Regulatory requirements.
10. Construction staking and other survey work not provided by Owner’s representative.
11. Location of existing utilities and piping.
12. Protection of existing underground piping and utilities.
13. Quality assurance and quality control testing and inspections not provided by the Owner’s representative.
14. All safety related costs.
15. Shop drawings and other submittals.

1.3 BLOWER/FLARE EQUIPMENT SKID AND INSTALLATION

A. The unit price for Proposal Item 2 work includes:
2. Install blower/skid compacted gravel foundation to vendor’s specifications.
3. Provide shop drawings for blower/flare skid.
4. Furnish and install blower/flare skid and all accessories in accordance with the Specifications and Figures.

B. Measurement for payment will be not be made.

C. The unit of measurement for payment is lump sum.

1.4 PIPING, HEAT TRACE, AND INSULATION INSTALLATION

A. The unit price for Bid Item 4 work includes:
2. Furnish and install all piping and associated fittings and valves in accordance with Specifications and Figures.
3. Tie-in to all existing gas and condensate piping and systems as shown on the Figures.
4. Furnish and install insulation and heat tracing in accordance with Specifications and Figures.
5. Provide shop drawings for the heat trace and insulation components.
6. Abandon existing propane piping and control system as shown on the Figures.

B. Measurement for payment will be not be made.

C. The unit of measurement for payment is lump sum.

1.5 ELECTRICAL/CONTROLS INSTALLATION

A. The unit price for Bid Item 5 work includes:
2. Provide shop drawings for the electrical and control system installation.
3. Furnish and install all electrical conduit/control systems, rack and panels to operate the blower and flare system in accordance with the Specifications and Figures.
4. Furnish and install a new 100 amp main breaker in maintenance building and conduit from breaker to the new power distribution and control panel on blower/flare skid.
5. Furnish and install thermal mass flow meter.
6. Install electrical conduit along with communications from new skid system to existing auto dialer alarm system. Include additional communications line for future remote control panel in maintenance building.
7. Remove and dispose of any unused power and control wiring, conduits, and fittings from old controls and electrical utility.

B. Measurement for payment will be not be made.

C. The unit of measurement for payment is lump sum.

1.6 START-UP AND COMMISSIONING

A. The unit price for Bid Item 6 work includes:
   2. Complete system testing, start-up, commissioning, and training in accordance with the Specifications and Figures.

B. Measurement for payment will be not be made.

C. The unit of measurement for payment is lump sum.

1.7 REMOVAL OF EXISTING EQUIPMENT

A. The unit price for Bid Item 7 work includes:
   2. In-place abandonment of existing blower and flare systems.
   5. Disposal/salvage all removed materials, including propane system piping and controls.
   6. Abandon and remove all electrical equipment associated with the existing flare as necessary.
   7. Coordination with landfill personnel.
   8. Removal of existing fencing as necessary to complete work.
B. Measurement for payment will be not be made.

C. The unit of measurement for payment is lump sum.

1.8 RESTORATION

A. The unit price for Bid Item 8 work includes:
   2. General site cleanup.
   3. Restoration of all areas disturbed by construction, including restoring vegetation.
   4. Remove all temporary facilities and unused materials.
   5. Restore fencing.

B. Measurement for payment will be not be made.

C. The unit of measurement for payment is lump sum.

END OF SECTION
SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for submittals:
   1. Progress Schedule
   2. Schedule of Shop Drawings and Sample Submittals
   3. Shop Drawings
   4. Samples
   5. Quality Assurance and Quality Control Submittals

B. Failure to meet Submittal requirements to the satisfaction of the Engineer will constitute unsatisfactory performance of the work, therefore, the Engineer may recommend to the Owner that all or a portion of payments requested during the corresponding pay period be withheld until these requirements are met.

1.2 SUBMITTAL PROCEDURES

A. Coordination
Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related elements of the work so processing will not be delayed by the need to review submittals concurrently for coordination.
      a. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.
   3. To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.
      a. Allow two weeks for initial submittal.
      b. Allow two weeks for reprocessing each submittal.
      c. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the work to permit processing.

B. Submittal Preparation
Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
   1. Assign a reference number to each submittal and resubmittal.
2. Provide a space approximately 4 by 5 inches (100 by 125 mm) on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.

3. Include the following information on the label for processing and recording action taken.
   a. Project name.
   b. Date.
   c. Name and address of the Engineer.
   d. Name and address of the Contractor.
   e. Name and address of the subcontractor.
   f. Name and address of the supplier.
   g. Name of the manufacturer.
   h. Number and title of appropriate Specification Section.
   i. Drawing number and detail references, as appropriate.

4. Each submittal shall be stamped by the Contractor indicating that submittal was reviewed for conformance with the Contract Documents. The Engineer will not accept unstamped submittals.

C. Submittal Transmittal
   Package each submittal appropriately for transmittal and handling. Transmit each submittal to the Engineer. The Engineer will not accept submittals received from sources other than the Contractor.
   1. On the transmittal, record relevant information and requests for Engineer action. On a form, or separate sheet, record deviations from Contract Document requirements, including variations, limitations and justification. Include Contractor's certification that information complies with Contract Document requirements.

1.3 CONTRACTOR'S PROGRESS SCHEDULE

A. Prepare and submit to the Engineer within 10 days after the Effective Date of the Agreement, six copies of a preliminary progress schedule of the work activities from Notice to Proceed until Substantial Completion.
   1. Provide sufficient detail of the work activities comprising the schedule to assure adequate planning and execution of the work, such that in the judgement of the Engineer, it provides an appropriate basis for monitoring and evaluation of the progress of the work. A work activity is defined as an activity which requires substantial time and resources (manpower, equipment and/or material) to complete and must be performed before the contract is considered complete.
   2. The schedule shall indicate the sequence of work activities. Identify each activity with a description, start date, completion date and duration. Include, but do not limit to the following items, as appropriate to this contract:
      a. Shop drawing review by the Engineer.
      b. Material and Equipment:
         1) Order.
         2) Manufacture.
         3) Delivery.
         4) Installation.
5) Startup.
6) Operation and maintenance training
c. Performance tests and supervisory service activities.
d. Excavation and grading.
e. Concrete placement sequence.
f. Construction of various facilities.
g. Construction of various segments of utilities.
h. Subcontractor's items of work.
i. Allowance for inclement weather.
j. Contract interfaces, date of Substantial Completion.
k. Interfacing and sequencing with existing facilities and utilities.
l. Sequencing of major construction activities.
m. Milestones and completion dates.

B. Distribution
Following response to the initial submittal, print and distribute copies of the revised construction schedule to the Engineer, Owner, Subcontractors, and other parties required to comply with scheduled dates. Post copies in the field office.
1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the work and are no longer involved in construction activities.

C. Schedule Updating
Revise the schedule after each meeting, event, or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

D. Punch List
Prepare and submit to the Engineer within 10 days after substantial completion a detailed progress schedule for outstanding work and punch list items.

1.4 SCHEDULE OF SHOP DRAWINGS AND SAMPLE SUBMITTALS

A. Submit three (3) copies of preliminary submittal schedule as follows:
1. Coordinate submittal schedule with the subcontractors, Schedule of Values, and the list of products as well as the Contractor's Progress Schedule.
2. Prepare the schedule in chronological order. Provide the following information:
a. Scheduled date for the first submittal.
b. Related Section number.
c. Submittal category (Shop Drawings, Product Data, or Samples).
d. Name of the subcontractor.
e. Description of the part of the work covered.
f. Scheduled date for the Engineer's final release or approval.

B. Distribution
Following response to the preliminary submittal schedule, print and distribute copies of the revised submittal schedule to the Engineer, Owner, subcontractors, and other
C. Schedule Updating

Revise the schedule after each meeting or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.5 SHOP DRAWINGS

A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

B. Shop drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information:
   1. Dimensions.
   2. Identification of products and materials included by sheet and detail number.
   3. Compliance with specified standards.
   4. Notation of coordination requirements.
   5. Notation of dimensions established by field measurement.
   6. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8½ by 11 inches (215 by 280 mm) but no larger than 24 by 36 inches.

C. Collect product data into a single submittal for each element of construction or system. Product data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
   1. Mark each copy to show actual product to be provided. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:
      a. Manufacturer's printed recommendations.
      b. Compliance with trade association standards.
      c. Compliance with recognized testing agency standards.
      d. Application of testing agency labels and seals.
      e. Notation of dimensions verified by field measurement.
      f. Notation of coordination requirements.

D. Do not use shop drawings without an appropriate final stamp indicating action taken.
E. Submittals
Submit 6 copies of each required submittal. The Engineer will retain two copies, forward one to the Owner, and will return the others to the Contractor marked with action taken and corrections or modifications required.

F. Distribution
Furnish copies of reviewed submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms. Maintain one copy at the project site for reference.
1. Do not proceed with installation until a copy of the Shop Drawing is in the Installer's possession.
2. Do not permit use of unmarked copies of the Shop Drawing in connection with construction.

1.6 SAMPLES

A. Submit full-size, fully fabricated samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern as necessary.
1. Mount or display samples in the manner to facilitate review of qualities indicated. Include the following:
   a. Specification section number and reference.
   b. Generic description of the sample.
   c. Sample source.
   d. Product name or name of the manufacturer.
   e. Compliance with recognized standards.
   f. Availability and delivery time.
2. Submit samples for review of size, kind, color, pattern, and texture.
   a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least three multiple units that show approximate limits of the variations.
   b. Refer to other specification sections for requirements for samples that illustrate workmanship, fabrication techniques, and details of assembly, connections, operation, and similar construction characteristics.
   c. Refer to other sections for samples to be returned to the Contractor for incorporation in the work. Such samples shall be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of sample submittals.
   d. Samples not incorporated into the work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.
B. Submittals
Except for samples illustrating assembly details, workmanship, fabrication techniques, connections, operation, and similar characteristics, submit three samples for review. The Engineer will return one sample marked with the action taken.

C. Distribution of Samples
Prepare and distribute additional samples to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the work. Show distribution on transmittal forms.
1. Maintain reviewed samples at the project site for quality comparisons throughout the course of construction.

D. Field Samples
Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity. The contractor will be required to field verify blower/flare foundation meets vendor requirements.

1.7 QUALITY ASSURANCE SUBMITTALS
A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other sections of the specifications.

B. Certifications
Where other sections of the specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.
1. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.

C. Inspection and Test Reports
Submit as required by other sections of the specifications.

1.8 ENGINEER’S ACTION
A. Except for submittals for the record or information, where action and return is required, the Engineer will review each submittal, mark to indicate action taken, and return promptly. The Engineer will stamp each submittal with a uniform action stamp. The Engineer will mark the stamp appropriately to indicate the action taken, as follows:
1. "No Exceptions Taken": The work covered by the submittal may proceed provided it complies with requirements of the Contract Documents.
2. "Make Corrections Noted": The work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents.
3. "Amend and Resubmit": Do not proceed with work covered by the submittal. Resubmit without delay. Do not use, or allow others to use, submittals marked
"Amend and Resubmit" at the Project Site or elsewhere where work is in progress.

4. "Rejected - See Remarks": Do not proceed with work covered by the submittal. Resubmit without delay. Do not use, or allow others to use, submittals marked "Rejected and Resubmit" at the Project Site or elsewhere where work is in progress.

B. Unsolicited Submittals
The Engineer/Architect will return unsolicited submittals to the sender without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 01 35 53.13

SAFETY AND ENVIRONMENTAL PROCEDURES FOR HAZARDOUS MATERIAL SITES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Site safety and health plan
   2. Personal injury and property damage prevention
   3. Personnel organization, qualifications and responsibilities

1.2 REFERENCES

A. Code of Federal Regulations
   1. 29 CFR 1910 Occupational Safety and Health Standards
   2. 29 CFR 1926 Safety and Health Regulations for Construction

1.3 SUBMITTALS

A. Submit Site Safety and Health Plan, not for approval, but as evidence of compliance with State and Federal requirements.

1.4 SITE SAFETY AND HEALTH PLAN

A. Develop and implement a site safety and health plan meeting the requirements of 29 CFR 1910.120, 29 CFR 1926 and other applicable federal, state and local regulations.

B. Prepare the plan specifically for the site and the anticipated activities based on available information on site conditions and hazards.

C. The plan shall be considered a living document, updated as conditions change during Project execution.

D. On-site work shall not begin until the plan has been prepared and implemented.

E. Include the following in the implementation portion of the plan:
   1. Monitoring for flammable atmospheres in the work area including excavations.
   2. Monitoring of atmosphere for toxic vapors.
   3. Monitoring for other hazards commonly associated with construction activities.
1.5 PERSONAL INJURY AND PROPERTY DAMAGE PREVENTION

A. Provide necessary protection to prevent damage, injury or loss to:
   1. Persons on the Site or who may be affected by the Work;
   2. Materials and equipment to be incorporated in the Work;
   3. Operating landfill gas collection system, including existing landfill gas lines, blowers, and the enclosed flare on Site.
   4. Other property at or adjacent to the Site, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and underground facilities not designated for removal, relocation, or replacement.

B. Comply with all applicable laws, ordinances, rules and regulations affecting the safety of persons or property providing any necessary safeguards for such safety and protection.

C. Notify the owners of any properties or utilities that are affected by the Work.

D. The duties and responsibilities of the Contractor for the safety and environmental protection of the workers and the site shall continue until final payment is made by the Owner to the Contractor.

1.6 PERSONNEL ORGANIZATION, QUALIFICATIONS AND RESPONSIBILITIES

A. Designate the Safety Representative per the General Conditions, a Site Safety and Health Officer and at least one alternate.

B. The Site Safety and Health Officer shall:
   1. Implement and enforce the site health and safety plan.
   2. Provide hazard communication information.
   3. Be responsible for any safety environmental monitoring.
   4. Have the authority to stop work activities if unacceptable health or safety conditions exist.
   5. Coordinate and recommend corrective actions for identified health and safety deficiencies and oversee the corrective actions.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 01 71 23
FIELD ENGINEERING

PART 1 - GENERAL

1.1 DESCRIPTION OF THE WORK

A. Work under this section is associated with:
   1. Staking
   2. Documentation Surveys

1.2 STAKING OF THE WORK

A. Staking to be provided by Contractor.
   1. Contractor shall set lines and grades necessary for the detailed execution of the work.
   2. Contractor shall perform “as-built” survey of underground piping on a minimum 20-foot interval in addition to all fittings and bends.
   3. Costs for construction staking necessary for the detailed execution of the work shall be borne by the Contractor.

1.3 PROFILE AND TOPOGRAPHY

A. Contours or profiles of the ground are shown on the figures. These profiles and contours are reasonably correct, but are not guaranteed to be absolutely so, and together with any schedule of quantities are presented only as an approximation.

1.4 PROTECTION, RELOCATION AND REPLACEMENT

A. The Contractor shall protect and preserve all permanent and temporary reference points.

B. The Contractor shall make no changes in grade, alignment or location without written approval of the Owner.

C. The Contractor shall report to the Engineer any reference point which is lost, destroyed or requires relocation because of necessary changes in grades or location.

D. The Contractor shall be responsible for the cost of relocating any stake or reference point lost as a result of his negligence during the construction period.

1.5 SITE DOCUMENTATION SURVEYS

A. The Contractor shall provide safe access to the Engineer for collection of all necessary measurements both above and below ground.
B. Items that are specified to be documented will not be considered complete until documented.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION
SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Inspection Procedures
   2. Project Record Documents.
   3. Operation and Maintenance Manuals
   4. Warranties
   5. Instruction of Owner's Personnel
   6. Final Cleaning

1.2 SUBSTANTIAL COMPLETION

A. Before notification that the Work is substantially complete, provide the following:
   1. Demonstrate to the Engineer that systems and system components operate as intended.
   2. Advise Owner of pending insurance changeover requirements, if any.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Prepare and submit Project Record Documents, operation and maintenance manuals, construction photographs, damage or settlement surveys, property surveys, and similar final record information.
   6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   7. Make final changeover of permanent locks and deliver keys to Owner if necessary. Advise Owner's personnel of changeover in security provisions.
   8. Complete startup testing of systems.
   10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
   11. Advise Owner of changeover in heat and other utilities if necessary.
   12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
   13. Complete final cleaning requirements, including touchup painting.
   14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
B. Submit written notification to Owner and Engineer that the entire Work is ready for its intended use and the entire Work is substantially complete.

1. If the items in paragraph A. above are complete, then within 14 days Owner, Contractor and Engineer will make an inspection of the Work to determine status of completion.

2. If Engineer considers the Work substantially complete, then Engineer will prepare and deliver to the Owner a tentative Certificate of Substantial Completion fixing the date of Substantial Completion with an attached tentative list of items to be completed or corrected before final payment.

3. Engineer will issue a definitive Certificate of Substantial Completion with list of items to be completed or corrected or notify Contractor that the Work is not substantially complete within 21 days after submittal to Owner.

4. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

5. Results of completed inspection will form the basis of requirements for Final Completion.

1.3 FINAL COMPLETION

A. Before requesting final inspection for determining final completion, complete the following:

1. Items identified as requiring correction or completion.

2. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Submit a written notice that the entire Work is complete. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.4 PROJECT RECORD DOCUMENTS

A. Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record documents for Engineer’s reference during normal working hours.

B. Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.

1. Mark record drawings to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, Subcontractor, or similar entity, to prepare the marked-up record drawings.

   a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.

   b. Accurately record information in an understandable drawing technique.
c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.

d. Mark contract drawings or shop drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where shop drawings are marked, show cross-reference on contract drawings.

2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.

3. Mark important additional information that was either shown schematically or omitted from original Drawings.

4. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.

C. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.5 OPERATION AND MAINTENANCE MANUALS

A. Assemble and deliver three (3) complete sets of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual specification sections and as follows:

1. Operation Data:
   a. Emergency instructions and procedures.
   b. System, subsystem, and equipment descriptions, including operating standards.
   c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
   d. Description of controls and sequence of operations.
   e. Piping diagrams.

2. Maintenance Data:
   a. Manufacturer's information, including list of spare parts.
   b. Name, address, and telephone number of Installer or supplier.
   c. Maintenance procedures.
   d. Maintenance and service schedules for preventive and routine maintenance.
   e. Maintenance record forms.
   f. Sources of spare parts and maintenance materials.
   g. Copies of maintenance service agreements.
   h. Copies of warranties and bonds.

B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title
"OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

1.6 WARRANTIES

A. Submit written warranties for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Submit properly executed warranties of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
   1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8½ by 11 inch (115-by-280-mm) paper.
   2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
   3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 DEMONSTRATION AND TRAINING

A. Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   1. Provide instructors experienced in operation and maintenance procedures.
   2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
   3. Schedule training with Owner through Engineer with at least seven days advance notice.
   4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.

B. Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline. Include instruction for the following:
   1. System design and operational philosophy.
2. Review of documentation.
3. Operations.
4. Adjustments.
5. Troubleshooting.
7. Repair.

3.2 FINAL CLEANING

A. Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project site.
   e. Remove snow and ice to provide safe access to building.
   f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
   g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   h. Sweep concrete floors broom clean in unoccupied spaces.
   i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscurring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
   j. Remove labels that are not permanent.
   k. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
      1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
   l. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Replace parts subject to unusual operating conditions.

n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

p. Clean ducts, blowers, and coils if units were operated without filters during construction.

q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

r. Leave Project clean and ready for occupancy.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION
SECTION 09 96 00

HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Coating Systems for Application on Metal and Plastic

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM D16 Terminology for Paint and Related Coatings, Materials and Applications
   2. ASTM D4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

B. Society for Protective Coatings (SSPC)
   1. SSPC-SP1 Solvent Cleaning
   2. SSPC-SP6 Commercial Blast Cleaning
   3. SSPC-SP10 Near White Blast Cleaning
   4. SSPC Paint 12 Cold-Applied Mastic

C. American National Standards Institute (ANSI)
   1. ANSI A13.1 Scheme for Identification of Piping Systems

D. Federal Specification (FS)
   1. FS-TT-P-645A Primer, Paint, Zinc Chromate, Alkyd Type

1.3 DEFINITIONS

A. Standard coating terms defined in ASTM D16 apply to this section.

1.4 SUBMITTALS

A. Provide product data for each coating system indicated. Include block fillers and primers.
   1. Provide an inclusive material list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer’s catalog number and general classification.
   2. Provide manufacturer’s technical information, including label analysis and instructions for handling, storing, and applying each material specified.
B. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.

C. Manufacturers color charts showing full range of colors available for each type of finish coat material indicated for Owner's selection.

D. Provide names of firms of experienced applicator and information as required to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information pertinent to the project.

1.5 QUALITY ASSURANCE

A. Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Where painting materials will come in contact with potable water, provide current written acceptance for their coating system from the state's governing authority.

D. Where Tnemec brand coatings are referenced, it is used as a guide to quality only and equivalent materials of manufacturers listed may be used.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to Project site in manufacturer’s original, unopened packages and containers bearing manufacturer’s name and label with the following information:
   1. Name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer’s stock number and date of manufacture.
   4. Contents by volume for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.
   8. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45°F (7°C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
   1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing and applying coatings.
1.7 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 45 and 95°F (7 and 35°C).

B. Verify moisture content of concrete per ASTM D4263 for compliance with manufacturer’s recommendation for painting of concrete.

C. Do not apply coatings in snow, rain, fog or mist when relative humidity exceeds 85 percent; at temperatures less than 5°F (3°C) above the dew point or to damp or wet surfaces.
   1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
   2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carboline

B. Tnemec

C. Sherwin Williams

D. Or other as approved by blower/flare skid vendor

2.2 COATING MATERIALS - GENERAL

A. Provide primers, undercoats, and finish coat materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Provide manufacturer’s highest grade of the various high performance coatings specified. Materials not displaying manufacturer’s product identification are not acceptable.

C. Color shall be as selected by Engineer/Architect from manufacturer’s full range.
# 2.3 PAINTING SYSTEMS

## Table 1
Coating Systems for Application on Concrete and Concrete Block

<table>
<thead>
<tr>
<th>System Type</th>
<th>Application</th>
<th>Generic Type</th>
<th>Finish Coat</th>
<th>Primer Coat</th>
<th>Min. Mils (Dry Film Thickness)</th>
<th>Surface Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>Concrete Block in Corrosive Environments or Immersion Services</td>
<td>Polyamidomine Epoxy</td>
<td>Tnemec Series N69 (color as selected by Owner)</td>
<td>Concrete: Self-priming Block: Tnemec Series 54-660</td>
<td>2 coats 8-12 mils each coat. 2 finish coats 8-12 mils each coat. 1 block filler coat 6-8 mils.</td>
<td>Concrete: Allow new concrete to cure for 28 days. Prepare surface per Section 03300. Temperature must be 50° and rising unless an approved accelerator is added. Block: Allow mortar to cure for 28 days. Level protrusions and splatter. All surfaces must be clean and dry. Concrete surface must be cured 28 days. Moisture content at the surface shall be less than 5% as determined by ASTM D4263.</td>
</tr>
<tr>
<td>C-2</td>
<td>Concrete Floors</td>
<td>Polyamine Epoxy</td>
<td>Tnemec Series 280</td>
<td>Tnemec Series 203</td>
<td>Primer: 4 mils DFT. Finish: 2 coats 8 mils each coat.</td>
<td>Remove laitance and contaminants from surface. Concrete must be cured at least 28 days. Acid etch.</td>
</tr>
<tr>
<td>C-3</td>
<td>Interior Concrete Walls, Ceilings and Concrete Block</td>
<td>Polyamidoamine Epoxy</td>
<td>Tnemec Series N69 (color as selected by Owner)</td>
<td>Concrete: Self-priming Block: Tnemec Series 54-660</td>
<td>Concrete: 2 coats 6 mils each coat. Block: 2 finish coats 6 mils each coat. 1 block filler coat 6-8 mils.</td>
<td>Concrete: Allow new concrete to cure for 28 days. Brush-off blast. Block: Allow mortar to cure for 28 days. Level protrusions and splatter. All surfaces must be clean and dry.</td>
</tr>
<tr>
<td>C-4</td>
<td>Exterior Precast Concrete Wall Panels, Above Grade Concrete Walls or Concrete Block Walls, Brick Walls to be Painted</td>
<td>Waterborne acrylic emulsion.</td>
<td>Tnemec Series 180 (color by Owner)</td>
<td>Self-priming.</td>
<td>10 mils per coat: Concrete: 1 coat Block: 2 coats Brick: 2 coats</td>
<td>Concrete: Allow new concrete to cure for 28 days. Brush-off blast. Block: Allow mortar to cure for 28 days. Level protrusions and splatter. All surfaces must be clean and dry.</td>
</tr>
<tr>
<td>C-5</td>
<td>All Exposed, Nonsubmerged, Unpainted, Exterior, Interior, Concrete, Concrete Block and Brick Surfaces</td>
<td>Concrete: Acrylic or acrylate based sealer. Masonry: Siloxane based water repellent. Concrete: Clear seal 300 by Tamms, Inc., or equal. Masonry: Chemprobe Technologies Prime-A-Pell H2O</td>
<td>N/A</td>
<td>N/A</td>
<td>Note: Apply one coat per manufacturer recommendations.</td>
<td></td>
</tr>
<tr>
<td>System Type</td>
<td>Application</td>
<td>Generic Type</td>
<td>Min. Mils (Dry Film Thickness)</td>
<td>Surface Preparation</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>C-6</td>
<td>Interior Concrete Block Walls for Office Space, Laboratory and Toilet Rooms</td>
<td>Waterborne Acrylic Epoxy</td>
<td>Primer: 1 coat 6 mils.</td>
<td>28-day cure on mortar joints, level protrusions and mortar splatter. Clean and dry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tnemec Series 113 HB Teneme-Tufcoat at 120-175 sfp (spray apply to achieve coverage).</td>
<td>Finish: 1 coat 6 mils.</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tnemec Series 54-580 at 60-80 sfp (wet applied material shall be back rolled to fill substrate porosity).</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2
Coating Systems for Application on Metal and Plastic

<table>
<thead>
<tr>
<th>System Type</th>
<th>Application</th>
<th>Generic Type</th>
<th>Finish Coat</th>
<th>Primer Coat</th>
<th>Min. Mils (Dry Film Thickness)</th>
<th>Surface Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-1</td>
<td>Non-Submerged Normal Conditions Indoors and Outdoors</td>
<td>Polyamidoamine Epoxy and Urethane (exterior only).</td>
<td>Tnemec Series N69 (Tnemec Series 1074 exterior only).</td>
<td>Self-priming.</td>
<td>Interior: 2 coats 6-10 mils each coat.</td>
<td>Steel SSPC-SP6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exterior: 2 coats N69 6-10 mils each coat.</td>
<td>PVC: hand sand to roughen, solvent clean.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Interior: 1 coat 1074 3 mils.</td>
<td></td>
</tr>
<tr>
<td>M-2</td>
<td>Non-Submerged Severe Conditions of Moisture, Submerged or Intermittently Submerged (except potable water).</td>
<td>Polyamidoamine Epoxy and Urethane (exterior only).</td>
<td>Tnemec Series N69 (Series 1074 exterior only).</td>
<td>Self-priming.</td>
<td>Interior: 3 coats 6-10 mils each coat.</td>
<td>Steel non-immersion. Service: SSPC-SP6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exterior: 2 coats N69 6-10 mils each coat.</td>
<td>Steel immersion. Service: SSPC-SP10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Interior: 1 coat 1074 3 mils.</td>
<td></td>
</tr>
<tr>
<td>M-3</td>
<td>Submerged or Intermittently Submerged (except potable water).</td>
<td>Moisture Cured Polyurethane</td>
<td>Tnemec Series 446</td>
<td>Self-priming.</td>
<td>2 coats 446 5-9 mils each coat.</td>
<td>Steel immersion service SSPC-SP10</td>
</tr>
<tr>
<td>M-4</td>
<td>Interior of Tanks for Potable Water (Color – White)</td>
<td>Epoxy-Polyamide</td>
<td>Tnemec Series 20 Potapox</td>
<td>Self-priming.</td>
<td>Three coats to 12 dry mils.</td>
<td>SSPC-SP10</td>
</tr>
<tr>
<td>M-5</td>
<td>Non-Epoxy Factory Primed Steel Doors, Frames and Miscellaneous Equipment</td>
<td>Polyamidoamine Epoxy and Urethane (exterior only)</td>
<td>Interior: 1 coat Series N69</td>
<td>Tnemec Series 27</td>
<td>Primer: 2-3 mils</td>
<td>Clean and dry.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Exterior: 1 coat Series 1074 over N69</td>
<td></td>
<td>Interior: 1 coat N69 3 mils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exterior: 1 coat N69 3 mils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 coat 1074 3 mils.</td>
<td></td>
</tr>
</tbody>
</table>
### PART 3 - EXECUTION

#### 3.1 PROTECTION

A. Protect with tarpaulin or drop cloth all floors, walls, glass, finished painted work and equipment from paint spatter or other damage that might result from this Work.

B. Promptly remove all oil, paint and solvent waste rags from the site and legally dispose of them. Do not burn waste materials.

C. Paint, varnish, and mixing cans shall not be placed on bare floors.

D. Dirty, oily and dusty covers shall not be used.

E. No stains or spots shall remain after completion of painting.

F. Remove hardware accessories, light fixtures, and similar items before painting.
   1. Replace above items after finish coat is applied.
   2. Masking may be utilized in lieu of removal of items.

#### 3.2 APPLICATION

A. Apply by spraying, brushing, or rolling.
   1. Use material manufacturer approved application method.
   2. Notify Engineer as to method to be employed.
   3. Spraying:
      a. Nozzles shall be as recommended by supplier for product being applied.
      b. Maintain air pressure recommended by product supplier.
   4. Brushing:
      a. Brush in one direction then smooth at right angles to original brushing to produce a uniform thickness of coating.
   5. Thickness of Coating:
      a. Where number of coats are indicated, it is intended to show the normal practice to obtain the proper dry mil thickness.
b. Provide the dry mil film thickness in all cases even though it may require more or less coatings than specified. Apply coating shall be applied in accordance with manufacturer's recommendations.

B. Spray Painting Exterior of Building
1. Take care that no spray falls on nearby structures.
2. Confine spraying on exterior surfaces to quiet days when it will not affect adjacent property.
3. Contractor shall be responsible for any and all damage resulting from drifting spray.

C. Provide ventilation when painting interior surfaces of tanks, pits, vaults or other enclosures.
1. Provide adequate ventilation at all times.
2. Provide ventilation adequate to remove fumes, preventing injury to workmen or possibility of accumulating volatile gases.

3.3 COLOR CODING AND LABELING OF PIPING AND EQUIPMENT

A. Color Coding
1. Primer color shall be at least two shades lighter in color than the finish to facilitate adequate inspection of field application.
2. Apply the following color code for all piping exposed to view in all wastewater installations.
   a. Wastewater Lines: Medium Grey
   b. Primary Sludge Lines: Dark Brown
   c. Return Activated Sludge Lines: Light Brown
   d. Waste Sludge Lines: Light brown with 3 inch green bands 6 ft. on center
   e. Treated Sludge Lines: Light brown with 3 inch white bands 6 ft. on center
   f. Gas Lines (Natural or LP): Orange
   g. Gas Lines (Methane): Orange with 3 inch blue bands 6 feet on center
   h. Chlorine Lines (Hypochlorite): Yellow
   i. Potable Water Lines: Blue
   j. Non Potable Water Lines: Blue with 6 inch red band 30 inches on center
   k. Compressed Air Lines: Dark Green
   l. Polymer Solution Lines: Red
   m. Lime Slurry Lines: Light green
   n. Ferric Chloride Solution Lines: Red with 3 inch black bands 6 feet on center.
   o. Alum Solution Lines: Red with 3 inch white bands 6 feet on center
   p. Bisulfite: Violet
3. Apply the following color code for all piping exposed to view in all potable water supply installations.
   a. Raw Water Lines: Olive Green
   b. Settled or Clarified Water Lines: Aqua
   c. Finished or Potable Water Line: Dark Blue
   d. Alum or Primary Coagulant: Orange
   e. Ammonia: White
f. Carbon Slurry: Black
g. Caustic: Yellow with Green Band
h. Chlorine (Gas and Solution): Yellow
i. Chlorine Dioxide: Yellow with Violet Band
j. Fluoride: Light Blue with Red Band
k. Ozone: Yellow with Orange Band
l. Phosphate Compounds: Light Green with Red Band
m. Polymers or Coagulant Aids: Orange with Green Band
n. Potassium Permanganate: Violet
o. Soda Ash: Light Green with Orange Band
p. Sulfuric Acid: Yellow with Red Band
q. Sulfur Dioxide: Light Green with Yellow Band
r. Backwash Waste: Light Brown
s. Sludge: Dark Brown
t. Sewer (Sanitary of Other): Dark Grey
u. Compressed Air: Dark Green
v. Gas: Red
w. Other Lines: Light Grey

B. Pipeline Identification
1. Furnish and apply pipeline identification labels for pipelines shown on drawings. Label piping per color coding designations as listed above.
2. Size of Markers:
   a. Markers for 3" OD and larger pipe (including insulation) shall be 2" standard label, self-sticking.
   b. Markers for pipe under 3" OD (including insulation) shall be 1" standard label, self-sticking.
3. Application of Pipe Markers:
   a. Apply marker at main valves to show proper identification of pipe contents.
   b. Use an arrow marker with each pipe content marker. Point arrow away from the pipe marker and in the direction of flow. If flow can be in both directions, use a double-headed arrow marker.
   c. Apply marker and arrow marker at every point of pipe entry or exit where pipe goes through wall if visible.
   d. Identify long continuous lines with pipe and arrow marker approximately every 30 feet.
   e. On horizontal pipe apply markers on the two lower quarters of the pipe where markers can be read at a glance from floor level; and dust will not obscure the marker.
   f. Apply pipe marker and arrow marker on each riser and "T" joint.
4. References:
   a. Brady Self-Sticking Industrial Products Catalogue, or as approved, conforming to ANSI A13.1 "Identification of Pipe Systems."
5. Identification Code Tabulation:
   a. Yellow background with black letters for ANSI classified inherently hazardous materials: flammable, explosive, chemically active or toxic, extreme temperature or pressure, or radioactive.
b. Green background with white letters for ANSI classified inherently low hazard liquid or liquid admixture materials.
c. Blue background with white letters for ANSI classified inherently low hazard gas or gaseous admixture materials.
d. Red background with white letters for ANSI classified fire quenching materials such as water (for firefighting), foam, CO2, halon, etc.

### 3.4 PAINTING SCHEDULES

A. The following schedules apply to painting and coating work for water and wastewater installations as shown on drawings.

1. Paint or coat concrete and concrete block surfaces with system indicated below:

<table>
<thead>
<tr>
<th>Surface</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>All submerged or intermittently submerged concrete surfaces</td>
<td>Unpainted</td>
</tr>
<tr>
<td>All painted exterior, above grade, precast concrete wall panels, cast</td>
<td>Table 1</td>
</tr>
<tr>
<td>in place concrete or concrete block walls</td>
<td>C-4</td>
</tr>
<tr>
<td>All painted interior concrete walls and ceilings, precast concrete</td>
<td>Table 1</td>
</tr>
<tr>
<td>concrete walls and ceilings and concrete block walls not in contact</td>
<td>C-3</td>
</tr>
<tr>
<td>with sewage in unoccupied buildings.</td>
<td></td>
</tr>
<tr>
<td>All unpainted, exposed, nonsubmerged, exterior and interior concrete</td>
<td>Table 1</td>
</tr>
<tr>
<td>surfaces</td>
<td>C-5</td>
</tr>
<tr>
<td>All painted interior concrete block walls in office spaces.</td>
<td></td>
</tr>
</tbody>
</table>

2. Paint or coat exterior and interior metal except the following:
   a. Stainless steel.
   b. Aluminum (unless in contact with or embedded in concrete).
   c. Shop finished enameled surfaces.
   d. Galvanized steel (unless otherwise specified). Use galvanized steel primer if required to paint.
   e. Chromium plate.
   f. Copper.
   g. Bronze.
   h. Weathering steel.
   i. Steel to be encased in concrete.

3. Metal surfaces except those specifically exempted in subparagraph 2. above shall be painted or coated with system as indicated below:
<table>
<thead>
<tr>
<th>Surface</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-submerged, normal conditions indoors including:</td>
<td>Table 2</td>
</tr>
<tr>
<td>a. Machinery</td>
<td>M-1</td>
</tr>
<tr>
<td>b. Pipes</td>
<td></td>
</tr>
<tr>
<td>c. Pumps</td>
<td></td>
</tr>
<tr>
<td>d. Blowers</td>
<td></td>
</tr>
<tr>
<td>e. Railings</td>
<td></td>
</tr>
<tr>
<td>f. Steel Doors</td>
<td></td>
</tr>
<tr>
<td>g. Steel Sash</td>
<td></td>
</tr>
<tr>
<td>h. Valves and Fittings</td>
<td></td>
</tr>
<tr>
<td>i. Platforms</td>
<td></td>
</tr>
<tr>
<td>j. Ladder and Stairs</td>
<td></td>
</tr>
<tr>
<td>k. All exposed structural and miscellaneous steel.</td>
<td></td>
</tr>
<tr>
<td>l. Non-insulated tank interiors.</td>
<td></td>
</tr>
</tbody>
</table>

| Non-submerged, normal conditions outdoors including:                   | Table 2    |
| a. Pipes                                                               | M-1        |
| b. Machinery                                                           |            |
| c. Pumps                                                               |            |
| d. Blowers                                                             |            |
| e. Railings                                                            |            |
| f. Steel Doors                                                         |            |
| g. Steel Sash                                                          |            |
| h. Valves and Fittings                                                 |            |
| i. Platforms                                                           |            |
| j. Ladders and Stairs                                                  |            |
| k. Structural and Miscellaneous Steel                                  |            |
| l. Non-insulated Tank Exteriors                                        |            |

| Non-submerged, severe conditions of moisture including:                | Table 2    |
| a. Piping                                                              | M-2        |
| b. Machinery                                                           |            |
| c. Pumps                                                               |            |
| d. Blowers                                                             |            |
| e. Railings                                                            |            |
| f. Steel Doors                                                         |            |
| g. Steel Sash                                                          |            |
### Surface System

<table>
<thead>
<tr>
<th>h. Valves and Fittings</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Platforms</td>
<td></td>
</tr>
<tr>
<td>j. Ladders and Stairs</td>
<td></td>
</tr>
<tr>
<td>k. Structural and Miscellaneous Steel</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aluminum Encased in Concrete</th>
<th>Table 2 M-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum in Contact with Concrete</td>
<td>Table 2 M-7</td>
</tr>
</tbody>
</table>

**Non-submerged, large area including:**

<table>
<thead>
<tr>
<th>a. Bridges Over:</th>
<th>Table 2 M-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦ Clarifier</td>
<td></td>
</tr>
<tr>
<td>♦ Aeration Tanks</td>
<td></td>
</tr>
<tr>
<td>♦ Grit Chambers</td>
<td></td>
</tr>
<tr>
<td>♦ Nitrification Tanks</td>
<td></td>
</tr>
<tr>
<td>♦ Chlorine Tanks</td>
<td></td>
</tr>
<tr>
<td>♦ Aerobic Digester Tanks</td>
<td></td>
</tr>
<tr>
<td>♦ Thickener Tanks</td>
<td></td>
</tr>
<tr>
<td>b. Non-insulated tank and hopper exteriors.</td>
<td></td>
</tr>
<tr>
<td>c. Walkways on bridges.</td>
<td></td>
</tr>
<tr>
<td>d. Digestor covers.</td>
<td></td>
</tr>
</tbody>
</table>

**Submerged or intermittently submerged:**

| a. Aeration tank equipment and piping. | Table 2 M-2 |
| b. Clarifier equipment and piping. | |
| c. Nitrification and denitrification tank equipment and piping. | |
| d. Chlorination tank equipment and piping. | |
| e. Sludge thickener tank equipment and piping. | |
| f. All equipment or piping in clear wells or storage tanks associated with tertiary filters or fine screens. | |
| g. All equipment or piping in dosing tanks, splitter boxes, manholes or head boxes. | |
| h. All equipment or piping in aerobic digesters. | |
| i. All equipment or piping in anaerobic digesters including any steel on inside of cover dome or roof. | |
| j. All wetted parts of vacuum filters, vats and piping. | |

**PVC exposed piping to be color coded.**

**Rubber or vinyl pipe/duct insulation (to be color coded).**

**END OF SECTION**
SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

1.3 DESCRIPTION OF WORK

A. Furnish and install complete and operable electrical systems as indicated on the drawings and as specified herein

B. Design Requirements:
1. The table included in this section under Hardware Design Requirements specifies the usage requirements for the hardware and equipment specified in the following sections:
   a. Section 26 05 29 Hangars and Supports for Electrical Systems
   b. Section 26 05 34 Conduit
   c. Section 26 05 37 Boxes

C. Electrical Work Specified Elsewhere:
1. Every attempt has been made to indicate in these specifications and figures all work required under Division 26. However, there may be additional specific requirements in the specifications, figures, or addenda of other trades which pertain to the work of this trade, and any such requirements are hereby made a part of the requirements for this trade.

D. Design Intent:
1. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
2. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or Figures, the Contractor shall furnish the item, system, or workmanship that is the highest quality, largest, or most closely fits the design intent.

3. Refer to the General Conditions of the Contract for further clarification of Design Intent.

4. The details and figures are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.

5. All sizes as given are minimum except as noted.

6. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to inspections, tests and approval from the commencement until the acceptance of the completed work.

7. Electrical requirements for equipment are based on design data. It shall be the responsibility of the Contractor to verify actual requirements with the provider of the equipment and adjust electrical installation based upon actual requirements.

E. Substitution of Materials:
1. Refer to General Conditions of the Contract.
2. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the specified performance from the system into which these items are placed.

F. Continuity of Existing Services and Systems:
1. The work described herein must be performed in stages to minimize interruptions to system operation.
2. No outages shall be permitted on existing systems except at the time and during the interval specified by the Owner and the Engineer. Any outage must be scheduled when the interruption causes the least interference with normal schedules and routines. No extra costs will be paid to the Contractor for such outages that must occur outside of regular weekly working hours.
3. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.

1.4 RELATED SECTIONS

A. Common Work Results for Electrical are applicable to all Division 26 sections.

B. Section 44 10 01 – Landfill Gas Blower/Flare System

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.
B. Submittal Requirements for Division 26 Shop Drawings:
1. Submit individual shop drawings for each section requiring submittal.
2. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.
3. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered or controlled equipment.
4. Clearly note any exceptions taken to these specifications.
5. Do not release equipment for construction until submittal has been reviewed.
6. Failure to comply with these requirements does not relieve the Contractor of responsibility for meeting the project schedule.

C. Review of shop drawings constitutes acceptance of general design only and will not release the Contractor for fulfilling the terms and intent of the contract documents.

D. Shop Drawings shall be prepared and submitted for the following work:
1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less)
2. Section 26 05 29 - Hangers and Supports for Electrical Systems
3. Section 26 05 34 - Conduit
4. Section 26 05 37 - Boxes
5. Section 26 90 00 - Process Instrumentation & Control

1.6 FACTORY TESTING

A. Refer to the requirements the individual technical sections.

1.7 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

B. Submittal Requirements for Division 26 Operation & Maintenance Manuals and Instructions:
1. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
   a. Copies of as-built submittals.
   b. Wiring diagrams for electrically powered or controlled equipment
   c. Records of tests performed to certify compliance with system requirements
   d. Certificates of inspection by regulatory agencies
   e. Parts lists for manufactured equipment
   f. Preventive maintenance recommendations
   g. Warranties
   h. Additional information as indicated in the technical specification sections
   i. Test Reports and Demonstration Log:
1) Permanently record checks and tests and demonstrations.
2) Submit copy of complete testing or demonstration report no later than 30 days after testing or demonstration is complete.

C. Operation & Maintenance Manuals and Instructions shall be prepared and submitted for the following equipment:
   1. Section 26 90 00 - Process Instrumentation & Control

1.8 QUALITY ASSURANCE

A. All work and materials shall conform to or exceed in every detail the applicable rules and requirements of the Wisconsin State Electrical Code Volumes 1 and 2, the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association standards, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

B. All work shall be performed under the direction of a State of Wisconsin Licensed Master Electrician.

C. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled.

D. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
   1. Underwriters Laboratories Inc.
   2. Electrical Testing Laboratories, Inc.

E. Certificates And Inspections:
   1. Refer to the General Conditions of the Contract.
   2. Obtain and pay for all required inspections including but not limited to state or local electrical inspections and fuel tank inspections. Deliver original inspection certificates to the Engineer.

1.9 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS

A. See Division 01 for additional requirements.
1.11 DESIGN REQUIREMENTS

A. The following table specifies the usage requirements for the hardware and equipment specified in the following sections:
   1. Section 26 05 29 Hangars and Supports for Electrical Systems
   2. Section 26 05 34 Conduit
   3. Section 26 05 37 Boxes

<table>
<thead>
<tr>
<th>ATMOSPHERE</th>
<th>CONSTRUCTION</th>
<th>CONDUIT</th>
<th>HARDWARE</th>
<th>JUNCTION BOX</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous, Corrosive, Wet or Dry, New Construction</td>
<td>Concealed or Exposed</td>
<td>RMCS</td>
<td>SS</td>
<td>N/A</td>
<td>NEMA 7</td>
</tr>
<tr>
<td>Underground, Wet New Construction</td>
<td>Buried, Concrete Encased or Direct</td>
<td>RMCCS</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>General, Dry Existing Construction</td>
<td>Exposed</td>
<td>RMCS</td>
<td>SS</td>
<td>NEMA 12</td>
<td></td>
</tr>
<tr>
<td>General, Damp Existing Construction</td>
<td>Exposed</td>
<td>RMCS</td>
<td>SS</td>
<td>NEMA 12</td>
<td></td>
</tr>
<tr>
<td>General, Wet Existing Construction</td>
<td>Exposed</td>
<td>RMCCS</td>
<td>SS</td>
<td>NEMA 4X</td>
<td></td>
</tr>
<tr>
<td>Hazardous, Corrosive, Wet or Dry, Existing Construction</td>
<td>Exposed</td>
<td>RMCCS</td>
<td>Cast, PVC Coated</td>
<td>NEMA 7</td>
<td></td>
</tr>
</tbody>
</table>

GENERAL NOTES:
1. Conduits which transition from underground to exterior, or from underground through concrete slab shall be RMCCS.

PART 2 - PRODUCTS

2.1 SEALING AND FIRE-STOPPING

A. Refer to Architectural requirements.

B. Sealing and fire stopping of sleeves/openings between conduits, cable trays, wire ways, troughs, cable bus, bus duct, etc. and the structural or partition opening shall be the responsibility of the Contractor whose work penetrates the opening. Individuals skilled in such work shall perform the sealing and fire stopping.
C. Whenever possible, avoid penetrations of fire and smoke rated partitions. When they cannot be avoided, verify that sufficient space is available for the penetration to be effectively fire and smoke stopped.

D. Manufacturers:
   1. 3M, STI/SpecSeal, Tremco, or approved equal.
   2. The same manufacturer shall provide all fire stopping systems.
   3. The Contractor will be responsible for selecting the appropriate UL tested fire stop system for each application required on the project.

E. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

F. Contractor shall use fire stop putty, caulk sealant, intumescent wrap strips, intumescent fire stop collars, fire stop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

2.2 NON-RATED PENETRATIONS

A. Conduit Penetrations Through Below Grade Walls:
   1. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or a water-stop type wall sleeve.

B. Conduit and Cable Tray Penetrations:
   1. At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections.

B. Field verify all measurements. Do not base electrical installation or equipment locations on the contract figures.

C. Identify conflicts with the work of other trades prior to installation of electrical system.
D. Electrical installation shall be based upon shop drawing requirements and field verified measurements. Adjust electrical system installation to satisfy field requirements.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Accept electrical equipment on site. Inspect for damage.

B. Protect electrical equipment from weather, corrosion, and entrance of debris.

3.3 INSTALLATION

A. Excavation And Backfill:
   1. Perform all excavation and backfill work to accomplish indicated electrical systems installation in a manner that will cause minimal disturbance to existing soils. Restore to existing condition after installation is complete.

C. Cutting And Patching:
   1. Cutting and patching shall be coordinated with owner. Restore surface to existing condition after work is complete.

D. Building Access:
   1. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

E. Equipment Access:
   1. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance.

F. Working Clearances:
   1. Minimum installed equipment working clearances as required by the NEC shall be maintained.
   2. Minimum required dedicated electrical equipment space as required by the NEC shall be maintained.
   3. Coordinate these requirements with the work of other trades.
   4. Identify conflicts with working space requirements prior to installation of equipment.

G. Coordination:
   1. Cooperate with owner in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Owner.
2. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panel boards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.

3. Coordinate all work prior to installation. Any installed work that is not coordinated and that interferes with the work of another trade shall be removed or relocated at no additional cost to the Owner.

4. Verify the integrity of fire or smoke ratings where penetrations are required.

H. Sleeves:
   1. Process Equipment Areas:
      b. All other construction: core drill sleeve openings large enough to insert Schedule 40 PVC sleeve and grout around the sleeve.
      c. Floor penetrations:
         1) Extend top of sleeve two inches above the floor.
         2) Where installation of sleeve in floor is not practical, provide two inch deep housekeeping pad extending three inches around cast in place conduits.
   2. Non-Process Equipment Areas:
      a. Hollow walls: Schedule 40, PVC sleeves, grout around sleeve in masonry construction.
      b. All other Areas: core drill sleeve openings large enough to insert Schedule 40 PVC sleeve and utilize the core drilled opening as the sleeve.
   3. Conduit Support:
      a. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to the floor structure.

I. Sealing and Firestopping:
   1. Fire and/or Smoke Penetrations:
      a. Install approved product in accordance with the manufacturer's instructions where a pipe (i.e. cable tray, bus, cable bus, conduit, wire way, trough, etc.) penetrates a fire rated surface.
      b. Where fire stop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Fire stop mortar alone is not adequate to support any substantial weight.
   2. Non-Rated Surfaces:
      a. When the opening is through a non-fire rated wall, floor, ceiling or roof the opening must be sealed using an approved type of material.
      b. Install escutcheons or floor/ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces for this paragraph include only those rooms with finished ceilings and the penetration occurs below the ceiling.
      c. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions.
d. At interior partitions, conduit penetrations are required to be sealed for all areas. Apply sealant to both sides of the penetration in such a manner that the annular space between the conduit sleeve and the conduit is completely filled.

J. Housekeeping and Clean-up
1. On a daily basis, clean up and remove all debris and rubbish resulting from work and repair all damage to new and existing equipment resulting from work.
2. Remove all tools, excess material, and unused equipment from the site when job is complete.

K. General Inspection and Cleaning of Electrical Equipment
1. Inspect for physical damage and abnormal mechanical or electrical conditions.
2. Any item found to be out of tolerance, or in any other way defective as a result of the required testing, shall be reported to the Engineer. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.
3. Compare equipment nameplate information with the Contract Drawings and report any discrepancies.
4. Verify proper auxiliary device operation and indicators.
5. Check tightness of accessible bolted electrical joints. Use torque wrench method.
6. Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.
7. Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.
8. Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, horizontal and vertical busducts, MCC's, control panels, and any other similar equipment
9. Clean All Equipment:
   a. Loosen attached particles and vacuum them away.
   b. Remove any remaining packing material adhesives with suitable cleaning solution.
   c. Touch-up factory applied finishes damaged during installation using manufacturer approved means to match original finish.

3.4 TESTING AND START-UP SERVICES
A. Refer to the requirements the individual technical sections.

3.5 TRAINING
A. Refer to the requirements the individual technical sections.

END OF SECTION
SECTION 26 05 01

MINOR ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.


1.3 DESCRIPTION OF WORK

A. Furnish labor and materials to demolish and remodel existing electrical systems as indicated on the figures and as specified herein

B. Design Intent:

1. Every effort has been made to identify major demolition and remodeling work required as part of this project. There may, however be minor work items not specifically identified for demolition or remodeling.

2. The Contractor shall thoroughly review the figures and shall include work associated with demolition and remodeling of minor items such as receptacles, exit lights, and control stations affected by the work shown on the demolition figures.

3. Because of the demolition and remodeling work required as part of this project, the Contractor is required to investigate the extent of work on site prior to bidding. Failure to perform this investigation will not relieve the Contractor of responsibility for demolition and remodeling of the minor work items described.

C. Construction Methods:

1. Where detailed construction methods are identified for demolition and remodeling of electrical equipment (for example, methods for implementing service change), it is not intended that the methods proposed be the only acceptable methods for completing the work. The Contractor is encouraged to investigate and propose alternate methods which simplify the work.

2. Alternate methods shall be reviewed by the Engineer prior to commencing the...
3. Only alternate methods which adequately accomplish the goals of the specified methods will be allowed.

1.4 RELATED SECTIONS – NOT USED

1.5 SUBMITTALS - NOT USED

1.6 FACTORY TESTING - NOT USED

1.7 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS- NOT USED

1.8 QUALITY ASSURANCE

A. All materials and labor required under this section shall be compatible with existing equipment and conditions.

PART 2 - PRODUCTS - NOT USED

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base electrical installation or equipment locations on the contract figures.

B. Verify all circuiting arrangements

C. Verify that abandoned wiring and equipment serve only abandoned facilities.

D. Figures are based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.

E. The Contractor shall review figures and existing conditions for the extent of demolition work required.

F. Commencement of demolition work indicates that Contractor accepts existing conditions and fully comprehends the extent of demolition work.

3.2 PREPARATION

A. Identify existing electrical equipment which is to be removed.

B. Identify existing electrical equipment which is to remain but will be affected by demolition or new construction work.
C. Identify existing equipment which is to be removed and which the Owner wishes to retain. Owner shall have first right to all removed equipment not specifically being reused. If Owner retains equipment, Contractor shall transport to designated storage facility located on site. If Owner refuses equipment, Contractor shall be responsible for disposal.

D. Identify damaged or inoperable existing equipment prior to performing work.

E. Maintain access to existing electrical installations, which are to remain active.

F. Utilize materials and methods compatible with existing electrical installations. Verify existing requirements for compatibility.

3.4 GENERAL DEMOLITION OF ELECTRICAL WORK

A. Demolition of Electrical Work, Structure Modified:
   1. This paragraph defines requirements for electrical demolition where the surfaces or areas containing the work are to be removed.
      a. Disconnect electrical equipment which is to be removed.
      b. Remove surface mounted and free-standing electrical equipment.
      c. Remove existing wiring to source of supply.
      d. Remove surface mounted conduits and raceways.
      e. Disconnect concealed conduits from equipment which is to remain.
      f. Concealed conduits may be removed with structure which is to be removed.
      g. Transport Owner retained equipment to on-site location as directed by Owner.
      h. Dispose of all other removed equipment.

B. Demolition of Electrical Work, Structure Not Modified:
   1. This paragraph defines requirements for electrical demolition where the surfaces or areas containing the work are to remain.
      a. Disconnect electrical equipment which is to be removed.
      b. Remove surface mounted and free-standing electrical equipment.
      c. Remove existing wiring to source of supply.
      d. Remove surface mounted conduits and raceways.
      e. Concealed conduit which is abandoned shall be cut flush with walls and floors. Patch surfaces to match existing finish.
      f. Transport Owner retained equipment to on-site location as directed by Owner.
      g. Dispose of all other removed equipment.

3.5 GENERAL REMODELING OF ELECTRICAL WORK

A. Reconnection of Electrical Equipment
   1. This paragraph defines requirements for electrical remodeling where the conduit and/or conductors connecting existing equipment must be replaced because of remodeling work in the area.
      a. Thoroughly investigate existing wiring and conduit to determine requirements for reconnection.
b. Provide temporary wiring and connections to maintain existing systems in service during construction. Minimize and coordinate necessary outages with the Owner. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Complete Hot Work Permit.

c. Install new conduit and/or wiring as indicated to maintain existing operational characteristics or to provide new operational characteristics.

d. Demolish abandoned conduit and wiring as described above.

e. Remove temporary work upon completion of the permanent work.

B. Relocation of Electrical Equipment

1. This paragraph defines requirements for electrical remodeling where the existing equipment must be removed and re-installed in a new location and new conduit and conductors must be provided to reconnect the equipment.

   a. Thoroughly investigate existing wiring and conduit to determine requirements for reconnection.

   b. Provide temporary wiring and connections to maintain existing systems in service during construction. Minimize and coordinate necessary outages with the Owner. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Complete Hot Work Permit.

   c. Remove equipment which is to be relocated.

   d. Install equipment in designated new location.

   e. Install new conduit and wiring as indicated to maintain existing operational characteristics or to provide new operational characteristics.

   f. Demolish abandoned conduit and wiring as described above.

   g. Remove temporary work upon completion of the permanent work.

3.6 CLEANING, PATCHING, AND REPAIR

A. Repair existing construction and finishes damaged during demolition and remodeling work. Refer to architectural specifications for patching requirements. Any damaged construction shall be repaired to match the finished, surrounding surfaces.

B. Clean and repair existing materials and equipment, which remain or are to be reused.

C. Clean exposed surfaces and check tightness of electrical connections.

D. Replace electrical equipment damaged during construction.

E. Remove construction debris from all electrical enclosures.

END OF SECTION
SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.


2. ASTM International, originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
   b. ASTM B801-99 Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation


   d. U.L. 514B - Conduit, Tubing, and Cable Fittings.
   e. U.L. 758 - 105 degree C Appliance Wiring Materials.
   h. U.L. 1277 - Type TC Power and Control Tray Cables.
   i. U.L. 1569 - Metal-Clad Cables
   j. UL 1581 - Vertical Tray.

1.3 DESCRIPTION OF WORK

A. Furnish and install complete and operable wire and cable systems as indicated on the figures and as specified herein.
1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. The following information shall be submitted specifically for wire and cable:
   1. Literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Clearly identify the types of wire and cable proposed.

1.5 QUALITY ASSURANCE

A. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

B. Wire and cable manufacturers shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development and production in accordance with ISO 9001.

C. All materials, equipment, and parts shall be new and unused of current manufacture.

D. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE - GENERAL PURPOSE (600V, COPPER)

A. Manufacturer: Contractor option.

B. General:
   1. THWN/THHN general purpose building wire insulated with polyvinyl chloride (PVC) and covered with protective sheath of nylon intended for lighting and power circuits at 600 volts or less, in residential, commercial and industrial buildings.
   2. The wire shall be suitable for 90 degree C maximum continuous conductor temperature in dry locations and 75 degree C in wet locations and listed by Underwriters Laboratories for use in accordance with the National Electrical Code.

C. Conductors:
   1. Class B or Class C stranded, annealed uncoated copper per UL Standard 83 or 1063.
D. Insulation:
   1. Each conductor shall be insulated with PVC and sheathed with nylon complying with the requirements of UL Standard 83 for Types THHN/THWN and UL Standard 1063 for Type MTW and CSA C22.2 No. 75 for T90 Nylon.
   2. Types THWN/THHN shall comply with the optional Gasoline and Oil Resistant rating of UL Standard 83. The insulation shall also comply with UL requirements for 105 degree C Appliance Wiring Material.
   3. The average thickness of PVC insulation, for a given conductor size, shall be as specified in UL Standard 83 for Types THWN or THHN. The minimum thickness at any point, of the PVC insulation, shall be not less than 90 percent of the specified average thickness.
   4. The minimum thickness at any point of the nylon sheath shall be as specified in UL Standard 83 for Types THWN or THHN.
   5. The PVC insulation shall be applied tightly to the conductor and shall be free-stripping.

E. Identification:
   1. The wire shall be identified by surface marking indicating manufacturer's identification, conductor size and metal, voltage rating, UL Symbol, type designations and optional ratings. The wire shall also be identified as C(UL) Type T90 Nylon or TWN75, FT1.

F. Tests:
   1. Wire shall be tested in accordance with the requirements of UL Standard 83 for Types THWN or THHN wire and for the optional Gasoline and Oil Resistant listings; as Type MTW to UL Standard 1063 (stranded items); as AWM to UL Standard 758 (stranded items); and as C(UL) Type T90 Nylon or TWN75.

G. Usage:
   1. General use power wiring, minimum size No.12 AWG.
   2. General use control wiring, minimum size No.14 AWG.

2.2 SHIELDED POWER CABLE (600V)

A. Manufacturer: Contractor’s option.

B. General:
   1. Three conductor type TC Tray Cable insulated with cross linked polyethylene and PVC jacket overall, for use on circuits rated 600 volts and 90 degree C maximum continuous conductor temperature in wet or dry locations.
   2. Cables approved for installation in cable trays in accordance with the NEC and for installation in air, in ducts or conduits, in tray or trough, in open wiring or direct buried.
C. Conductors:
1. Shall be Class B stranded uncoated soft copper.
2. Suitable separator over the conductor may be used at the option of the manufacturer.
3. Three phase conductors shall be cabled together with a Class B stranded, uncoated copper grounding conductor and suitable non-hygroscopic fillers to make round.
4. Length of lay shall not exceed 35 times the phase conductor diameter.
5. The grounding conductor shall comply with the requirements of UL Standard 1277.
6. The cable assembly shall be covered with a copper tape shield with drain wire, applied with a 10 percent minimum lap.

D. Insulation:
1. Each phase conductor shall be insulated with chemically cross linked polyethylene, meeting Type XHHW-2 requirements of Underwriters Laboratories.
2. The average thickness of insulation shall be as specified in UL Standard 44 for Type XHHW-2 conductors. The minimum thickness at any point shall be not less than 90 percent of the specified average thickness.
3. The insulated phase conductors shall be black in color and shall be printed with the numerals "1", "2", and "3" on their surface.
4. Each cable shall have a PVC protective jacket applied over the taped assembly. The jacket shall meet the Sunlight Resistant requirements of UL Standard 1277.
5. The average jacket thickness shall be in accordance with UL Standard 1277. The minimum thickness at any point shall be not less than 80 percent of the specified average thickness.

E. Identification:
1. Cables shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and required UL information.

F. Tests:
1. Individual conductors and completed cables shall be tested in accordance with UL requirements for Type TC Power Control Tray Cables having XHHW-2 conductors.
2. Cables shall be capable of passing the ribbon burner cable tray flame test requirements of UL and IEEE.

G. Usage:
1. Power wiring for motor loads controlled by adjustable frequency drives.

2.3 SHIELDED INSTRUMENTATION CABLE (300V)

A. Manufacturer: CONTRACTOR option.
B. General:
1. Power limited tray cable - two conductor, No.16 AWG (7x24) bare copper, PVC insulation, overall shield with No.18 AWG (7x26) tinned copper drain wire, PVC jacket with nylon ripcord.

C. Electrical Characteristics:
2. Conductor DC resistance at 20 deg. C: 3.7 Ohms/1000 ft.
3. Shield DC resistance at 20 degrees C: 5.1 Ohms/1000 ft.
4. Capacitance between conductors at 1 kHz: 61 pF/ft.
5. Capacitance between conductor and shield at 1 kHz: 114 pF/ft.
6. Inductance: 0.19 uH/ft.

D. Physical Characteristics:
1. Temperature rating: -30 to 105 degrees C.
2. Insulation material: PVC.
3. Average insulation thickness: 0.016-in.
4. Jacket material: Sun resistant PVC.
5. Jacket thickness: 0.037-in. nominal.
6. Shield: Aluminum/Polyester, 100 percent coverage.
7. Overall lay length: 2-in. (6 twists/ft).
8. Maximum pulling tension: 94 lbs.
9. Minimum bend radius: 2.6-in.

E. Usage:
1. Instrumentation cable.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base electrical installation or equipment locations on the contract figures.

B. Identify conflicts with the work of other trades prior to installation of electrical system.

C. Adjust electrical system installation to satisfy field requirements.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Accept electrical equipment on site. Inspect for damage.

B. Protect electrical equipment from weather, corrosion, and entrance of debris.
3.3 INSTALLATION

A. Pre-Installation:
1. Verify that interior of building has been protected from weather.
2. Verify that mechanical work likely to damage wire has been completed.
3. Completely and thoroughly swab raceway prior to installation.
4. Verify field measurements.
5. Wire and cable routing shown on figures is approximate unless dimensioned. Route wire and cable to satisfy project conditions.
6. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.
7. Determine required separation between cable and other work.
8. Determine cable routing to avoid interference with other work.
9. Any single conduit or raceway utilized for a feeder circuit shall contain only power conductors of a single feeder circuit. Do not combine feeder circuits without engineer's written approval.
10. Contractor may combine branch circuits of common types in single conduits provided the following conditions are met:
   a. NEC requirements for conductor de-rating are satisfied.
   b. Conduit fill does not exceed thirty percent. Ten percent fill shall be reserved for future use.
11. No more than eight 24VDC analog circuits may be combined in a single conduit unless specifically stated otherwise on the figures.

B. Conductor Sizing:
1. Conductor sizes are based on copper unless otherwise noted.
2. Use conductor not smaller than No.12 AWG for power and lighting circuits.
3. Use No.10 AWG conductors for 20 ampere, 120-volt branch circuits longer than 75 feet.
4. Where circuit wiring length exceeds length identified on the feeder schedule, increase wire size as needed to maintain a maximum voltage drop of three percent.
5. Use conductor not smaller than No.14 AWG for control circuits.
6. Unless shown otherwise on the contract figures, power wiring shall be No.12 AWG. Contractor shall determine appropriate wire size based on actual loading.

C. Wire Pulling:
1. Pull all conductors into raceway at same time.
2. No.4 AWG and larger wire and power cables shall lubricated with pulling lubricant to reduce pulling tension and abrasion damage. The lubricant shall be water or wax based containing no oils or greases that may adversely affect cable jackets.
3. The minimum bend radius and maximum pulling tension ratings of the wire and cable shall not be exceeded.
D. Splices and Terminations:
1. Splices and terminations shall not be made within raceways.
2. Clean conductor surfaces before splicing or terminating.
3. Make splices, taps, and terminations to carry full amp capacity of conductors with no perceptible temperature rise.
4. Insulated spring wire connectors may be used to splice 120V power circuits.
5. Control, communication, and data transmission wire and cable shall not be spliced.
6. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
7. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
8. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

E. Motors:
1. Motor wiring to motors less than 10 horsepower shall be spliced and terminated with fully insulated crimp-on end cap with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. “SkotchLocks” and similar devices shall not be used.
2. Motor wiring to motors 10 horsepower or larger shall be spliced and terminated with crimp-on ring terminal lugs, brass nuts, bolts and washers with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. “SkotchLocks” and similar devices shall not be used.

F. Unshielded power cables:
1. Unshielded power cables shall be spliced and terminated with crimp-on ring terminal lugs, brass nuts, bolts and washers with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. “SkotchLocks” and similar devices shall not be used.

3.4 TESTING AND START-UP SERVICES

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer’s recommended values.

C. Verify continuity of each conductor.

D. Feeder or branch circuits with ampacity greater than 100 amperes shall be tested after installation to measure insulation resistance of each conductor.

E. All equipment shall be disconnected and the wire ends shall be cleaned and dried.
F. Connect Megohmeter between conductor and a grounded point in the enclosure and energize until the reading stabilizes.

END OF SECTION
SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.


5. Institute of Electrical and Electronics Engineers (IEEE), Specifications and Standards, current edition:

1.3 DESCRIPTION OF WORK

A. Furnish and install complete and operable grounding and bonding systems as indicated on the figures and as specified herein.

1.4 QUALITY ASSURANCE

A. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms. Additional grounding electrodes shall be used to satisfy ground resistance requirements where required by earth conditions.
PART 2 - PRODUCTS

2.1 ROD ELECTRODE

A. Material: Copper-clad steel.

B. Diameter: 3/4-inch minimum.

C. Length: 10-feet minimum. Rod shall be driven at least 9.5-feet deep.

D. Use one or more ground rods to obtain the minimum specified ground resistance. This applies to manholes, pad-mount switches, transformers, service entrances, and all other equipment requiring a supplemental grounding electrode. Minimum of three ground rods shall be used to ground the service entrance as indicated on plans.

2.2 MECHANICAL CONNECTORS

A. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two bolt type.

B. Split bolt connector types are not allowed.

C. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

2.3 COMPRESSION CONNECTORS

A. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99 percent.

B. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

C. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.

D. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

E. Each connector shall be factory filled with an oxide-inhibiting compound.
2.4 EXOTHERMIC CONNECTIONS

A. Select the appropriate kit for specific types, sizes, and combinations of conductors and other items to be connected. Field personnel shall be trained in execution of welds.

2.5 WIRE

A. Material: Stranded copper (aluminum not permitted).

B. Grounding Electrode Conductor: Size as shown in specifications or as required by NFPA 70, whichever is larger.

C. Manhole and Vault Bonding: No. 4/0 minimum.

D. Feeder and Branch Circuit Equipment Ground: Size as shown in specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base electrical installation or equipment locations on the contract figures.

B. Identify conflicts with the work of other trades prior to installation of electrical system.

C. Adjust electrical system installation to satisfy field requirements.

3.2 INSTALLATION

A. General:
1. Verify that final backfill and compaction has been completed before driving rod electrodes.
2. Install products in accordance with manufacturer instructions.
3. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
4. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.
5. Attach grounds permanently before permanent building service is energized.
6. Install rod electrodes at locations indicated or as required by local code, whichever requires the most rods. Install additional rod electrodes as required to achieve specified resistance to ground.
7. Connect grounding electrode conductor and reinforcing steel in foundation footing. Bond steel together.
8. Bond all conductive components to meet Regulatory Requirements.
9. Bond together metal siding not attached to grounded structure; bond to ground.
10. All separate ground wires shall be enclosed in rigid galvanized steel conduit and bonded at both ends to the rigid galvanized steel conduit with an approved fitting.

B. Less than 600 volt system grounding:
1. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.
2. Copper grounding electrode conductor shall be sized as indicated or as required by NEC, whichever is larger and shall be extended from secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes. Bonding jumper shall be installed around water meter. Install conductor in separate rigid conduit. Bond conduit as described above.
3. Receptacle Grounding: All receptacles installed shall have a separate grounding contact.
4. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
5. Bond together each metallic raceway, pipe, duct and other metal objects.
6. Equipment Grounding Conductor: Separate, insulated green conductor shall be installed within each raceway and cable tray, sized per NEC or as indicated in the contract documents whichever is larger. Terminate each end on suitable lug, bus, enclosure or bushing, per NEC. Install a ground wire from each device to the respective enclosure.

3.3 TESTING AND START-UP SERVICES

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION
PART 1    GENERAL

1.1    APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2    APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
      a. ASTM A653 - General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process.
      b. ASTM A1011 - Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low Alloy with Improved Formability (Formerly ASTM A570).
      b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).

1.3    DESCRIPTION OF WORK

A. Furnish and install supporting devices as indicated on the figures, scheduled in Section 26 05 00, and as specified herein.
1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. The following information shall be submitted specifically for supporting devices:
   1. Submit outline drawings and dimensions for equipment support racks.

1.5 QUALITY ASSURANCE

A. Bolted framing channels and fittings shall have the manufacturer’s name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

B. Stainless steel bolted framing parts shall be stamped to identify the material. Material certification sheets and test reports must be made available by the manufacturer upon request.

C. All materials, equipment, and parts shall be new and unused of current manufacture.

D. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

PART 2 PRODUCTS

2.1 STRUT, CHANNELS, AND CONNECTORS

A. Manufacturers:
   1. Cooper B-Line, Inc.
   2. or equal.

B. General:
   1. Strut shall be 1-5/8-inches wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the figures.

C. Materials and Finish:
   1. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633 (SC3 for fittings, SC1 for threaded hardware) for indoor use only. For outdoor use, all fittings and hardware shall be stainless steel Type 304.
   2. Hot-dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 304 or chromium zinc ASTM
F1136 Gr. 3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.

3. Stainless Steel: All struts, fittings and hardware shall be made of AISI Type 304 stainless steel.

2.2 ANCHORS AND FASTENERS

A. Concrete and Structural Elements: Use stainless steel precast insert system, expansion anchors and preset inserts.

B. Steel Structural Elements: Use stainless steel beam clamps.

C. Concrete Surfaces: Use stainless steel self-drilling anchors and expansion anchors.

D. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.

E. Solid Masonry Walls: Use stainless steel expansion anchors and preset inserts.

F. Sheet Metal: Use stainless steel sheet metal screws.

G. Wood: Use stainless steel wood screws.

H. All other fasteners: stainless steel screws, suitable for the required usage.

2.3 HARDWARE

A. Conduit and equipment supports, clamps, and other miscellaneous materials shall be constructed of the following materials as scheduled in Section 26 05 00.
   1. Steel.
   2. Zinc plated steel.
   3. Galvanized, malleable iron.
   4. PVC coated galvanized, malleable iron.
   5. Stainless steel.
   6. PVC.

PART 3 CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base locations and dimensions on the contract figures.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.
C. Adjust equipment support rack installation to satisfy field requirements.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Accept supporting devices on site. Inspect for damage.

B. Protect supporting devices from corrosion and damage. Do not install damaged materials.

3.3 INSTALLATION

A. General:
1. Furnish and install supports and fasteners for all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.
2. Thoroughly clean and remove construction debris from installation.

B. Strut Channel:
1. Install strut in accordance with MFMA-102 "Guidelines for the Use of Metal Framing"; in accordance with equipment manufacturer's recommendations, and with recognized industry practices.
2. Fabricate supports from channel. Rigidly weld members or use hexagon head bolts to present a neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
3. File and de-bur cut ends of galvanized support channel and spray paint with cold galvanized paint to prevent rusting.
4. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

C. Anchors and Fasteners:
1. Provide anchors, fasteners, and supports in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting".
2. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.
3. Do not use spring steel clips and anchors.
4. Do not use powder-actuated anchors.
5. Obtain permission from Engineer before drilling or cutting structural members.
6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
7. Use channel supports to stand cabinets and panelboards 1-5/8-inch off interior or exterior surfaces of exterior walls.
8. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using anchors and fasteners.
9. Install free-standing electrical equipment on 3-inch concrete pads unless indicated otherwise on the figures.
10. Use threaded rod, minimum size 3/8-inch, for supports where indicated on the figures, unless indicated otherwise.
11. Install products in accordance with manufacturer instructions.

END OF SECTION
SECTION 26 05 34

CONDUIT

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

   a. ANSI C80.1 - Electrical Rigid Steel Conduit (ERSC).
   b. ANSI C80.3 - Steel Electrical Metallic Tubing (EMT).
   c. ANSI C80.5 - Electrical Rigid Aluminum Conduit (ERAC).
   d. NFPA 70 - National Electrical Code.

   a. ASTM F2160 - Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter.
   b. ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
   c. ASTM D3035 - Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
   d. ASTM D3350 - Polyethylene Plastics Pipe and Fittings Materials.

   b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).

   a. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association.
   b. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association.
   c. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit; National Electrical Manufacturers Association.
   d. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association.
   e. NEMA TC 7 - Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.
   a. UL 1 - Standard for Flexible Metal Conduit
   b. UL 6 - Electrical Rigid Metal Conduit - Steel.
   c. UL 6A - Standard for Electrical Rigid Metal Conduit - Aluminum and Stainless Steel.
   d. UL 651A Type EB and A Rigid PVC Conduit and HDPE conduit.
   e. UL 651B Continuous Length HDPE.
   f. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit.
   g. UL 2239 - Standard for Safety for Hardware for the Support of Conduit, Tubing, and Cable.

1.3 DESCRIPTION OF WORK

A. Furnish and install complete and operable conduit system as indicated on the figures, scheduled in Section 26 05 00, and as specified herein.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit the following information specifically for conduit:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Clearly identify the types of conduit and fittings proposed.

1.5 FACTORY TESTING - NOT USED

1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS- NOT USED

1.7 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 WARRANTY

A. See Division 01 for additional requirements.
1.9 EXTRA MATERIALS

A. See Division 01 for additional requirements.

PART 2 - PRODUCTS

2.1 GALVANIZED RIGID METAL CONDUIT (TYPE RMCS)

A. Manufacturer: Contractor option.

B. Conduit:
   1. Impact and crush resistant mild steel tube with an accurate circular cross section, a uniform wall thickness, a defect free interior surface, and a continuous welded seam.
   2. Interior and exterior surfaces thoroughly and evenly coated with zinc using the hot-dip galvanizing process.
   3. Top-coated with a compatible organic layer to inhibit white rust and increase corrosion resistance.
   4. Factory cut threads, 0.75-inch taper per foot, protected after cutting with an application of molten zinc.

C. Conduit Bodies:
   1. Ferrous metal construction electro-galvanized inside and out and coated with aluminum acrylic paint.
   2. Tapered, threaded hubs with integral bushing.
   3. Stainless steel hardware.
   4. Cover constructed of same material with solid gasket.

D. Fittings:
   1. Ferrous metal construction electro-galvanized inside and out.
   2. Components critical to performance such as set screws, split rings, and locknuts constructed of hardened steel or adequately designed to insure positive bonds.

2.2 PVC COATED GALVANIZED RIGID METAL CONDUIT (TYPE RMCCS)

A. Manufacturer:
   1. Perma-Cote Industries.
   2. Robroy.
   3. Or equal.

B. General:
   1. Conduit shall be UL Listed and the coating shall have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit.
   2. Independent certified test results shall be available to confirm coating adhesion under the following conditions:
3. Conduit immersed in boiling water with a minimum mean time to adhesion failure of 200 hours.
4. Conduit and condulet exposure to 150 degrees F and 95 percent relative humidity with a minimum mean time to failure of 30 days.
5. No trace of internal coating shall be visible on a white cloth following six wipes over the coating that has been wetted with acetone.
6. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

C. Conduit:
1. Impact and crush resistant mild steel tube with an accurate circular cross section, a uniform wall thickness, and a defect free interior surface, and a continuous welded seam.
2. Interior and exterior surfaces thoroughly and evenly coated with zinc using the hot-dip galvanizing process.
3. Factory cut threads, 0.75-inch taper per foot, protected after cutting with an application of molten zinc.
4. Coating:
   a. External: PVC, 40 mils nominal, free of blisters, bubbles, and pinholes.
   b. Internal: Urethane, 2 mils minimum.
5. Threaded connections:
   a. Factory threads: factory coated.
   b. Field threads: protected by coating sleeve extension on female fitting. Sleeve extension shall be equivalent in length to the nominal conduit size and the inside diameter less than the outside diameter of the coated conduit.
6. Strength:
   a. Coating bond to conduit shall be stronger than tensile strength of coating. Field cut, thread, and bent conduit shall not damage conduit.

D. Conduit Bodies:
1. Ferrous metal construction electro-galvanized inside and out and PVC coated to match the conduit.
2. Tapered, threaded hubs with integral bushing.
3. Stainless steel or encapsulated stainless steel hardware.
4. PVC coated cover constructed of same material with solid tongue-in-groove gasket.

E. Fittings:
1. Ferrous metal construction electro-galvanized inside and out and PVC coated to match conduit.

2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (TYPE LMFC)
A. Manufacturer: Contractor option.
20B029.10 Landfill Gas Blower and Flare System Replacement
Brown County Port & Resource Recovery Department

B. Usage:
1. Use in conjunction with galvanized rigid metal conduit.
2. Use in conjunction with PVC coated galvanized rigid metal conduit.
3. Use in conjunction with rigid aluminum conduit.

C. Conduit:
1. Single strip, helically wound, galvanized steel core inside and outside with smooth interior surface with sunlight resistant thermoplastic jacket suitable for ambient environmental conditions conforming to applicable UL Standards.
2. Jacket shall be positively locked to core to prevent sleeving.
3. All runs of flexible conduit shall be as short as practicable, of the same size as the conduit it extends and with enough slack to reduce the effects of expansion and vibration.

D. Fittings:
1. Where used in conjunction with galvanized rigid metal conduit, connectors shall be malleable iron or steel, electro zinc plated, with insulated throat and taper threaded hub.
2. Where used in conjunction with PVC coated galvanized rigid metal or rigid aluminum conduit connectors shall be malleable iron or steel, electro zinc plated and PVC coated, with insulated throat and taper threaded hub.
3. Particular attention shall be given to maintaining ground bond and firm support through flexible connections.
4. All fittings shall be liquid tight.

2.7 LIQUIDTIGHT HAZARDOUS LOCATION FLEXIBLE CONDUIT (STAINLESS STEEL BRAID)

A. Manufacturer:
2. Or equal.

B. Usage:
1. Use for all non-intrinsically safe, hazardous location installations.

C. Conduit:
1. Conduit shall have an insulating wire duct with smooth inner surface inside a flexible brass inner core. Packing material shall be woven cotton impregnated with asphalt.
2. Flexible portion of coupling shall be covered with stainless steel braid.
3. Conduit shall bear U.L. label indicating suitability for use in hazardous location as necessary.

D. Fittings:
1. Integral stainless steel end fittings shall be included with coupling.
2. Coupling shall be available with two threaded male end fittings or one female union and one threaded male end fitting.
3. Particular attention shall be given to maintaining ground bond and firm support through flexible connections.
4. All fittings shall be liquid tight.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections. Conduit rough-in shall be based upon shop drawing requirements.

B. The Contractor shall be responsible for coordinating conduit location and rough-in with actual equipment conditions and requirements.

C. Field verify all measurements. Do not base conduit rough-in or equipment locations on the contract figures.

D. Identify conflicts with the work of other trades prior to installation of electrical equipment and conduit work.

E. Adjust conduit system installation to satisfy field requirements.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Accept conduit on site. Inspect for damage.

B. Protect conduit from corrosion and entrance of debris.

C. Store conduit above grade. Protect from environment with suitable covering.

D. Protect PVC and PVC coated conduit from sunlight.

3.3 INSTALLATION

A. General:
   1. Install conduit in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting", all requirements of the NEC, and manufacturer recommended practices.
   2. Arrange conduit to maintain headroom and present neat appearance.
   3. Design raceway systems to minimize the number of fittings, couplings, kicks, and offsets.
   4. Raceways located above lowest floor level, if necessary:
      a. Route conduit parallel and perpendicular to walls.
b. All raceways shall be level and straight.
c. Vertical conduits shall be plumb.

5. Raceways located in or under lowest level floor:
a. Route conduit in and under slab from point-to-point.
b. Do not cross conduits in slab.

6. Do not use flexible conduit in place of bends, conduit bodies, or expansion fittings.

7. Flexible conduit shall be used at all equipment terminations. Maximum length of 24-inches unless specifically allowed otherwise by Engineer based upon field conditions.

8. Do not use cords for equipment connections unless specifically allowed otherwise by Engineer based upon field conditions.

B. Raceway sizing:
1. Size raceways as indicated on figures.
2. Where raceways sizes are not indicated on figures, size in accordance with NEC requirements. Minimum size 3/4-inch.
3. Exposed conduit runs not longer than 10-feet in length and terminating at a single device may be 1/2-inch unless prohibited by NEC.

C. Raceway Installation:
1. Maintain adequate clearance between conduit and piping.
2. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.
3. Cut conduit square using saw or pipe cutter; de-burr cut ends.
4. Bring conduit to shoulder of fittings; fasten securely.
5. Use conduit hubs to fasten conduit to NEMA 4X and NEMA 12 boxes.
6. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic factory elbows for bends in metal conduit larger than 2-inch size.
7. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
8. Suitable pull string shall be installed in each empty conduit, sleeves and nipples excepted.
9. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
10. Remove all debris and moisture from raceways prior to installing conductors.
12. Identify conduit under provisions of Section 26 05 53.
13. Install plastic coated conduit in accordance with manufacturer's instructions. All 90 degree bends shall be manufactured elbows. Touch-up PVC coating after installation.
14. All field cut threads shall be coated with Thomas & Betts Kopr-Shield prior to assembly.
D. Structural Coordination:
1. Suitable fittings, designed and listed for the purpose, shall be used to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
2. Install conduit to preserve fire resistance rating of partitions and other elements.
3. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
4. Where conduit passes between areas subject to variable temperatures, seal conduits to prevent air interchange and condensation formation. Use conduit fitting specifically manufactured for this purpose.

E. Raceway Support:
1. General:
   a. Arrange supports to prevent misalignment during wiring installation.
   b. Do not permanently support conduit with wire or perforated pipe straps.
   c. Remove wire used for temporary supports.
   d. Do not attach conduit to ceiling support wires.
   e. Channel, rod, and hardware shall comply with the requirements of Section 26 05 29.
2. Hardware:
   a. Construct conduit support rack with channel and rod to support conduits not supported from structure.
   b. Support conduit with channel anchored to structure when conduit offset from structure is required.
   c. Secure conduits to channel with pipe straps.
   d. Support conduit from structure when conduit offset from structure is not required.
   e. Secure conduits directly to structure with one-hole strap and conduit spacer.

F. Conduit Separation:
1. Separate conduit systems shall be used for the following circuit categories:
   a. 120-volt power circuits.
   b. 480-volt power circuits.
   c. 120-volt control circuits.
   d. 24 VDC analog control circuits.
   e. Intrinsically safe control circuits.
   f. UTP control cables.
   g. Manufacturer supplied cables (for example, magnetic flow meter cables).
   h. Radio frequency coaxial cables (for example, antenna cables).
2. The Contractor may combine circuits of common types (as identified above) into single conduits provided the following conditions are met:
   a. NEC requirements for conductor de-rating are satisfied.
   b. Conduit fill does not exceed thirty percent. Ten percent fill shall be reserved for future use.
   c. No more than eight 24VDC analog circuits are combined in a single conduit, unless specifically stated otherwise on the figures.

END OF SECTION
SECTION 26 05 37

BOXES

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
2. National Electrical Contractors Association (NECA), current edition:
   b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
3. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
   a. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association.
   b. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   c. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 DESCRIPTION OF WORK

A. Furnish and install complete and operable box systems as indicated on the figures, scheduled in Section 26 05 00, and as specified herein.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit the following information specifically for boxes:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Clearly identify the types of boxes proposed.
1.5 FACTORY TESTING - NOT USED

1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS- NOT USED

1.7 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 WARRANTY

A. See Division 01 for additional requirements.

1.9 EXTRA MATERIALS

A. See Division 01 for additional requirements.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes:
   1. Galvanized steel, with stamped knockouts.
   2. Gangable, suitable for number of devices shown.
   3. Suitable for flush mounting with drywall, FRP panel, masonry block, and poured concrete wall and ceiling finishes.

B. Luminaire and Equipment Supporting Boxes:
   1. Rated for weight of equipment supported; include 3/8-inch male fixture studs where required.

C. Cast Boxes:
   1. Cast ferralloy or aluminum, deep type, gasketed cover, threaded hubs.
   2. Suitable for surface or flush mounting with drywall, FRP panel, masonry block, and poured concrete wall and ceiling finishes.

D. PVC Coated Cast Boxes:
   1. PVC coated cast ferralloy, deep type, gasketed cover, threaded hubs.
2. Suitable for surface mounting with drywall, FRP panel, masonry block, and poured concrete wall and ceiling finishes.
3. Of the same manufacturer as the associated PVC coated conduit.

2.2 PULL AND JUNCTION BOXES

A. General:
1. Pull boxes and junction boxes shall be minimum 4 inch square (100 mm) by 2 1/8th inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4 11/16 inch square (117 mm).
2. For telecommunication, fiber optic, security, and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on telecommunication, security, other low voltage and fiber optic systems with conduits of 1 1/4” and larger, shall be sized per the NEC conduit requirements. For determining box size, the conduit is the determining factor not the wire size.

B. Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

C. Boxes Larger than 12 Inches (300 mm) in any dimension shall have a hinged cover, be rated NEMA 4X, and constructed of stainless steel.

D. Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain-tight. Galvanized cast iron or aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

E. Cast Metal Boxes for Hazardous Locations: Type 7, cast malleable iron with drilled and tapped conduit entrance. Cast malleable iron cover, non-hinged with Type 316 stainless steel screws and gasketed.

F. Cast Metal Boxes for Underground Installations: Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Hot dipped galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws. Cover Legend: ELECTRIC.

G. Fiberglass Handholes for Underground Installations: Die- molded with pre-cut 6 x 6 inch (150 x 150 mm) cable entrance at center bottom of each side; fiberglass weatherproof cover with non-skid finish. Provide traffic-rated cover for installation in traffic areas.

H. Box extensions and adjacent boxes within 48” of each other are not allowed for the purpose of creating more capacity.

I. Junction boxes 6” x 6” or larger size shall be without stamped knock-outs.
J. Wireways shall not be used in lieu of junction boxes.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections. Box rough-in shall be based upon shop drawing requirements.

B. The Contractor shall be responsible for coordinating box location and rough-in with actual equipment conditions and requirements.

C. Field verify all measurements. Do not base box rough-in or equipment locations on the contract figures.

D. Identify conflicts with the work of other trades prior to installation of electrical equipment and conduit work.

E. Adjust box locations to satisfy field requirements.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Accept boxes on site. Inspect for damage.

B. Protect boxes from corrosion and entrance of debris.

C. Store boxes above grade. Protect from environment with suitable covering.

3.3 INSTALLATION

A. General:
   1. Install conduit in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting", all requirements of the NEC, and manufacturer recommended practices.

B. Box Installation:
   1. Install electrical boxes as shown on Figures, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
   2. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
   3. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
   4. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
   5. Use flush mounting outlet boxes in all areas.
6. Do not install flush mounting boxes back-to-back in walls; provide minimum 6-inch separation. Provide minimum 24 inches separation in acoustic rated walls.

7. Use gang box where more than one device is mounted together. Do not use sectional box.

8. Electrical boxes are shown on Figures in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Include installation within 10 feet of location shown.

9. Position outlet boxes to locate luminaires as shown on lighting plans.

10. Adjust flush-mounting outlets to make front flush with finished wall material.

11. Install knockout closure in unused box opening.

C. Structural Coordination:

1. Install boxes to preserve fire resistance rating of partitions and other elements.
2. Install flush mounting box without damaging wall insulation vapor barrier or reducing its effectiveness. Provide vapor box or vapor barrier hat for each box flush mounted in an exterior wall.
3. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
4. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

D. Box Support:

1. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
2. Use stamped steel bridges to fasten flush mounting outlet box between studs.
3. Use adjustable stainless steel channel fasteners for hung ceiling outlet box.
4. Do not fasten boxes to ceiling support wires.
5. Support boxes independently of conduit.

3.4 TESTING AND START-UP SERVICES - NOT USED

3.5 TRAINING - NOT USED

END OF SECTION
SECTION 26 05 41

WIRING DEVICES

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS
A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS
A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
   a. NEMA WD 1 - General Purpose Wiring Devices.
   b. NEMA WD 6 - Wiring Device Configurations.

1.3 DESCRIPTION OF WORK
A. Provide and install complete and operable wiring devices as required on the figures and as specified herein.

1.4 SHOP DRAWINGS
A. Submit shop drawings in accordance with Division 01.
B. The following information shall be submitted specifically for wiring devices:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Clearly identify the types of wiring devices proposed.

1.5 QUALITY ASSURANCE
A. All materials, equipment, and parts shall be new and unused of current manufacture.
B. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

D. Manufacturer shall specialize in manufacture of products specified in this Section with minimum three years’ experience.

PART 2 - PRODUCTS

2.1 REQUIREMENTS

A. Contactor to verify all products with vendor to ensure field wiring requirements are met and follow specification Section 44 10 01. All products are to be outdoor grade, weather proof and corrosion resistant. Anything within 8 feet of the gas train system will need to be Class I, Division I rated.

2.2 120V SPECIFICATION GRADE SWITCHES

A. Single Pole Switch:
   1. Hubbell #HBL1221I.
   2. Or equal.

B. Double Pole Switch:
   1. Hubbell #HBL1222I.
   2. Or equal.

C. Three-way Switch:
   1. Hubbell #HBL1223I.
   2. Or equal.

D. Four-way Switch:
   1. Hubbell #HBL1224I.
   2. Or equal.

E. Indicator Switch:
   1. Hubbell #HBL1221 PLC.
   2. Or equal.

F. Weather-proof Switch:
   1. Hubbell #HBL1281I w/ Crouse-Hinds DC185C cover.
   2. Or equal.

G. Explosion Proof Switch:
   1. Appleton.
2. Crouse-Hinds.
3. Or equal.

2.3 120V SPECIFICATION GRADE RECEPTACLES

A. All receptacles shall utilize a one-piece brass strap and integral ground.

B. Duplex Convenience Receptacle:
   1. Hubbell #HBL5362I.
   2. Or equal.

C. GFCI Receptacle:
   1. Hubbell #HBL8300IA.
   2. Or equal.

D. Corrosion Resistant Duplex Receptacle, for use in Chemical Rooms:
   1. Hubbell #HBL52CM62.
   2. Or equal.

2.4 WALL PLATES

A. Wall plates shall be installed as follows:
   1. Use smooth stainless steel plates for receptacles and switches in sheet steel or
      PVC boxes.
   2. Use multi-screw gasketed cast plate where cast outlet boxes are required. Covers
      shall not be attached by using a single screw mounting into the wiring device, but
      shall be attached by mounting directly to the box.
   3. Use Crouse Hinds WLRS or WLRD wet location covers for receptacles identified
      as “WP” which are located inside structures.
   4. Use aluminum or cast metal cover rated for “Constant Use” for receptacles
      identified as “WP” and that are exposed to the weather.
   5. Use Crouse-Hinds OS185 cover for all switches identified as “WP”.

PART 3 - CONSTRUCTION METHODS

3.1 DIVISION OF WORK

A. The Contractor shall have overall system responsibility and shall provide all materials
   and labor necessary provide a complete and operable system and comply with all
   requirements of this section.

B. The Contractor shall be responsible for coordinating device locations with actual
   equipment conditions and requirements.
3.2 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact wiring device locations on the contract figures.

B. Adjust location of wiring devices to satisfy field requirements.

3.3 INSTALLATION

A. Wiring Device Installation:
   1. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
   2. Provide extension rings to bring outlet boxes flush with finished surface.
   3. Clean debris from outlet boxes.
   4. Install products in accordance with manufacturer's instructions.
   5. Install devices plumb and level.
   6. Install switches with OFF position down.
   7. Install receptacles with grounding pole on top.
   8. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
   9. Install plates on switch, receptacle, and blank outlets in all areas.
  10. Connect wiring devices by wrapping conductor around screw terminal.
  11. Provide stainless steel hardware.
  12. Install wall switch 46 inches above finished floor.
  13. Install convenience receptacle 18 inches above finished floor.
  15. Adjust devices and wall plates to be flush and level.

B. Structural Coordination:
   1. Verify outlet boxes are installed at proper height.
   2. Verify wall openings are neatly cut and will be completely covered by wall plates.
   3. Verify floor boxes are adjusted properly.

3.4 TESTING AND STARTUP SERVICES

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

END OF SECTION
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS
   A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS
   A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
         b. ANSI Z535.4 - Product Safety Signs and Labels.

1.3 DESCRIPTION OF WORK
   A. Furnish and install electrical identification systems as indicated on the figures and as specified herein.

PART 2 - PRODUCTS

2.1 NAMEPLATES
   A. Engraved three-layer laminated plastic, black letters on white background.

   B. Lettering:
      1. 1/4-inch letters for identifying individual equipment and loads.
      2. 1/2-inch letters for identifying grouped equipment and loads.

2.2 CONDUCTOR MARKING
   A. The ends of each conductor shall be marked with circuit number, motor number, wire or terminal number.

   B. Control system wire marking shall be coordinated with control system and equipment shop drawings.
C. Labels shall be typed in black lettering with indelible ribbons on a white, heat shrink sleeve. Markers shall be shrunk around the wire to ensure a tight, non-slip bond with a compatible heat gun.

D. Heat shrink wire markers shall be Brady Bradysleeve Type B-321 or B-322.

2.3 CONDUCTOR COLOR CODING

A. Conductors No.6 AWG and smaller shall be provided with color coded insulation as described herein. Conductors larger than No.6 AWG may be color coded with appropriately colored Scotch No.35 tape at each end.

B. Color Coding:
   1. 277/480 vac system shall be colored brown, orange, yellow, and gray for phases A, B, C, and neutral respectively.
   2. 120/208 vac system shall be colored black, red, blue, and white for phases A, B, C, and neutral respectively.
   3. 120/240 vac shall be colored black, red, and white for Line 1, Line 2, and neutral respectively.
   4. 120 vac control wiring shall be colored red.
   5. 24 VDC control wiring shall be colored purple and purple with white stripe for positive and negative conductors respectively.
   6. Intrinsically safe control wiring shall be colored light blue.
   7. Conductors within control cabinets and motor control centers which are supplied from an external source shall be colored yellow.
   8. Grounding conductor and equipment ground conductors shall be colored green.

2.4 CONDUIT MARKING

A. Colored band markers shall be field painted.

B. Color:
   1. 480 Volt System: Yellow.

2.5 EQUIPMENT, ENCLOSURE, AND CABINET WARNING SIGNS

A. Electrical Voltage and Shock Hazard Signs
   1. Provide OSHA Voltage and Shock Hazard sign for each electrical enclosure, cabinet, or other piece of equipment that presents an electrical hazard under normal operating circumstances or presents an electrical hazard while the enclosure is open.
B. Electrical Arc Flash Hazard Signs
1. Provide Arc Flash Hazard sign for each electrical enclosure, cabinet, or other piece of equipment that presents an arc flash hazard in accordance with NEC and ANSI Z535.4.

C. Electrical Source Signs
1. Provide sign indicating voltage level and source for each component of the power distribution system and for all control panels.
2. Provide indicating multiple sources where equipment is fed from multiple sources or where signal wiring is present that is powered from a source external to the equipment.

PART 3 - CONSTRUCTION METHODS

3.1 INSTALLATION

A. Nameplates:
1. Provide nameplates for grouped equipment such as panelboards, transformers, motor control centers, and control panels. Nameplate shall identify tag number, voltage, ampere rating, and description.
2. Provide nameplates for individual equipment such as motor control center compartments, field instruments, and field control stations. Nameplate shall identify tag number and description.
3. Provide nameplates for individual receptacles. Nameplate shall identify panel and circuit number supplying the receptacle.
4. Provide nameplates for control cabinets and motor control center compartments which contain wiring supplied from an external source. Nameplate shall state: Multiple power sources within, verify all power supplies are disconnected before servicing equipment.
5. Nameplates shall be secured to the front of equipment enclosures with stainless steel screws or rivets. Double sided tape will not be acceptable.
6. Secure nameplates for flush mounted panelboards behind the panelboard door.

B. Conductor Marking:
1. Mark conductors at every termination and splice point.
2. Mark conductors with wire numbers identified by control system supplier, with panel and circuit identification, or with MCC compartment and wire numbers.

C. Conduit Marking:
1. Furnish colored band markers for each conduit longer than six feet and mark each conduit a minimum of twenty feet on center.
SECTION 26 28 19

ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

1. American National Standards Institute/Instrument Society of America (ANSI/ISA), Specifications and Standards, current edition:
      1) NFPA 70 - National Electrical Code.
      1) NEMA FU 1 - Low Voltage Cartridge Fuses
      2) NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
      3) NEMA 250 - Enclosures for Electrical Equipment.
   d. International Electrical Testing Association (NETA)
   e. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition.
      1) UL 98 - Enclosed and Dead Front Switches

1.3 DESCRIPTION OF WORK

A. Furnish and install complete and operable enclosed switches as indicated on the figures and as specified herein.

B. Furnish and install spare fuse cabinet.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.
B. Submit the following information specifically for enclosed switches:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the
      requirements of this specification.
   2. Outline drawings with dimensions.
   3. Equipment ratings for voltage, amperage, horsepower and short circuit.

1.5 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required
   for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products
   specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority
   having jurisdiction as suitable for the purpose specified and indicated.

1.6 WARRANTY

A. See Division 01 for additional requirements.

1.7 EXTRA MATERIALS

A. See Division 01 for additional requirements.

B. Supply five spare fuses of each type supplied for this project

PART 2 - PRODUCTS

2.1 HEAVY DUTY DISCONNECT SWITCH

A. Install 100A main fusible disconnect switch in the maintenance building at indicated
   on figures. Switch to power blower/flare skid main 480 V power panel.

B. Manufacturers
   1. Square D Company
   2. Cutler-Hammer
   3. or equal

C. Switch Interior
   1. All switches shall have switch blades which are visible when the switch is off and
      the cover is open.
   2. Lugs shall be front removable and UL Listed for 60 degree C or 75 degree C
      aluminum or copper conductors as required by the application.
3. Fusible switches shall be equipped with factory installed or field installed fuse pullers.
4. Switches shall be equipped with plated copper current carrying parts to resist corrosion.
5. Switches shall be equipped with removable arc suppressors to facilitate access to line side lugs.
6. Switches shall have provisions for a field installable electrical interlock.

D. Switch Mechanism
1. Switch operating mechanism shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be restrained by the operating handle after the closing or opening action of the contacts has started.
2. The operating handle shall be an integral part of the box, not the cover.
3. The handle position shall travel at least 90 degrees between off and on positions to clearly distinguish and indicate handle position.
4. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is on and prevent turning the switch on when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Switch Enclosures
1. Environmental Rating:
   a. Service entrance switch, exterior: Type 4X, stainless steel.
   b. Service entrance switch, interior: Type 1.
   c. Disconnect switch, exterior: Type 4X, stainless steel.
   d. Disconnect switch, interior: Type 4X, stainless steel.
   e. Disconnect switch, interior when EMT conduit is allowed: Type 1.
   f. Disconnect switch, hazardous location: Type 7/9.
2. Covers:
   a. Type 1, 4X stainless steel enclosures: attached with welded pin-type hinges.
   b. Type 7/9 enclosures: attached with Type 316 stainless steel bolts.
3. Finish:
   a. Type 1 enclosures: gray baked enamel paint electrodeposited on cleaned, phosphate pre-treated steel.
   b. Type 4X stainless steel enclosures: brush finish on type 304 stainless steel.
   c. Type 7/9 enclosures: gray baked enamel on copper free cast aluminum alloy.
4. The enclosure shall have on and off markings stamped or cast into the cover.
5. The operating handle shall be provided with a dual colored, red/black position indication.
6. All switches shall have provisions to accept up to three 3/8-inch hasp padlocks to lock the operating handle in the off position.
7. Exterior switches shall have provisions to accept one 3/8-inch hasp padlocks to lock the operating handle in the on position.
8. Conduit Entrance:
ENCLOSED SWITCHES

a. Tangential knockouts shall be provided for Type 1 switches rated 30-200A.
b. Watertight conduit hubs for Type 4X stainless steel switches.
c. Threaded conduit openings in both end walls for Type 7/9 enclosures.

9. Cover sealing means for switches rated through 200 amperes shall be quick release trunk latches (Type 1, 4X stainless steel enclosures) and type 316 stainless steel bolts (Type 7/9 enclosures).

10. Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor applications.

11. Type 4X stainless steel enclosures shall be dual rated as Type 3R to facilitate their use in outdoor applications.

F. Switch Ratings

1. Switch shall be suitable for use as service entrance equipment.
2. Switches shall be horsepower rated for ac and/or dc as indicated on the plans.
3. Switches shall be rated for the voltage applied.
4. The UL Listed short circuit current rating of the switches shall be:
   a. 10,000 rms symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere).
   b. 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).
   c. 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

2.2 FUSES

A. Manufacturers
   1. Bussmann
   2. or equal

B. 250 Volt Fuses
   1. Class RK-1, one end rejection or to fit mountings specified. 0-600 ampere, 200,000 ampere interrupting rating.
   2. Low-Peak LPN-R, dual element, time delay with short circuit protection for motor, transformer, feeder and main service protection.

C. 600 Volt Fuses
   1. Class RK-1, one-end rejection or to fit mountings specified, 0-600 ampere, 200,000 ampere interrupting rating.
   2. Low-Peak LPS-R, dual element, time delay with short circuit protection. 0-600 ampere, 200,000 ampere interrupting rating for motor, transformer, feeder and main service protection.
   3. Class L, bolt-in, 601-6,000 amperes, 200,000 ampere interrupting rating.
   4. HI-CAP KRP-C, time delay for overload and short circuit protection. 601-6,000 amperes, 200,000 ampere interrupting rating for motor, transformer, feeder and main service protection.
5. Class CC, fast acting, single element, 0-30 amperes, 200,000 ampere interrupting rating.

2.3 SPARE FUSE CABINET

A. Description
Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified.

B. Doors: Hinged, with padlock hasp.

C. Finish: Field painted.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact enclosed switch locations on the contract figures.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.

C. Adjust enclosed switch installation to satisfy field requirements.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Accept enclosed switches on site. Inspect for damage.

B. Protect enclosed switches from corrosion and entrance of debris.

C. Store enclosed switches above grade. Protect from environment with suitable covering.

3.3 INSTALLATION

A. Install fuses where switches are necessary.

B. Install wall mounted enclosure for spare fuses.

C. Install enclosed switches plumb and level.

D. Install enclosed switches such that top of enclosure is located at an elevation of 6-feet above finished floor elevation.
E. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

F. Verify that bonding jumper is properly installed in service entrance rated switches.

G. Thoroughly clean and remove construction debris from switch interior and exterior.

END OF SECTION
SECTION 26 29 23

ADJUSTABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.


   a. EN 60947 - Low-Voltage Switchgear and Control Equipment - Part 4-2: Contactors and Motor-Starters - AC Semiconductor Motor Controllers and Starters


5. Institute of Electrical and Electronics Engineers (IEEE), current edition.

6. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition:
   a. IEC-60439 - Low Voltage Switchgear and Control Equipment Assemblies.


8. National Electrical Manufacturers Association (NEMA), Specifications and Standards, Current Edition:
   a. ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   c. ICS 4-2000 - Industrial Control and Systems: Terminal Blocks.
   e. ICS 6-1993 - Industrial Control and Systems Enclosures
f. ICS 7-1993 - Industrial Control and Systems Adjustable-Speed Drives

g. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

9. Underwriters Laboratories, Inc. (UL), Specifications and Standards, Current Edition:
   a. 4. UL 508C - Power Conversion Equipment.

1.3 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation & Control
   2. Section 44 10 01 – Landfill Gas Blower/Flare Skid

B. Furnish and install complete and operable adjustable frequency drive systems as indicated on the figures and as specified herein.

C. Motor control equipment specified under this section shall be the product of a single manufacture unless necessary otherwise.

D. Adjustable frequency drive systems work may include

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein in accordance with the requirements specified under Section 26 24 19, which state that submittals for all motor control equipment be included as part of the submittal for the complete, integrated process instrumentation and control system and in accordance with the requirements specified under Section 26 90 00.

C. In addition to the requirements of Section 44 10 01 the following information shall be submitted specifically for adjustable frequency drive systems:
   1. Submit harmonic voltage distortion analysis based upon the minimum three phase bolted fault short circuit current available at the point of service. Submittal data shall not relieve contractor of specified performance requirements. Analysis shall include:
      a. Calculate percent voltage distortion, with respect to fundamental voltage, for all harmonics up to the 99th.
      b. Comparison with IEEE 519 standards for acceptable voltage distortions on such systems.

1.5 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.
B. Submit operation and maintenance manuals for the equipment specified herein in accordance with the requirements as all submittals for all motor control equipment be included as part of the submittal for the complete, integrated process instrumentation and control system and in accordance with the requirements specified under Section 26 90 00.

C. The following information shall be provided specifically for adjustable frequency drive systems:
   1. Motor controller data listing identifying the configured values of all adjustable settings and configurable parameters.

1.6 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications:
   1. All equipment provided under this section shall be the products of a single company specializing in manufacturing products specified in this section, with not less than twenty years of documented experience.
   2. The adjustable frequency drive system manufacturer shall have been engaged in the manufacture of PWM style adjustable frequency drives for a minimum of ten years.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

E. Adjustable frequency drive system manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.7 WARRANTY

A. See Division 01 for additional requirements.

1.8 EXTRA MATERIALS

A. See Division 01 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Allen-Bradley, Bulletin Power Flex.
2.2 GENERAL

A. Provide adjustable frequency drives necessary to receive 60Hz line voltage that will convert output voltage to a variable frequency signal appropriate for the process motors to use.

B. Harmonic Distortion:
   1. The adjustable frequency drive systems shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when operated from the same bus.
   2. Individual or simultaneous operation of the adjustable frequency drive systems shall not add more than 5 percent total harmonic voltage distortion to the normal bus, nor more than 10 percent while operating from the standby generator in accordance with IEEE 519, 1992.
   4. If harmonic filters or reactors are needed to meet these requirements, then the manufacturer shall provide and be responsible for the design and manufacture of these items.

2.3 RATINGS

A. The drive shall accept an input voltage of the nominal three phase voltage indicated on the figures, plus or minus 10 percent.

B. Displacement power factor: shall range between 1.0 and 0.95, lagging, over the entire speed range.

C. Efficiency: minimum of 97 percent at full load and speed.

D. Environmental Ratings:
   1. Storage ambient temperature range: -40 to 70 degrees C.
   2. Operating ambient temperature range: 0 to 40 degrees C without derating.
   3. Relative humidity range: 5 to 95 percent non-condensing.
   4. Operating elevation: up to 1000 meters without derating.

E. Provide redundant, thermostatically controlled ventilation fans to maintain interior of drive enclosure within the specified environmental ratings.

F. Output power Ratings:
   1. The output voltage shall be adjustable from 0 to rated input voltage.
2. The output frequency range shall be adjustable from 0 to 120Hz.
3. The inverter section shall produce a pulse width modulated (PWM) waveform using latest generation IGBTs.

2.4 DRIVE UNIT DESIGN

A. Hardware:
1. Utilize diode or fully gated bridge on the input.
2. Utilize DC bus inductor on all drives rated 7.5hp or greater.
3. Utilize switching logic power supply operating from the DC bus.
4. Incorporate phase to phase and phase to ground MOV protection.
5. Utilize gold plated plug-in connections on printed circuit boards.
6. Microprocessor based inverter logic shall be isolated from power circuits.
7. Utilize latest generation IGBT inverter section.
8. Inverter section shall not require commutation capacitors.
9. Employ interface common for all horsepower ratings. Interface shall include a LCD digital display and programming keypad.
10. Utilize a main control board with common control connections for all ratings.

B. Control Design:
1. The drive design shall be optimized for NEMA Design B motors rated for use with VFDs.
2. The drive design shall allow for operation of the drive with the motor disconnected.
3. Provide a controlled shutdown, when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
4. Utilize an adjustable PWM carrier frequency within a range of 2 to 8 kHz to help eliminate audible noise.
5. Provide either Selectable Sensorless Vector or V/Hz modes.
6. The drive shall have the capability of selecting operation for either variable or constant torque loads. Selection of variable torque shall provide 115 percent of rated VT current for up to one minute. Selection of constant torque shall provide 150 percent of rated CT current for up to one minute.
7. Provide multiple programmable stop modes including:
   a. Ramp
   b. Coast
   c. DC-Brake
   d. Ramp-to-Hold
   e. S-Curve
8. Provide multiple acceleration and deceleration rates.
9. The drive shall have an adjustable output frequency up to 400Hz.
10. The drive shall be capable of sensing a loss of the speed reference.
11. All adjustments shall be made with the door closed.

C. Power Conditioning:
1. The drive shall be designed to operate on an AC line which may contain line notching and up to 10 percent harmonic distortion.
2. An input isolation transformer shall not be required for protection from normal line transients. If line conditions dictate the use of a transformer, the K factor shall be 4.0 or less.

2.5 DRIVE UNIT FEATURES

A. Control Mode:
1. Selectable sensorless vector or V/Hz mode selectable through programming.
2. The sensorless vector mode shall use motor nameplate data plus motor operating data such as IR drop, nominal flux current and flux up time.
3. The volts per hertz mode shall be programmable for squared, cubed, straight line, pre-programmed or full custom patterns.

B. Current Limit:
1. Programmable current limit from 20 to 160 percent of constant torque rating.
2. Current limit shall be active for all drive states: accelerating, constant speed and decelerating.
3. The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.

C. Acceleration / Deceleration:
1. Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 to 3600 seconds.
2. A second set of remotely selectable Accel/Decel settings shall be accessible through the control interface.
3. An adaptive current limit circuit shall be available and capable of being disabled through programming for fast acceleration of low inertia loads.

D. Speed Regulation Modes:
1. Open Loop.
2. Slip Compensation with 0.5 percent speed regulation.
3. Droop - Negative Slip Compensation with 0.5 percent speed regulation.
4. Traverse Function.
5. Closed loop encoder feedback with 0.1 percent speed regulation.
6. Process PI control.

E. Speed Profiles:
1. Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S-Curve" profiles that provide changing accel/decel rates.
2. S-Curve profiles shall be selectable for fixed or adjustable values.

F. Adjustments:
1. A digital interface shall be used for all set-up, operation and adjustment settings.
2. All adjustments shall be stored in nonvolatile memory (EEPROM).
3. No potentiometer adjustments shall be required.
4. The drive shall provide EEPROM memory for factory default values.
G. Process PI Control:
1. The drive shall incorporate an internal process PI regulator with proportional and integral gain adjustments as well as error inversion and output clamping functions.
2. The feedback shall be configurable for normal or square root functions. If the feedback indicates that the process is moving away from the setpoint, the regulator shall adjust the drive output until the feedback equals the reference.
3. Process control shall be capable of being enabled or disabled with a hardwire input. Transitioning in and out of process control shall be capable of being tuned for faster response by preloading the integrator.
4. Protection shall be provided for a loss of feedback or reference signal.

H. Fault Reset / Run:
1. The drive shall provide up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
2. Ground fault, shorted output faults, and other internal microprocessor faults shall not automatically reset/restart.
3. The time between restarts shall be adjustable from 0.5 to 30 seconds.

I. Skip Frequencies:
1. Three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance shall be provided.
2. The set points shall have a bandwidth adjustable from 0 to 15Hz.

J. Run on Power Up:
1. A user programmable restart function shall be provided to automatically restart the equipment after restoration of power after an outage.

K. Line Loss Restart:
1. The drive shall have a line loss restart function. This programmable function shall select the reconnect mode of the drive after recovery from a line loss condition.
2. The reconnect modes shall be Last Speed, Speed Search, Track Volts, or Use Encoder.
3. This feature shall be capable of being disabled thus forcing the drive to start from zero hertz.

L. Fault Memory:
1. The last four faults as well as operating frequency, drive status and power mode shall be stored at the time of fault.
2. Information shall be maintained in the event of a power loss.

M. Overload Protection:
1. The drive shall provide internal Class 10 motor overload protection investigated by UL to comply with N.E.C. Article 430.
2. Overload protection shall be speed sensitive and adjustable for motors with speed ranges of 2:1, 4:1 and 10:1.
3. A viewable parameter shall store the overload usage in percent.
4. An alarm bit shall be available to adjust a process to eliminate an overload trip.

N. Auto Economizer:
1. An auto economizer feature shall automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage. If the load increases, the drive shall automatically return to normal operation.

O. Flying Start:
1. The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed.
2. The flying start feature shall be operable with or without encoder feedback.

P. Control Logic Ride Through:
1. The control logic shall be capable of "riding through" a power outage of up to 2 seconds in duration.

Q. Inertia Ride Through:
1. The drive shall respond to a loss of AC input power by adjusting the output frequency to create a regenerative situation in the motor. The regenerated energy shall be used to power the drive logic during the power outage.
2. The amount of voltage drop required to trigger inertial ride through and the level at which regulation occurs shall both be adjustable.
3. Inertia ride through shall be capable of being enable or disable through programming.

R. Inputs and Outputs:
1. The standard Input / Output board shall consist of both analog and digital I/O.
2. No jumpers or switches shall be required to configure inputs and outputs. All functions shall be fully programmable.
3. The Input / Output board shall have the following analog inputs as standard.
   a. Quantity one (1) differentially isolated plus or minus 10V (bi-polar) / 20mA, 11 bit plus sign, 10V common mode noise rejection
   b. Quantity one (1) differentially isolated plus or minus 10V (bi-polar) / 20mA, 11 bit plus sign, 160V common mode noise rejection
   c. Analog inputs shall be user programmable for a variety of uses including frequency command and process loop input. Analog inputs shall be user programmable for function scaling (including invert), offset, signal loss detect and square root.
4. The Input / Output board shall have the following analog outputs as standard.
   a. Quantity one (1) differentially isolated plus or minus 10V (bi-polar) / 20mA, 11 bit plus sign.
   b. The analog output shall be user programmable to be proportional to one of fourteen process parameters including output frequency, output current, encoder feedback, output power.
   c. Programming shall be available to select either absolute or signed values of these parameters.
5. The Input / Output board shall have the following digital inputs as standard.
   a. Quantity of six (6) digital inputs rated 115Vac
   b. All inputs shall be individually programmable for functions from a list of twenty-nine (29) that includes Start, Run, Stop, External Fault, Speed Select, Jog and Process PI functions.

6. The Input / Output board shall have the following digital outputs as standard.
   a. Quantity of two (2) relay outputs, form C (1 N.O. - 1 N.C.)
   b. Contact output ratings shall be 250Vac / 30Vdc (2.0 Amps maximum), resistive or inductive.
   c. Relays shall be programmable to twenty-six (26) different conditions including Fault, Alarm, At Speed, Drive Ready and PI Excess Error.
   d. Timers shall be available for each output to control the amount of time, after the occurring event, that the output relay actually changes state.

S. Reference Signals:
   1. The drive shall be capable of using the following input reference signals
      a. Analog inputs
      b. Preset speeds
      c. Remote potentiometer
      d. Digital MOP
      e. Human Interface
      f. Communication module commands

T. Communication:
   1. The drive shall be capable of communicating with a DeviceNet network and also with an Ethernet network.

U. Loss of Reference:
   1. In the event of loss of the reference signal, the drive shall be user programmable to the following:
      a. Fault the drive
      b. Alarm and maintain last reference
      c. Alarm and go to preset speed
      d. Alarm and go to minimum speed
      e. Alarm and go to maximum speed
      f. Alarm and maintain last output frequency

V. Metering:
   1. The following parameters shall be accessible through the human interface module:
      a. Output Current in Amps
      b. Output Voltage in Volts
      c. Output Power in kW
      d. Elapsed MWh
      e. DC Bus Voltage
      f. Output Frequency
      g. Heatsink Temperature
      h. Last eight (8) faults
i. Elapsed Run Time

W. Faults:
   1. Fault information shall be accessible through the human interface module.
   2. A fault buffer shall store the last four faults in a first-in / first-out manner.
   3. At a minimum the following faults shall be displayed:
      a. Power Loss.
      b. Undervoltage.
      c. Overvoltage.
      d. Overload.
      e. Overtemperature (Heat Sink).
      f. Overcurrent detected in instantaneous overcurrent trip circuit
      g. Maximum retries.
      h. Phase-to-phase and phase-to-ground faults.

2.6 DISCONNECTING MEANS

A. Provide a door interlocked motor circuit protector disconnect

B. Operator Handles
   1. Provide flange mounted operator handles for free standing units
   2. Provide through the door operating handles for wall mounted units
   3. Handles shall be padlockable

C. The system shall be rated for the available fault current as identified by the engineer. The rating shall be shown on the drive label.

2.7 DRIVE INPUT FUSES

A. Provide drive input fuses to provide branch circuit protection for the drive.

B. The drive input fuses shall be selected by the manufacturer and mounted in fuse blocks.

2.8 CONTROL POWER TRANSFORMER

A. Provide a control power transformer mounted and wired inside of the drive system enclosure.

B. The transformer shall be rated for drive power plus 250VA for customer use.

2.9 CONTACTORS

A. General:
   1. Contactors shall be IEC or NEMA rated devices suitable for the application intended.
2. Provide Isolation, Output, or Bypass with Across the Line Starting contactors where necessary.

B. Isolation:
1. Input contactor shall provide positive isolation of the controller from line power.
2. Input contactor shall close when motor is signaled to start, energizing the controller and allowing adjustable speed control.
3. Input contactor shall open after the controller has stopped the motor and de-energize the controller.
4. Input contactor shall not switch loaded motor under any circumstances.

C. Output:
1. Provide an output contactor between the drive output and the motor.
2. The contactor shall close on power up and open after a drive fault or loss of power.

D. Bypass with Across the Line Starting:
1. Provide means to manually and automatically switch a single motor from drive control to bypass (across the line operation).
2. Provide separate drive output and bypass contactors. The contactors shall be electrically interlocked.
3. Provide a Class 10 overload for motor protection while operating in the bypass mode.

2.10 POWER CONDITIONING EQUIPMENT

A. General:
1. Provide Input Line Reactors where necessary.

B. Common Mode Choke:
1. Provide a common mode choke at the drive output to help, in conjunction with the proper grounding techniques, reduce or eliminate interference with sensitive electronic equipment or communication devices installed in the same system.

C. Input Line Reactor:
1. Provide a drive input line reactor mounted within the drive system enclosure
2. The line reactor shall meet the following specifications:
   a. The construction shall be iron core with an impedance of (3) percent
   b. The winding shall be copper wound.
   c. The insulation shall be Class H with a 115 degree C rise.
   d. The unit shall be rated for system voltage and frequency

2.11 ENCLOSURES

A. The enclosure shall be NEMA 4x as specified in Specification 44 10 01.
B. Starters shall have an adjustable instantaneous motor circuit protector (HMCP) type disconnect device.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact equipment locations on the contract figures.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.

C. Identify deviation from physical sizes shown on the figures to Engineer prior to bid date.

D. Contractor shall be responsible for modifications to the installation due to deviations from physical sizes shown on the figures.

E. Identify conflicts with the work of other trades prior to installation of electrical equipment.

F. Record nameplate data for each motor served.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Accept adjustable frequency motor controllers on site. Inspect for damage.

B. The Contractor shall be responsible for all equipment necessary to receive, unload, and install blower/flare skid and connect adjustable frequency motor controllers.

C. The Contractor shall be responsible for coordinating specific shipping split requirements with the manufacturer/supplier.

D. Conform to written instructions of manufacturer.

E. Protect adjustable frequency motor controllers from corrosion and entrance of debris.

F. Store adjustable frequency motor controllers above grade. Protect from environment with suitable covering.

3.3 INSTALLATION

A. Adjust disconnecting means trip settings to satisfy motor nameplate requirements.

B. Record information for motor data labels and install motor data labels.
C. Adjust all programmable drive features, including but not limited to auto restart parameters. The drive system must automatically restart after a power fail condition.

D. Provide typed label inside each unit identifying configured values for all programmable drive parameters.

E. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of all connections.

F. Verify that cooling fans are operating properly.

G. Thoroughly clean and remove construction debris from filters, enclosure interior, and exterior.

3.4 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.5 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

END OF SECTION
SECTION 26 90 00

PROCESS INSTRUMENTATION & CONTROL

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

1. American National Standards Institute/Instrument Society of America (ANSI/ISA), Specifications and Standards, current edition:
   b. ANSI/ISA-5.3-1983 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.


3. CE - European Community, Applicable Directives.
   a. EN50005 - for Terminal Markings.
   b. EN50081-1- Generic Emission Standard.
   c. EN50082-1 - Generic Immunity Standard.
   d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
   e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.

4. Canadian Standards Association (CSA), Specifications and Standards, current edition:
   a. CSA C22.2, Industrial Control Equipment.

5. CUL - Underwriter's Laboratories of Canada.

   a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures

7. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
   a. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and
Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

b. NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.

8. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
   a. UL508 - Industrial Control Equipment.
   b. UL508A - Industrial Control Panels.
   c. UL 913 - Intrinsically Safe Specification.
   d. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated Process Instrumentation and Control System, the following sections shall be included under the scope of this section:
   1. Section 26 29 23 - Adjustable Frequency Motor Controllers
   2. Section 26 90 10 - Control Panel Construction
   3. Section 26 90 11 - Control Panel Components
   4. Section 26 90 30 - Programmable Logic Controllers
   5. Section 26 90 31 - Human-Machine Interface Equipment

B. The work specified herein shall include the furnishing of all materials, equipment, labor, and supervision necessary to fabricate, install, start-up, and test a complete and operable Process Instrumentation and Control System.

C. The labor specified herein includes but is not limited to engineering, software development, panel fabrication, equipment calibration and adjustment, testing, training, and documentation.

D. This section identifies the overall functional requirements for the Process Instrumentation and Control System.

E. This section includes coordination with the work of other sections. This work includes identification of exact interface requirements with motors, control panels, and field instrumentation provided under other portions of this specification. It shall be the responsibility of the system integrator specified under this section to execute this coordination during the shop drawing submittal phase of the work. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.

F. This section includes coordination with electrical contractor to ensure that the proper number of raceways and conductors are installed. It shall be the responsibility of the system integrator to coordinate this work with the installing electrician. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.
1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit the following information specifically for hardware alarm notification system:
   1. General requirements specific to this section include:
      a. Submit complete and integrated document containing all equipment included under the scope of this section.
      b. Submittal shall be complete, neat, orderly, and indexed with tabbed dividers. Partial submittals will not be accepted.
      c. Include a complete list of proposed exceptions to and deviations from these specifications.
      d. Clarity and completeness are of prime importance. Acceptability of submittal drawings shall be at the sole discretion of the Engineer in regards to this requirement.
      e. Additional requirements for the various subsystems are specified in the corresponding sections.

2. Submit the following information:
   a. Bill of Materials:
      1) Complete listing of all components identifying exact make and model, quantity, and description.
   b. Component Data Sheets:
      1) Detailed listing for each type of device, identifying Engineer's tag number, manufacturer, model, options, ranges, and other information necessary to supplement component catalog cut sheets and clearly show compliance with these specifications.
   c. Component Catalog Cut sheets:
      1) Manufacturer's standard catalog information.
   d. Control Panel Construction Drawings:
      1) Scaled drawings of all control panels and enclosures.
      2) Front panel elevation complete with nameplate legend.
      3) Back panel elevation complete with schedule of devices.
      4) Panel shall be built to UL 508A standards.
   e. Control Panel Schematic Wiring Diagrams:
      1) Ladder type schematic diagrams.
      2) Show all devices requiring electrical connections.
      3) Identify all wire and terminal numbers.
      4) Identify PLC I/O addresses.
      5) Reference Engineer's tag number where assigned.
      6) Cross-reference all relay contacts and coils.
      7) Identify switching action on all switching devices.
      8) Common diagrams will not be accepted.
   f. Analog Loop Diagrams:
      1) Show all devices requiring electrical connections.
      2) Identify all wire and terminal numbers.
      3) Identify PLC I/O addresses.
      4) Identify location of loop power supply.
      5) Identify field devices, back-of-panel devices, and front-of panel devices.
6) Show tabular summary of transmitter output capability, input impedance of each receiver, total loop impedance, and reserve output capacity.
7) Reference Engineer's tag number where assigned.
8) Common diagrams will not be accepted.
g. Control Panel Plumbing Diagrams:
   1) Show all devices requiring plumbing connections (air or liquid).
   2) Show pipe/tube sizing.
   3) Show all control devices (valves, regulators, filters, etc.).
h. Control Panel Power and Environmental Requirements:
   1) Identify voltage and ampacity requirements.
   2) Show sizing calculations for environmental controls (ventilation, heat, air conditioning).
i. Interconnecting Wiring Diagrams:
   1) Show all interconnections between control panels.
   2) Show all interconnections between control panels and field devices.
   3) Identify all wire and terminal numbers, including field terminal junction box terminals.
j. Control Device Installation Details:
   1) Supplement contract documents with additional details necessary for proper installation of control devices.
k. Configuration Documentation:
   1) Submit complete, documented configuration data for all configurable controllers.
   2) Additional requirements for PLC systems and PC based data acquisition systems are identified in the individual subsystem sections.

1.5 FACTORY TESTING

A. The entire Process Instrumentation and Control System shall be assembled at the manufacturer's facility and tested to the greatest extent possible. This test shall include simulation of all I/O points and demonstration of proper system operation. Document the results of this test in writing and submit to the Engineer.

B. The Engineer and Owner may witness the factory acceptance test. Schedule test date a minimum of two weeks in advance to allow attendance by the Engineer and the Owner.

C. Correct any deficiencies identified during the test prior to shipping the control system to the job site.

1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.
B. Submit the following information specifically for hardware alarm notification system:
   1. Submit final revised shop drawings incorporating any modifications made as a result of factory test, installation, start-up, operational testing, or for any other cause. Submit results of all field-testing and corrective actions taken for all discrete control devices and for all analog control devices. Submit analog device calibration data sheets.
   2. Submit manufacturer’s standard operation & maintenance information including installation manuals and safety instructions.
   3. Submit contact list identifying names, addresses, telephone numbers, and any additional contact information for each equipment service organization involved with the Process Instrumentation and Control System.
   4. Submit detailed operation and maintenance procedures for each major equipment item; include description of operation for all modes of operation, routine maintenance procedures, and troubleshooting guide.
   5. Submit listing spare parts provided under this contract and of recommended additional spare parts not provided under this contract along with costs.

1.7 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 WARRANTY

A. See Division 01 for additional requirements.

PART 2 - PRODUCTS

2.1 SYSTEM INTEGRATOR

A. The system integrator shall be a firm specializing in the integration of control systems with documented experience in the detailed design, construction, configuration, and maintenance of PLC based control systems for the industrial process utility market. This experience must include a minimum of five projects similar in nature to this project during the last five years.
1. Acceptable System Integrator
   a. PJ Kortens
      Appleton, WI
      Phone: 920.730.9023
   b. Or equivalent as approved by Owner.

2.2 GENERAL FUNCTIONAL DESCRIPTION

A. Summary of System
   1. New PLC based control systems and/or data acquisition system HMI workstations shall be provided at the following locations:
      a. Landfill Gas Blower/Flare Skid:
         1) MCP (Master Control Panel) shall consist of a programmable logic controller and industrial touch screen operator interface. This control panel along with associated instrumentation shall be provided under the scope of this section.

B. General Requirements:
   1. The process instrumentation and control system consists of the following functional divisions which will be defined in detail for each loop under Detailed Functional Description:
      a. Local Control Functions: includes local control panels, pilot control devices, instruments, and sensors.
      b. Data Acquisition and Monitoring System Control Functions: includes PLC hardware, interface devices, and PLC logic. Includes graphical user interface hardware and configuration, event monitoring and logging functions, analog parameter trending, and alarm handling. Includes historical database, report configuration, and auto-dialer.
   2. The process instrumentation and control system includes controls for the blower/flare skid components and the existing auto dialer alarm system. It shall be the responsibility of the system integrator to coordinate all efforts specified herein with these existing systems so as to minimize impact on facility operations.
   3. HMI Graphical Interface
      a. All HMI functions shall be configured on the control panel mounted touch screen(s) in a consistent manner in accordance with industry conventions and standards. Screens shall display information in a logical, hierarchical fashion that allows simple navigation and operator understanding of the interface. The Owner and Engineer shall determine the acceptability of all proposed interface screens; refer to the submittal requirements for this section.
      c. Provide HMI display images sized for the display hardware. Distorted display images due to the lack of coordination between display image and display hardware resolutions will not be acceptable.
      d. Configure a facility overview display that graphically displays all skid processes.
      e. Operator interface functions shall include an event/alarm log which will time and date stamp each event and alarm occurrence and will also indicate the time an alarm was acknowledged and the time an alarm was cleared. Alarm handling shall be configured such that acknowledgment will only be required
in a single location in order to acknowledge a cleared alarm.

f. Operator interface functions shall include an equipment runtime/starts-per-day log, analog signal trends, and totalization for the signals indicated. Provide a non-resettable totalizer for each runtime and flow total.

4. Historical Data
   a. The historical data shall also be available in tabular format for manipulation and analysis by operations and engineering personnel. Data format and process reporting and graphing shall be coordinated and verified with the owner and engineer. Data should be accessible from the MCP front via a port so that the Owner can download and store data without having to open the panel.

2.3 LANDFILL GAS BLOWER/FLARE

   A. General Operation
      1. The landfill gas (LFG) blower/flare system will run in manual mode or automatic operating modes that shall be selectable by an O/I touch screen selection at the MCP.
      2. The manual mode shall allow the blower/flare system to run continuously for system testing including:
         a. Allow for manual control and setting of the compressor motor VFD speed.
         b. In manual mode the blower/flare system shall run with all safety features engaged including run permissives, alarms and auto-shutdown features.
      3. The automatic modes shall include:
         a. Normal operation

   B. Operation Logic
      1. Blower/Flare PLC shall function in the new operating sequence to receive a signal from the Compressor System to initiate lighting the pilot flame without opening the auto-block valve and/or starting the blower.
      2. The operating sequence shall allow the pilot gas system, pilot flame thermocouples, and pilot flame prove features of the PLC to function and should not alarm or shut-down the flare system when the auto-block valve remains closed and the blowers do not start.
      3. Safety features of the system such as the flame arrestor temperature alarm and shut-down and/or flame failure alarms shall be included.
      4. The Blower/flare system shall operate using the compressor VFD motor speed to control and maintain inlet vacuum and LFG delivery pressure.
      5. The Blower/flare system inlet pressure shall be controlled and maintained at an adjustable inlet pressure set-point using the blower VFD motor speed.
         a. The Blower/flare system PLC shall provide for an operator adjustable inlet pressure set-point.
         b. The Blower/flare system shall include an alarm and auto-shut down switch for low inlet pressure conditions (high vacuum).
      6. The Blower/flare system LFG delivery pressure shall be maintained at an adjustable delivery pressure set-point using a combination of PID loops.
         a. The Blower/flare system PLC shall provide for an operator adjustable LFG delivery pressure set-point.
b. The Blower/flare system shall include alarm and auto-shut-down for high delivery pressure conditions.

C. Minimum Alarms/Auto shut-down conditions:
2. Pilot flame failure.
3. Flame arrester high temperature.
5. Low landfill gas flow rate annunciation.
7. Blower bearing high temperature.
8. Blower high vibration annunciation.
10. Inlet low pressure.
11. Thermocouple failure.
12. Main flame failure.
13. High condensate level annunciation.

D. Minimum Operating Data
1. The following minimum operating data shall be displayed on the HMI screen and made available to the data acquisition system:
   a. LFG flow
   b. Flare status and alarms
   c. Blower status
   d. Blower VFD operating speed
   e. Condensate system alarms
   f. Inlet valve status
   g. Inlet LFG pressure
   h. Inlet LFG temperature
   i. Pilot ignition sequence status
   j. Pilot flame temperature
   k. Flare system start up sequence status

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Field verify the available mounting space for control system equipment and accessibility in relation to the existing enclosed flare location.

3.2 DELIVERY STORAGE AND HANDLING

A. It shall be the responsibility of the installing contractor to receive all process instrumentation and control equipment at the job site. Carefully inspect all equipment for damage prior to accepting from the shipping agency. Do not accept shipment if damage is evident.
B. Exercise due diligence in storing, protecting, and moving process instrumentation and control equipment. Damaged or worn equipment will not be accepted and will be replaced at no additional cost to the Owner.

3.3 INSTALLATION

A. Install equipment in locations as indicated on the contract documents. Adjust locations as needed to ensure operability, serviceability, and compliance with all applicable codes and standards.

B. Installation shall be completely tested prior to start-up. This work includes verification of all field wiring continuity and proper termination of wiring.

3.4 TESTING AND START-UP SERVICES

A. System Integrator shall provide installation and start-up services required to place the complete system into operation. Refer to,
1. Section 43 08 00 – Start-Up and Commissioning
2. Section 44 10 01 – Blower/Flare Skid

B. Each signal and function shall be fully tested. These tests shall be based on actual operation of primary elements and verification of proper control system response. Submit test results as part of Operations and Maintenance Manual.

C. Record calibrations of all analog devices.

D. Demonstrate proper operation of the process and instrumentation control system to the Owner and in the presence of the Engineer.

3.5 TRAINING

A. Training shall be suitable for plant operations personnel with limited knowledge of electrical components. Refer to:
1. Section 43 08 00 – Start-Up and Commissioning
2. Section 44 10 01 – Blower/Flare Skid

B. Provide one eight hour training session for landfill personnel with a qualified technician from the manufacturer. Training shall consist of operations instruction and maintenance/troubleshooting instruction.
1. Operations instruction shall identify all control loops with description of all interlocks, interface with other loops, and operational input requirements. Describe procedures for re-starting the system.
2. Maintenance instruction shall identify periodic maintenance that can be performed by the operator. Provide description of procedures and locations for replacement of consumable devices such as fuses and for checking the calibration or operation of devices.
3. Troubleshooting instruction shall identify simple procedures and methods for identifying potential causes in the event of failures. For example, instruct operator on correlation of input signals and PLC I/O module indicator lights.

END OF SECTION
SECTION 26 90 10

CONTROL PANEL CONSTRUCTION

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards:
   a. ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
   b. ANSI/NFPA 79 - Electrical Standard for Industrial Machinery.


   a. CSA Standard C22.2 No. 0 - General Requirements - Canadian Electrical Code, Part II
   b. CSA Standard C22.2 No. 0.4 - Bonding and Grounding of Electrical Equipment (Protective Equipment)
   c. CSA Standard C22.2 No. 14 - Industrial Control Equipment for Use in Ordinary (Non-Hazardous) Locations
   d. CSA Standard C22.2 No. 40 - Cutout, Junction, and Pull boxes
   e. CSA Standard C22.2 No. 94 - Special Purpose Enclosures


   a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
   b. IEC 60204 - Safety of Machinery - Electrical Equipment of Machines
   c. IEC 60079 - Electrical Apparatus for Explosive Gas Atmospheres

   a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
   b. NEMA ICS6 - Enclosures for Industrial Controls and Systems

   a. UL50 - Cabinets and Boxes
   b. UL508 - Industrial Control Equipment
   c. UL508A - Industrial Control Panels
   d. UL94 - Flammability of Plastic Materials
#### 1.3 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Instrumentation & Controls

#### 1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Instrumentation & Controls.

#### 1.5 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Instrumentation & Controls.

#### 1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under Section 26 90 00 - Instrumentation & Controls.

#### 1.7 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. All control panels shall be constructed in accordance with UL 508 standards and shall bear the UL 508 listing.

#### 1.8 WARRANTY

A. See Division 01 for additional requirements.
1.9 EXTRA MATERIALS

A. See Division 01 for additional requirements.

B. Provide one spare vapor phase corrosion inhibiting capsule for each control panel.

C. Provide a ten or twenty percent of the total number of terminals as installed spares in each control panel.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Fabricate, install instruments, plumb and wire in factory.

B. Test wiring and plumbing prior to shipment.

C. Make external connections by way of numbered terminal blocks.

D. Separate electrical components from pneumatic and hydraulic components by metal barriers.

E. Conform to ISA standards.

2.2 TYPE A - CONTROL PANEL ENCLOSURE, WALL-MOUNTED

A. Manufacturer:
   1. Hoffman Enclosures, Inc. Concept Wall-Mount Enclosure
   2. or equal

B. Environmental Rating:
   1. NEMA Type 4X

C. Construction:
   1. 16 gauge stainless steel
   2. Seams continuously welded and ground smooth
   3. Minimum width body flange trough excludes liquids and contaminants
   4. Integral body grounding stud
   5. Panel mounting studs
   6. Mounting holes in back of body for direct mounting
   7. Hidden hinges for clean aesthetic appearance
   8. Standard full access 170 degree door opening
   9. Doors are interchangeable and easily removable by pulling captive hinge pins
   10. Door bar on hinge side for wire management and grounding
   11. Additional door bar and stiffener on larger enclosures for extra rigidity
   12. High-impact thermoplastic data pocket
13. Seamless foam-in-place one-piece gasket provides oil-tight and dust-tight seal against contaminants
14. Self-grounding latch system with double seal provides maximum protection against leakage
15. Quarter-turn door latching system installed on door with a slotted insert
16. Control panel should be built to UL 508A standards

PART 3 - EXECUTION

3.1 FIELD MEASUREMENTS

A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation.

3.2 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation

3.3 INSTALLATION

A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation

3.4 CONTROL PANEL FABRICATION AND ENVIRONMENTAL PROTECTION REQUIREMENTS

A. Instrument Mounting:
   1. Instrument mounting height shall not exceed 6 ft-6 in. Minimum height shall be 4 ft-0 in.
   2. Panel cutouts for instruments and other devices, such as lights and switches, shall be cut, punched, or drilled and smoothly finished with rounded edges.
   3. Provide steel angle stiffeners on back of panel face to prevent panel deflection under instrument loading or operation.
   4. Provide internal structural steel framework for instrument support purposes and panel bracing. Internal framework shall permit lifting of panel without racking or distortion.

B. Corrosion Protection:
   1. Provide vapor phase corrosion inhibiting capsules in each control panel to protect all exposed metal surfaces for a period of at least two years. Corrosion inhibiting modules shall be Northern Instrument Corporation, Zerust vapor capsules Model VC-2-2 or Hoffman Engineering Corporation corrosion inhibitor Model A-HCI-5.
   2. Provide thermostatically controlled condensation heater in panels located high humidity areas and in areas in which ambient temperature will vary. Heater shall be sized to prevent condensation within panel.
C. Heating, Ventilating, and Air Conditioning:
   1. Provide heating equipment as specified under Part 2.
   2. Provide filtered ventilation fan(s) where needed and sized to dissipate heat generated by components located within control panel.
   3. Provide filtered air conditioning equipment and insulate panel where needed to maintain internal panel temperature within operating parameters of internal panel components.

3.5 CONTROL PANEL ELECTRICAL REQUIREMENTS

A. Electric Service:
   1. Design control panel to operate on electrical supply indicated on the drawings.
      a. Three phase service:
         1) Provide main circuit breaker.
         2) Provide branch circuit breakers for distribution of three phase and single phase power at voltages above 120VAC.
         3) Control panel and internal components shall be rated to interrupt the available fault current.
         4) Main circuit breaker and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the main circuit breaker.
         5) Separate 480VAC wiring from control voltage wiring.
         6) Provide appropriately sized control power transformer.
         7) Provide miniature circuit breakers for distribution of 120VAC control power in accordance with the following:
            (a) No more than 20 devices on any single circuit.
            (b) Where multiple units perform parallel operations, do not group all devices on the same branch circuit. The purpose is to prevent the failure of any single branch circuit from shutting down at entire operation.
            (c) Do not exceed the ampacity of the branch circuit.
            (d) Panel service outlet shall be protected by separate branch circuit breakers
            (e) Power supplies shall be protected by separate branch circuit breakers.
         8) Provide 20 amp, 120VAC service outlet circuit within back-of-panel area.
         9) Control power transformer fuses and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the control power transformer fuses.
         10) Branch circuit breakers shall be rated for 15A and 250VAC.
         11) Fuses shall not be substituted for circuit breakers.
      b. Single phase service:
         1) Provide main circuit breaker.
         2) Provide miniature circuit breakers for distribution of 120VAC control power in accordance with the following:
            (a) No more than 20 devices on any single circuit.
            (b) Where multiple units perform parallel operations, do not group all devices on the same branch circuit. The purpose is to prevent the failure of any single branch circuit from shutting down at entire operation.
operation.
(c) Do not exceed the amperage of the branch circuit.
(d) Panel service outlet shall be protected by separate branch circuit breakers.
(e) Power supplies shall be protected by separate branch circuit breakers.

3) Provide 20A, 120VAC service outlet circuit within back-of-panel area.
4) Main circuit breaker and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the main circuit breaker.
5) Branch circuit breakers shall be rated for 15A and 250VAC.
6) Fuses shall not be substituted for circuit breakers.

c. Uninterruptible power supply:
1) Where panel is equipped with an uninterruptible power supply, provide distribution of 120VAC power on the line and load sides of the UPS.
2) Panel service outlet and other non-critical loads shall be powered from the line side of the UPS. Critical loads, including but not limited to all digital control equipment, shall be powered from the load side of the UPS.
3) Provide UPS bypass circuitry to minimize heating of control panel and unnecessary wear of the UPS battery.

d. Back-up control systems:
1) Where panel includes fail-safe back-up control circuitry, the back-up control circuits shall be fed with a separate circuit from a lighting panel or from a separate control power transformer.

B. Output Signal Fusing:
1. Provide appropriately sized fuses for all output signals to devices located external to the panel in accordance with the following requirements:
   a. Maximum fuse size: 5A
   b. Separate fuse for each device
   c. Fuses shall be installed in indicating type fuse holder terminal blocks.

C. Control Panel Wiring:
1. Wiring within panels, consoles, racks, and cabinets shall meet the following requirements:
   a. Wires for ac circuits shall be 300V or 600V, Type MTW stranded copper and shall be sized for the current to be carried but not smaller than No.16 AWG.
   b. Wires for analog signal circuits shall be 300V stranded copper and shall be twisted shielded pairs not smaller than No.18 AWG.
   c. Wires for other dc circuits shall be 300V, Type MTW stranded copper not smaller than No.18 AWG.
   d. Wiring for special signals such as communications, digital data, and multiplexed signals shall use manufacturers standard cables.
2. Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:
   a. Wire all spare or unused panel mounted elements, including PLC input/output points, to terminal blocks.
   b. Provide open construction terminal blocks for wiring that is entirely internal to the panel.
c. Provide isolation switch terminal blocks for all wiring that is not entirely internal to the panel.
d. Rail-mount individual terminals to create a complete assembly. Provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.
e. Size all terminal block components to allow insertion of all necessary wire sizes and types.
f. Provide power distribution blocks for distribution of control panel power at voltages exceeding 120VAC.
g. All terminations within the control panel shall be finger safe.

3. Grounding:
a. Panels, consoles, racks, and cabinets shall be provided with an isolated copper grounding bus for all signal and shield ground connections. This ground bus shall be grounded at a common single ground point. The signal grounding system shall meet National Electrical Code requirements.
b. Each analog loop shall only be grounded at a single point for the loop. This single point shall be at the location of the dc power supply for the loop.

D. Power Supplies:
1. Provide dc power supplies as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Power supplies shall be suitable for intrinsically safe circuits where two-wire transmitters are located in a hazardous area.

E. Electrical Transient Protection:
1. All electrical and electronic elements of the control system shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.
2. Surge Suppressor Locations:
   a. As a minimum, provide surge suppressors at the following locations:
      1) Provide 480VAC, panel mounted surge suppressor on the load side of each 480VAC main circuit breaker in each panel.
      2) Provide 120VAC, panel mounted surge suppressor on the load side of each 120VAC main circuit breaker in each panel.
      3) Provide 24VDC, panel mounted surge suppressor at the panel connections of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.
      4) Provide 24VDC, field mounted surge suppressor at the field connection of each analog signal transmitter located outside of a protecting building.

3.6 STANDARD SIGNAL INTERFACES

A. Unless otherwise specified discrete input and output signals shall conform to the following:
1. Isolated unpowered (dry) contact closures.
2. Power contact from panel receiving signal or device receiving signal.
B. Unless otherwise specified input and output analog signals shall conform to following:
1. External to panel: isolated, 4-20 mA DC.
2. Internal to panel: 1 to 5VDC signals.
3. For 2-wire transmitter provide isolated type and power with 24VDC from panel or device receiving signal.
4. Where isolation is required to interface with particular equipment or because of loop impedance, provide isolated, DC-to-DC transmitter.

3.7 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Instrumentation & Controls.

3.8 TRAINING

A. Refer to the requirements of Section 26 90 00 - Instrumentation & Controls.

END OF SECTION
SECTION 26 90 11

CONTROL PANEL COMPONENTS

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

   a. ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
   e. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

2. CE - European Community, Applicable Directives.
   a. EN50005 - for Terminal Markings.
   b. EN50081-1 - Generic Emission Standard.
   c. EN50082-1 - Generic Immunity Standard.
   d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
   e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.

3. Canadian Standards Association (CSA), Specifications and Standards, current edition:
   a. CSA C22.2, Industrial Control Equipment.

4. CUL - Underwriter's Laboratories of Canada.

5. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
   a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures

6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
   a. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   b. NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
7. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
   a. UL508 - Industrial Control Equipment.
   b. UL508A - Industrial Control Panels.
   c. UL 913 - Intrinsically Safe Specification.
   d. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 44 10 01 – Landfill Gas Blower System Installation.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 44 10 01 – Landfill Gas Blower System Installation.

1.5 FACTORY TESTING

A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation.

1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under Section 44 10 01 – Landfill Gas Blower System Installation.

1.7 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.
C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 WARRANTY

A. See Division 01 for additional requirements.

1.9 EXTRA MATERIALS

A. See Division 01 for additional requirements.

B. Supply five spare control power transformer fuses of each type supplied for this project.

C. Supply five spare lamps of each type supplied for this project.

D. Supply two spare relays of each type supplied for this project.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKER - MINIATURE

A. Manufacturer:
   1. Square D QOU Unit Mount Class 720
   2. Or equal

B. Agency Approvals:
   1. UL Listed

C. General:
   1. Surface, flush or DIN rail mounting in one-, two- and three-pole construction.
   2. Used for overcurrent protection and switching on both ac and dc systems.

D. Construction:
   1. Terminal lug wire size: 1- No.14 - No.2 AWG Cu or Al
   2. Reversible line and load lugs for convenient flush or surface mount wiring
   3. DIN mounted (symmetrical rail 35 x 7.5 DIN/EN 50 022)
   4. UL Listed as HACR type -- 15A to 70A
   5. Field installable quick connectors
   6. Single handle with internal common trip
   7. UL Listed 48VDC (5,000 AIR)
2.2 CONTROL POWER TRANSFORMER

A. Manufacturer:
   1. Cutler Hammer, Type MTE
   2. Square D
   3. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CSA Certified

C. Construction:
   1. Epoxy encapsulated coils
   2. High quality silicon steel laminations
   3. Copper magnet wire
   4. 55 degree C rise, Class 105 insulation system
   5. Molded terminals

D. Electrical:
   1. Capacity:
      a. Select transformer VA rating based upon connected load with an additional 25 percent spare capacity.
   2. Primary terminals:
      a. 240 x 480VAC
      b. 230 x 460VAC
      c. 220 x 440VAC
      d. Finger-safe terminal covers
   3. Secondary terminals:
      a. 120VAC
      b. 115VAC
      c. 110VAC
      d. Finger-safe terminal covers
   4. Fusing:
      a. Dual primary fuse block
      b. Single secondary fuse block
      c. Finger-safe fuse block covers
      d. Class CC fuses, sized for VA rating of transformer
   5. Mounting:
      a. Back panel

2.3 INTRINSICALLY SAFE BARRIER

A. Manufacturer:
   1. R. Stahl, Intrinsipak Series 9001/9002
   2. Or equal
B. Certificates:
   1. Zone 1: PTB 01 ATEX 2088
   2. Zone 2: PTB 01 ATEX 2135

C. Explosion protection:
   1. Zone 1: E II (1/2)G [EEx ia/ib] IIC/IIB
   2. Zone 2: E II 3G EEx nA II T4

D. Enclosure material: Polyamide 6 GF

E. Degree of Protection
   1. According to IEC 60529
      a. Terminal enclosure: IP 20
      b. Housing: IP 40

F. Connection:
   1. 4 cage terminals, each maximum 1.5 sq-mm flexible/solid
   2. 2 PA-terminals, each maximum 4 sq-mm flexible / solid
   3. Replaceable back-up fuse

G. Environmental:
   1. Temperature:
      a. Ambient: -20 to 60 degrees C
      b. Storage: -20 to 75 degrees C
   2. Maximum relative humidity 95 percent, non-condensing

H. Leakage current: less than 1 mA

I. Installation:
   1. Panel mounted in accordance with ANSI/NFPA 70.

J. Hazardous Location Switch:
   1. Maximum lead length: 1000 feet
   2. Non-energy storing or generating
   3. Contains no capacitance or inductance, resistive switch only
   4. Installed in accordance with ANSI/NFPA 70.

2.4 INTRINSICALLY SAFE RELAY

A. Manufacturer:
   1. Diversified Electronics, Inc. - Model ISO-120-xx
   2. Or equal

B. Agency Approvals:
   1. UL 913
   2. Class I, Groups A, B, C, D
3. Class II, Groups, E, F, G
4. Class III

C. Construction:
1. Surface mount enclosure
2. Life expectancy:
   a. Mechanical: 20 million operations
   b. Electrical: 50,000 operations at rated load
   c. Duty Cycle: continuous
3. Operating Temperature: -4 to 131 degrees F

D. Electrical:
1. Control Voltage: 120VAC, 60 Hz, nominal
2. Control Switch:
   a. Open circuit voltage: 6.2VDC
   b. Short circuit current: 10μA
3. Isolation: 2500VAC, input to output
4. Power Consumption: 2.5VA
5. Contact rating:
   a. SPST - N.O.
   b. 5A per channel, 120VAC, resistive
   c. 278VA, inductive
6. Channels: 2, 3, or 4
7. Status LED: One per channel

E. Installation:
1. Panel mounted in accordance with ANSI/NFPA 70

F. Hazardous Location Switch:
1. Maximum lead length: 1000 feet
2. Non-energy storing or generating
3. Contains no capacitance or inductance, resistive switch only
4. Installed in accordance with ANSI/NFPA 70

2.5 PILOT DEVICE - INDICATING LIGHT

A. Manufacturer:
1. Allen Bradley Bulletin 800T/800H
2. Cutler-Hammer
3. Square D.
4. Or equal

B. Agency Approvals:
1. UL Listed
2. CSA Certified
3. CE Compliant
C. Mechanical:
   1. Size: 30.5 mm
   2. Environmental rating:
      a. NEMA 4/13 watertight/oiltight: NEMA 1, 12, 3R, 4 control panels
      b. NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
   3. Life expectancy: 200,000 operations
   4. Push-to-test, transformer type, dual input

D. Electrical:
   1. Input power: 120VAC
   2. Lamp:
      a. High visibility, 28 chip cluster LED
      b. Color: red, green, amber, as scheduled
   3. Lens: High impact plastic, colored to match lamp

E. Nameplate: Standard or jumbo with engraved service legend

F. Field Mounted Control Stations:
   1. Type I Enclosure: NEMA 4X polycarbonate enclosure
   2. Type II Enclosure: NEMA 4X stainless steel enclosure
   3. Type III Enclosure: NEMA 7 hazardous location enclosure

2.6 PILOT DEVICE - PUSHBUTTON

A. Manufacturer:
   1. Allen Bradley Bulletin 800T/800H
   2. Cutler-Hammer
   3. Square D
   4. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CSA Certified
   3. CE Compliant

C. Mechanical:
   1. Size: 30.5 mm
   2. Environmental rating:
      a. NEMA 4/13 watertight/oiltight: NEMA 1, 12, 3R, 4 control panels
      b. NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
   3. Life expectancy: 10,000,000 operations
   4. Momentary contact, non-illuminated
D. Electrical:
1. Rated Voltage: 120VAC
2. Continuous current rating:
   a. AC: 10A
   b. DC: 2.5A
3. Operational current:
   a. Make: 7200VA
   b. Break: 720VA
4. Operator:
   a. Mushroom head: Emergency stop service
   b. Flush-head: All other services

E. Nameplate: Standard or jumbo with engraved service legend

F. Field Mounted Control Stations:
1. Type I Enclosure: NEMA 4X polycarbonate enclosure
2. Type II Enclosure: NEMA 4X stainless steel enclosure
3. Type III Enclosure: NEMA 7 hazardous location enclosure

2.7 PILOT DEVICE - SELECTOR SWITCH

A. Manufacturer:
1. Allen Bradley Bulletin 800T/800H
2. Cutler-Hammer
3. Square D.
4. Or equal

B. Agency Approvals:
1. UL Listed
2. CSA Certified
3. CE Compliant

C. Mechanical:
1. Size: 30.5 mm
2. Environmental rating:
   a. NEMA 4/13 watertight/oiltight: NEMA 1, 12, 3R, 4 control panels
   b. NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
3. Life expectancy: 1,000,000 operations
4. Maintained contact, non-illuminated (spring return from right or left where scheduled)

D. Electrical:
1. Rated Voltage: 120VAC
2. Continuous current rating:
   a. AC: 10A
2. DC: 2.5A
3. Operational current:
   a. Make: 7200VA
   b. Break: 720VA

4. Operator:
   a. Standard knob operator, two-position, or three-position
   b. Keyed operator: where scheduled

E. Nameplate: Standard or jumbo with engraved service legend

F. Field Mounted Control Stations:
   1. Type I Enclosure: NEMA 4X polycarbonate enclosure
   2. Type II Enclosure: NEMA 4X stainless steel enclosure
   3. Type III Enclosure: NEMA 7 hazardous location enclosure

2.8 POWER SUPPLY - 12/24VDC

A. Manufacturer:
   1. IDEC PS5R Series
   2. SOLA/Hevi-Duty Series SDP
   3. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CE Marked

C. Mechanical:
   1. Enclosure:
      a. IP20
      b. Sealed plastic
      c. Fine ventilation grid
   2. Mounting: DIN rail

D. Electrical:
   1. Capacity:
      a. Size to power connected loads. Reserve 25 percent of capacity for future use.
      b. Provide multiple power supplies where needed to accommodate load.
   2. Input:
      a. Voltage: 85-264VAC
      b. Frequency: 43-67Hz
      c. Efficiency: 88.5 percent
      d. Current: 1.0A at 100VAC
   3. Output:
      a. Voltage: 24-28VDC or 10-12VDC
      b. Voltage regulation: 2 percent
c. Overvoltage protection: 40VDC
d. Noise suppression: EMI values below EN50081-1
e. Current: 2.1A at 24VDC or 2.5A at 12VDC

4. Monitoring:
   a. LED Indicator
   b. Output power good status contact

2.9 POWER SUPPLY - 120VAC, Uninterruptible

A. Manufacturer:
   1. Eaton/Powerware 9130
   2. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CE Marked
   3. FCC Approved

C. General:
   1. Topology: True online, double-conversion
   2. Diagnostics: Full system self-test on power up
   3. UPS Bypass Automatic: on Overload or UPS failure less than 4 ms
   4. Transfer Time to battery: 0 ms
   5. Overload Capacity:
      a. 125 percent for 10 minutes before transfer to bypass
      b. 150 percent for 10 seconds before transfer to bypass

D. Input:
   1. Input voltage: 80-144VAC, single phase, 60 Hz
   2. Input power factor: greater than 95 percent
   3. Input Line: NEMA 5-15 plug and cord
   4. Protection: fuse or circuit breaker

E. Electrical Output:
   1. Voltage Regulation:
      a. On Utility: +/-2 percent of nominal
      b. On Battery: +/-3 percent of nominal
   2. Nominal Output Voltage: Same as selected input voltage
   3. Output Voltage Waveform: Sine Wave
   4. Output Voltage Distortion: less than 3 percent THD
   5. Output Line: 4 NEMA 5-15 receptacles, minimum
   6. Output protection: Electronic overload sensing, and circuit breaker protection
   7. Efficiency:
      a. Online Mode: greater than 86 percent
      b. Hi-Efficiency Mode: greater than 90 percent
F. Battery:
1. Internal Battery type: Sealed, lead-acid; maintenance free
2. On Battery Runtime: ten minutes
3. Battery Replacement: Hot-swappable internal batteries
4. Recharge Time: less than 4 hours to 90 percent capacity
5. Start-On-Battery: Allows start of UPS without utility input

G. Environmental:
1. Temperature:
   a. Operating: 32 to 104 degrees F
   b. Storage: 5 to degrees 122 F
2. Relative Humidity: 0 to 95 percent non-condensing
3. Audible Noise at 1 meter: less than 52dB
4. Altitude: 10,000 feet without deteriorating

H. Communications:
1. Relay Output Card:
   a. Line Fail
   b. Low Battery
   c. UPS Fault
   d. Bypass
2. User Interface: LCD status screen
3. Audible Alarms UPS alarm conditions, including:
   a. On-Battery
   b. Low Battery
   c. Overload
   d. UPS Fault
4. Communications: One RS232 Serial Port; One Communications Slot; One USB Port
5. Communications cable: 6-foot communications cable included

I. Manufacturer’s Warranty:
1. Warranty: 2 year comprehensive, including battery
2. Equipment Protection Policy: $25,000 lifetime protection including lightning damage

2.10 POWER SUPPLY - 24VDC, Uninterruptible

A. Manufacturer:
1. PULS Dimension DC-UPS
2. Or equal

B. Agency Approvals:
1. UL Listed
2. CE Marked
C. Capacity:
   1. Provide DC-UPS system as needed to provide power to all connected loads for a minimum of 30 minutes in the event of a power outage.

D. Features:
   1. DC-Uninterruptible Power Supply
   2. Buffer Module.
   3. On-board status and diagnostic LEDs.
   4. Electronic output current limitation.

E. Battery:
   1. Internal Battery type: Sealed, lead-acid; maintenance free
   2. On Battery Runtime: ten minutes
   3. Battery Replacement: Hot-swappable internal batteries
   4. Recharge Time: less than 4 hours to 90 percent capacity
   5. Start-On-Battery: Allows start of UPS without utility input

F. Environmental:
   1. Temperature:
      a. Operating: -13 to 158 degrees F
      b. Storage: -40 to degrees 185 F
   2. Relative Humidity: 5 to 95 percent non-condensing
   3. Audible Noise at 1 meter: less than 52Db
   4. Altitude: 0 to 6000 meters without deteriorating (Listing applies only to 2000 meters).

G. Communications:
   1. Provide dry contacts for monitoring the following status:
      a. Ready
      b. Buffering (In Use)
      c. Replace Battery
   2. Interface all status signals to PLC and log events.

H. Manufacturer’s Warranty:
   1. Warranty: 3 year comprehensive, including battery

2.11 RELAY - 120V GENERAL PURPOSE

A. Manufacturer:
   1. Allen Bradley Bulletin 700-HB
   2. IDEC RU Series
   3. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CE Marked
C. Mechanical:
   1. Enclosure: Transparent dust cover
   2. Contacts: Silver cadmium oxide
   3. Insulating Material: Molded, high dielectric
   4. Terminal Markings: In accordance with EN50-0005
   5. Life expectancy: 10,000,000 operations
   6. Operations:
      a. Pickup: 20 mS
      b. Dropout: 4 mS
      c. Maximum Rate: Four operations per second
   7. Blade style, quick connect terminals

D. Electrical:
   1. Contacts:
      a. Double-pole, double throw
      b. Rated thermal current: 15A
      c. Make: 60A
      d. Break: 6A
   2. Coil:
      a. 120 VAC + 10, -20 percent
      b. Consumption:
         1) Inrush: 2.85 VA
         2) Sealed: 1.9 VA
   3. Voltage:
      a. Rated Insulation Voltage: 250V IEC-300V UL/CSA
      b. Dielectric Withstand Voltage:
         1) Pole-to-Pole: 1500V
         2) Contact to Coil: 6000V
         3) Contact to Frame: 4000V
   4. Push-to-Test Operator
   5. Pilot light

E. Relay Socket:
   1. 11-blade
   2. Finger-safe terminal
   3. DIN rail mounted
   4. Double tier
   5. Retainer clip
   6. Relay identification snap-in markers

2.12 RELAY - SOLID STATE

A. Manufacturer:
   1. Allen Bradley Bulletin 700-SH
   2. IDEC RSS Series
   3. Or equal
B. Agency Approvals:
   1. UL Recognized
   2. CE Marked

C. Electrical:
   1. Input:
      a. Voltage: 4-32VDC
      b. Impedance: 15mA, maximum, voltage dependent
      c. Pick-up voltage: 4VDC
      d. Drop-out Voltage: 1VDC
      e. Dielectric Strength: 2500VACrms
      f. Reverse voltage protection
   2. Output:
      a. Continuous current: 10A
      b. Voltage range: 19-264VAC
      c. Contact: SPST - N.O.
      d. Off State leakage: 5 mA max (at 100VAC)
      e. Turn-On/Turn-Off time: 0.5 cycle
   3. Features:
      a. Photo isolation
      b. Dual SCR output
      c. Built-in snubber

2.13 RELAY - TIME DELAY

A. Manufacturer:
   1. Allen Bradley Bulletin 700-HS
   2. IDEC, RTE Series
   3. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CE Marked

C. Mechanical:
   1. Insulation resistance: 100 Mohms, minimum
   2. Dielectric strength: 1500VAC, 1 minute
   3. Vibration resistance: 6N
   4. Shock resistance: 500N
   5. Operating temperature: -20 to 65 degrees C
   6. Operating humidity: 45 to 85 percent, relative
   7. Blade style: quick-connect terminals

D. Electrical:
   1. Contacts:
      a. Two Form C double-pole, double-throw
      b. 10A, 240VAC, resistive
2. Timing functions:
   a. Delay on make/interval
   b. Delay on break/single shot
   c. Range: 0.1 seconds - 10 minutes, or 0.1 minutes - 10 hours

3. Accuracy:
   a. Repeat: + 0.25 percent
   b. Voltage: + 1.0 percent
   c. Temperature error: + 2.0 percent
   d. Setting error: + 10.0 percent

E. Relay Socket:
   1. 11-blade
   2. Finger-safe terminal
   3. DIN rail mounted
   4. Double tier
   5. Retainer clip
   6. Relay identification snap-in markers

2.14 SURGE SUPPRESSOR - 24VDC, FIELD MOUNTED

A. Manufacturer:
   1. EDCO/Emerson SS65 Series
   2. Or equal

B. Agency Approvals:
   1. UL Listed

C. General Description:
   1. Transient Protection for Low-Voltage Signal Lines
   2. Sneak/Fault Current Protection
   3. Resettable Fusing-PTCs
   4. Differential and Common Mode Protection
   5. Automatic Recovery
   6. Encapsulated in Stainless Steel Pipe Nipples
   7. Silicon Avalanche Hybrid Technology
   8. UL 497B Listed
   9. Protection for One Pair (Two Wires & Shield on SS65)

D. Electrical:
   1. Response Time: less than 1 nanosecond
   2. Maximum Signal Voltage: 28VDC
   3. DC Clamping Level:
      a. Line-to-Ground: 36V +/-10 percent
      b. Line-to-Line: 72V +/-10 percent
   4. Maximum Let-Thru Voltage:
      a. Line-to-Ground (10x700 microseconds): 44V at 400A
      b. Line-to-Line (10x700 microseconds): 90V at 400A
5. Series Resistance (per conductor): 5 Ohms (typical)
6. Capacitance (zero volts bias):
   a. Line-to-Line: 600pf typical
   b. Line-to-Ground: 1200pf typical
7. Number of Occurrences: 400 at 500 Amps (10x1000 microseconds)

2.15 SURGE SUPPRESSOR - 24VDC/120VAC SIGNAL, PANEL MOUNTED

A. Manufacturer:
   1. Circuit Components Incorporated, Surge Control SPU Series
      a. Base Module: SPU-xx-LM
      b. Daughter Module: SPU-xx-CD-30/120
   2. Or equal

B. Agency Approvals:
   1. UL Listed

C. General Description:
   1. Performance exceeds highest class severity level of IEC/EN 61000-4-4 and 61000-4-5
   2. Enhanced filtering to attenuate high frequency and bring equipment into compliance with IEEE /ANSI C37.90.1
   3. Universal hardwired version for all I/O modules including AC, DC, contact output, current output and signal input
   4. Multi-stage design provides the most effective suppression and filtering available, and requires no additional secondary protection
   5. Sub-nano second response time stops failures due to lightning, spikes and over-voltage surges while filtering all other electrical noise
   6. Plug-in replaceable daughter card modules contain all active surge suppression
   7. Space efficient protector is hermetically sealed and suitable for the harshest industrial environments
   8. Universal DIN-Rail mounting allows easy installation on any standard DIN-Rail configuration
   9. Automatic reset and fail safe design requires no maintenance. Eliminates “Out of Service” downtime and repair/replacement costs caused by damaging electrical surges
   10. Protection for current loop instrumentation and low frequency signal/data lines
   11. UL-497B listed for Data Models (60 VDC or less) UL file E205158

D. Electrical:
   1. Signal Channels: 5, 10, 15, or 20
   2. Operating: +/-30VDC
   3. Maximum Operating Voltage: 33VDC
   4. Maximum Operating Current: 0.5A
   5. Clamping Action Turn-On: 37.1V
   6. Maximum Clamping (8x20 micro-seconds): 52V
   7. Maximum Surge Voltage: 6kV
8. Maximum Surge Current (8x20 micro-seconds): 2.5kA
9. Response Time: Less than 1 nanosecond
10. Operating & Storage Temperature: -40 to 85 degrees C.

2.16 SURGE SUPPRESSOR - 120VAC/208VAC/480VAC POWER, PANEL MOUNTED

A. Manufacturer:
   1. Intermatic Model AG2401C-IND/AGC6503-IND
   2. Or equal

B. Agency Approvals:
   1. UL Listed

C. General Description:
   1. ANSI/IEEE C62.11 for Category 'C' locations. The arrester shall provide protection between each phase conductor and ground. The Secondary Surge Arrester shall employ parallel MOV's and provide protection from Category 'C' level transient surges as defined in ANSI/IEEE C62.11, C62.34, C62.41.1 and C62.41.2 without degradation of components.
   2. The Maximum Continuous Operating Voltage (MCOV) shall comply with the following:
      a. 120VAC, single phase system: 150VAC
      b. 120/240VAC, single phase system: 150VAC
      c. 120/208VAC, three phase system: 150VAC
      d. 240VAC, three phase system: 275VAC
      e. 480VAC, three phase system: 550VAC
   3. The arrester housing shall be constructed of UV resistant polycarbonate or material of equal strength and UV resistance. All electrical connections shall be sealed in a UL component recognized epoxy to exclude moisture, dirt and corrosion. The encapsulation shall have a minimum UL Flame Class rating of 94V-0. A one-half inch threaded nipple and locknut shall be provided. Leads shall be a minimum of twelve gauge and eighteen inches in length.
   4. When subjected to a 8 x 20 micro-second test impulse, the Peak Clamping Voltage shall comply with the following: be no greater than 480V for 1500A, 710V for 5,000A or 1,110V for 10,000A (4 x 10 micro-second).
      a. 120VAC, or 120/240VAC, single phase systems:
         1) 480VAC for 1500A (4 x 10 micro-second)
         2) 710V for 5,000A (4 x 10 micro-second)
         3) 1,110V for 10,000A (4 x 10 micro-second)
      b. 120/208VAC, 240VAC, or 277/480VAC, three phase systems:
         1) 1850VAC for 1500A (4 x 10 micro-second)
         2) 2320V for 5,000A (4 x 10 micro-second)
         3) 2660V for 10,000A (4 x 10 micro-second)

D. Electrical:
   1. Technology: Parallel Metal Oxide Varistors (40 kA Line to Ground)
   2. Configuration: Each line to ground/neutral
3. Enclosure: Weatherproof and UV resistant NEMA 4 molded polycarbonate with metal threaded nipple
4. Operational indicators: Monitoring circuits supervise components in each phase. Individual green LED for each phase indicates proper operation. LED's will turn OFF on failure of protection
5. Encapsulation: UL component recognized epoxy potting compound. UL Flame class 94V-0; Relative Temperature Index: Electric - 90, Mechanical - 90
6. Mounting: 1/2-inch x 20 threaded nipple
7. Mounting bracket: Right angle aluminum bracket
8. Wiring: 18-inch of 12 gauge stranded copper wire is pre-connected for each phase, neutral and ground
9. Wire color code: Black - phase leads, White - ground/neutral lead
10. Ambient operating temperature: -40 to 185 degrees F

E. Manufacturer's Warranty:
1. 10-year limited

2.17 TERMINAL BLOCK - INDICATING FUSED

A. Manufacturer:
1. Allen Bradley Bulletin 1492-H4 (AC) or 1492-H5 (DC)
2. Or equal

B. Agency Approvals:
1. UL
2. CSA
3. IEC

C. Specifications:
1. Voltage Rating: 300VAC/VDC
2. Maximum Current: 12A
3. Wire Range (Rated Cross Section): No.30 to no.12 AWG
4. Leakage Current:
   a. 2 mA at 300VAC
   b. 2 mA at 24VDC
5. Working Voltage:
   a. 100 to 300VAC
   b. 10 to 57VAC/VDC
6. Fuse Size: 1/4 in x 1-1/4 in
7. Wire Strip Length 0.38 in
8. Tightening Torque: 3 to 7 lb-in
9. Density: 33 pcs./ft
10. Insulation Temperature Range: -40 to 221 degrees F
11. Accessories:
   a. Aluminum DIN Rail with Standoff Brackets
   b. End Barrier and End Anchors
   c. Side Jumper Insulating Sleeve
d. Marking Systems

2.18 TERMINAL BLOCK - ISOLATING SWITCH

A. Manufacturer:
   1. Allen Bradley Bulletin 1492-H7
   2. Or equal

B. Agency Approvals:
   1. UL
   2. CSA
   3. IEC

C. Specifications:
   1. Voltage Rating: 300VAC/VDC
   2. Maximum Current: 15A
   3. Wire Range (Rated Cross Section): No.30 to No.12 AWG
   4. Leakage Current:
      a. 2 mA at 300VAC
      b. 2 mA at 24VDC
   5. Working Voltage:
      a. 100 to 300VAC
      b. 10 to 57VAC/VDC
   6. Dummy Fuse Size: 1/4 in x 1-1/4 in
   7. Wire Strip Length 0.38 in
   8. Tightening Torque: 3 to 7 lb-in
   9. Density: 33 pcs./ft
  10. Insulation Temperature Range: -40 to 221 degrees F
  11. Accessories:
      a. Aluminum DIN Rail with Standoff Brackets
      b. End Barrier and End Anchors
      c. Side Jumper Insulating Sleeve
      d. Marking Systems

2.19 TERMINAL BLOCK - OPEN STYLE

A. Manufacturer:
   1. Allen Bradley Bulletin 1492-CAM1
   2. Or equal

B. Agency Approvals:
   1. UL
   2. CSA
   3. IEC
C. Specifications:
1. Voltage Rating: 600VAC/VDC
2. Maximum Current: 65A
3. Wire Range (Rated Cross Section): No.22 to No.8 AWG
4. Wire Strip Length: 0.38 in
5. Tightening Torque: 10 to 16 lb-in
6. Density: 30 pcs./ft
7. Insulation Temperature Range: -40 to 221 degrees F
8. Accessories:
   a. Aluminum DIN Rail with Standoff Brackets
   b. End Barrier and End Anchors
   c. Side Jumper Insulating Sleeve
   d. Marking Systems

2.20 TRANSMITTER - ISOLATED DC TO DC

A. Manufacturer:
1. Wilkerson Instrument Co., Model MM4300A
2. Or equal

B. Agency Approvals:
1. UL Listed

C. Construction:
1. 8-pin, relay socket
2. Operating temperature: -10 to 60 degrees C

D. Electrical:
1. Input: 4-20 mADC or 0-10VDC
2. Input impedance:
   a. Voltage: 200 kOhms
   b. Current 50 Ohms
3. Output range:
   a. Voltage: 0 - 10 VDC, 2 kOhm minimum load
   b. Current: 4-20 mADC, 24VDC compliance (1200 ohms/20 mADC)
4. Response time: Less than 100 ms
5. Accuracy: + 0.1 percent of span
6. Linearity: + 0.05 percent of span
7. Common mode rejection: 120 dB
8. Isolation:
   a. 500 megohms
   b. 1000VAC

E. Manufacturer's Warranty:
1. 10-year limited
PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS
A. Refer to the requirements Section 44 10 01 – Landfill Gas Blower System Installation.

3.2 DELIVERY STORAGE AND HANDLING
A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation.

3.3 INSTALLATION
A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation.

3.4 TESTING AND START-UP SERVICES
A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation.

3.5 TRAINING
A. Refer to the requirements of Section 44 10 01 – Landfill Gas Blower System Installation.

END OF SECTION
SECTION 26 90 20

INSTRUMENTATION DEVICES

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
      a. ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
      e. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   2. CE - European Community, Applicable Directives.
      a. EN50005 - for Terminal Markings.
      b. EN50081-1 - Generic Emission Standard.
      c. EN50082-1 - Generic Immunity Standard.
      d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
      e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.
   3. Canadian Standards Association (CSA), Specifications and Standards, current edition:
      a. CSA C22.2, Industrial Control Equipment.
   4. CUL - Underwriter's Laboratories of Canada.
   5. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
      a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
   6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
      a. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
b. NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.

7. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
   a. UL508 - Industrial Control Equipment.
   b. UL508A - Industrial Control Panels.
   c. UL 913 - Intrinsically Safe Specification.
   d. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation & Control

1.4 DESIGN REQUIREMENTS

### INSTRUMENTATION AND CONTROL COMPONENTS

<table>
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<tr>
<th>TAG</th>
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Notes:

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation & Control.
1.6 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

1.7 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation & Control.

1.8 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS

A. See Division 01 for additional requirements.

PART 2 - PRODUCTS

2.1 P4 - PRESSURE TRANSMITTER, GAUGE

A. Manufacturer:
1. Rosemount 3051 Series
2. Foxboro I/A Series
3. ABB 2600T Series
4. Siemens SITRANS Series
B. General:
1. High-performance gauge pressure transmitter with HART based digital communication capabilities.
2. Two-wire, capacitance, piezo-resistive, or silicon strain gauge

C. Construction:
1. The instrument shall be suitable for the following conditions:
   a. Humidity: 0-100 percent relative humidity.
   b. Ambient Temperature Limits: -40 to 185 degrees F.
2. Transmitter shall have dual-compartment housing with a moisture barrier completely isolating the electronic circuitry from the field wiring and calibration terminals.
3. Process-Wetted Parts:
   a. Drain/Vent Valves: 316 SST or Hastelloy C
   b. Process Flanges and Adapters: Plated carbon steel
   c. Wetted O-rings: Glass-filled TFE
4. Non-Wetted Parts:
   a. Electronics Housing: Low-copper aluminum
   b. Sensor Module Housing: CF-3M (Cast version of 316L SST, material per ASTM-A743)
   c. Bolts: 316SST
5. Sensor Module Fill Fluid: Silicone or inert halocarbon
6. Paint: Polyurethane
7. Cover O-rings: Buna-N
8. Isolating Diaphragm Material: 316L SST

D. Process Conditions:
1. Suitable for liquid, gas, and vapor service.
2. Process Temperature Limits:
   a. Silicone fill: -40 to 250 degrees F.
   b. Inert fill: 0 to 185 degrees F.

E. Measurement Ranges:
1. 2.5 in-H2O to 10,000 psig

F. Outputs:
1. Outputs shall be a 4-20 mA analog signal, user-selectable linear or square root, with a superimposed digital signal, using HART Protocol.
2. Analog output shall be adjustable remotely with a field communicator or control system.
3. Zero and span adjustments shall also be available on the transmitter.

G. Performance:
1. The transmitter shall meet the following performance criteria as a minimum:
   a. Total Performance: +/-0.15 percent of span.
   b. Stability: +/-0.125 percent of URL for 5 years.
   c. Accuracy: +/-0.075 percent of Calibrated Span.
d. Total Ambient Temperature Effect: +/- (0.0125 percent URL + 0.0625 percent span).

e. Time Response:
   1) Dead Time: 45 milliseconds (nominal)
   2) Time Constant: 55 milliseconds
   3) Update Rate: 20 times per second (minimum)

f. Vibration Effect: +/-0.1 percent of URL when tested from 15 to 2,000 Hz per SAMA PMC 31.1.

g. RFI Effect: Less than +/-0.1 percent of span from 20 to 1,000 MHz for field strength of 30 V/m per IEC 801-3.

H. Electrical:
   1. Electrical connections shall be 1/2-inch NPT conduit.
   2. Transmitter shall operate on 10.5 to 55 V dc, with no load.
   3. Enclosure rating: NEMA 4X (IP65), minimum.

I. Data Storage:
   1. Transmitter data shall be stored in nonvolatile EEPROM memory.
   2. Sensor module characterization data shall be an integral part of the sensor module.

J. Software Functionality:
   1. Transmitter shall be capable of digital communication over the 4-20 mA output loop without disruption, using the HART Communications Protocol.
   2. The transmitter shall perform continuous diagnostics, capable of self-test functions and be able to provide specific diagnostic information locally on the meter and remotely.
   3. The configuration capabilities of the transmitter shall allow the user the ability to input and store information including the range, engineering units, damping, square root or linear output, drain/vent valves, flange, and O-ring materials, date, message, descriptor, tag number, serial number, and remote seal information.
   4. Process variable and sensor module temperature information shall be available digitally.
   5. Transmitter software security shall be user selectable.
   6. Upscale/Downscale failure mode shall be user selectable.

K. Options:
   1. Digital LCD indicator with diagnostic capabilities.
   2. Mounting brackets.

2.2 T1 - TEMPERATURE TRANSMITTER, RTD

A. Manufacturer
   1. Temperature Sensor:
      a. Rosemount Series 68 Platinum RTD
      b. Or equal
   2. Temperature transmitter:
      a. Rosemount Model 644H
b. Or equal

B. Platinum RTD Temperature Sensor
   1. General:
      a. Spring-loaded design in sensor lengths from 1 to 24 inches.
   2. Construction:
      a. Designed for use with standard thermowell assemblies.
      b. Platinum Element and Lead Wire Configurations
         1) Single-element temperature sensors have four lead wires and may be used
            in 2-, 3-, and 4-wire signal conditioning systems.
   3. Specifications:
      a. Temperature Range: -50 to 400 degrees C (-58 to 752 degrees F).
      b. Effect of Temperature Cycling: +/-0.05 percent (0.13 degrees C or 0.23
         degrees F) maximum ice-point resistance shift following 10 cycles over the
         specified temperature range.
      c. Stability: +/-0.08 percent maximum ice-point resistance shift following 1,000
         hours at maximum specified temperature (400 degrees C).
      d. Maximum Hysteresis: +/-0.09 percent of operating temperature range.
      e. Time Constant: 4 seconds maximum required to reach 63.2 percent sensor
         response in water flowing at 3 ft/s (0.91 m/s).
      f. Self Heating: 20 mW minimum power dissipation required to cause a 1 degree
         C (1.8 degree F) temperature measurement error in water flowing at 3 ft/s.
      g. Insulation Resistance: 500 megohms minimum insulation resistance when
         measured at 100VDC at room temperature.
   4. Environmental:
      a. Humidity Limits: Lead seal is capable of withstanding 100 percent relative
         humidity.
      b. Vibration Limits: +/-0.05 percent maximum ice-point resistance shift due to 30
         minutes of 14 g peak vibration from 5 to 350 Hz at 20 degrees C (68 degrees
         F) for unsupported stem length of less than 6 inches.
   5. Quality Assurance:
      a. Each sensor is subjected to a resistance accuracy test at 0 degrees C and a rear
         seal integrity test.
   6. Physical:
      a. Sheath Material: 316 SST.
      b. Lead Wire: Teflon insulated, nickel-coated, 22-gauge stranded copper wire.

C. Thermowell:
   1. Type: spring-loaded.
   2. Material: 316SST.
   3. Length: 7.5 inches, field verify.

D. Transmitter:
   1. Functional:
      b. Output: 2-wire 4-20 mA, linear with temperature or linear with input. Digital
         output signal superimposed on 4-20 mA signal, available for HART
         communicator or control system interface.
c. Power Supply: 12.0 to 42.4VDC external power supply required with load resistance between 250 and 1100 ohms.
d. Isolation: Input/output isolation tested to 500VAC rms (707VDC)
e. Update Time: Approximately 0.5 seconds.
f. Local Indication: Five-digit LCD meter with fixed or floating decimal point. Display options include engineering units (F, C, R, K, ohms, and mV), percent, and mA. The display can also be set to alternate between selected display options. Display settings are preconfigured at the factory and can be reconfigured in the field with a HART communicator.
g. Humidity Limits: 0-99 percent, non-condensing
h. Transient Protection: Transient protector shall be provided to help prevent damage to the transmitter from transients induced on the loop wiring by lightning. The transient protection electronics are contained in an add-on assembly that attaches to the standard transmitter terminal block.
i. Temperature Limits: -40 to 185 degrees F operating, -50 to 185 degrees F storage.
j. Turn-on Time: Performance within specifications less than 5.0 seconds after power is applied to transmitter
k. Failure Mode:
   1) Software and hardware failure mode detection. An independent circuit is designed to provide backup alarm output if the microprocessor hardware or software fails.
   2) The alarm levels are user-selectable using the failure mode switch. If failure occurs, the position of the hardware switch determines the direction in which the output is driven (HI or LO). The switch feeds into the digital-to-analog (D/A) converter, which drives the proper alarm output even if the microprocessor fails.

2. Physical:
a. Electrical Connections:
   1) Conduit Connections: 1/2-inch NPT
   2) Power and Sensor Terminals: compression screws permanently fixed to terminal block.
b. Materials of Construction:
   1) Housing: Low-copper aluminum or CF-8M
   2) Electronics Housing: Noryl, glass reinforced
   3) Paint: Polyurethane
   4) Cover O-rings: Buna-N
c. Mounting: Transmitters may be attached directly to the sensor.
d. Enclosure Ratings: NEMA 4X, IP66, and IP68

3. Performance:
a. Accuracy: +/- 0.15 degrees C
b. Stability: +/-0.1 percent of reading or 0.1 degrees C, whichever is greater, for 12 months
c. Self Calibration: The analog-to-digital measurement circuitry automatically self-calibrates for each temperature update by comparing the dynamic measurement to extremely stable and accurate internal reference elements.
d. Power Supply Effect: Less than +/-0.005 percent of span per volt
e. RFI Effect: Worst case RFI effect is equivalent to the transmitter's nominal accuracy specification when tested in accordance with ENV 50140, 30 V/m, 80 to 1000 MHz, with unshielded cable.


2.3 T2 - TEMPERATURE SWITCH, AIR COIL SENSING

A. Manufacturer:
   1. Honeywell Model T631C1103
   2. Johnson/Controls/Penn Model A19BAC-1
   3. Or equal

B. General:
   1. Wide range control for applications with air coil sensing element
   2. Dustproof NEMA 1 enclosures
   3. UL Listed and CSA Certified

C. Specifications:
   1. Control Range: 30-100 degrees F
   2. Differential: 5 degrees F
   3. Switch Type: SPDT
   4. Application: Heating/Cooling
   5. Hydraulic Capillary:
      a. Dimensions: 1-3/8-inch by 2-1/4-inch, coiled
   6. Inductive Contact Ratings
      a. 120VAC/16A
      b. 240VAC/8A

2.4 T4 - TEMPERATURE SWITCH, HAZARDOUS LOCATION AIR COIL SENSING

A. Manufacturer:
   1. White-Rodgers Model 2A20-2
   2. Or equal

B. General:
   1. Wide range control for applications with air coil sensing element
   2. Cast aluminum housing
   4. UL Listed and CSA Certified

C. Specifications:
   1. Control Range: 40-90 degrees F
   2. Differential: 3 degrees F
   3. Switch Type: SPST
   4. Application: Heating
   5. Hydraulic Capillary: coiled
6. Inductive Contact Ratings
   a. 120VAC/14A
   b. 240VAC/7A

2.5 THERMAL MASS FLOW METER

A. Manufacturer:
   1. FCI (Model No. ST98).

B. General:
   1. Provide fully assembled flow meter train.
   2. Flow meter shall be installed at an accessible location, downstream of any disturbances as recommended by the manufacturer.
   3. Vendor shall install flow meter as per manufacturer recommendations.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.2 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.3 INSTALLATION

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.4 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.5 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

END OF SECTION
SECTION 26 90 30

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

   a. ANSI/NFPA 70 - National Electrical Code and state amendments thereto.

2. CE - European Community, Applicable Directives:
   a. EN50005 - for Terminal Markings.
   b. EN50081-1 - Generic Emission Standard.
   c. EN50082-1 - Generic Immunity Standard.
   d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
   e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.

3. Canadian Standards Association (CSA), Specifications and Standards, current edition:
   a. CSA C22.2, Industrial Control Equipment.

4. CUL - Underwriter's Laboratories of Canada.

5. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
   e. IEC1131-5. Programmable Controllers - Part 5: Communications.
   f. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures

6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
   a. NEMA ICS 2- Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   b. NEMA ICS 3- Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
7. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
   a. UL508 - Industrial Control Equipment.
   b. UL508A - Industrial Control Panels.
   c. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation & Control

B. Equip programmable logic controllers with memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.

C. Equip programmable logic controller systems with I/O as scheduled.

D. Provide modification to existing programmable logic controller systems as specified.

E. Software Configuration Rights:
   1. The software configuration files shall become the property of the owner. Identify all protection methods and turn over all keys and passwords to the owner.
   2. System supplier shall draft an agreement with the owner, to be reviewed by the engineer, identifying any consequences arising from modifications to the configuration files not authorized in writing by the system supplier during the specified warranty period. This agreement will be signed by the owner and supplier and copies of the document distributed to all parties. Unauthorized modifications to software configuration during the warranty period will result in a void warranty.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation & Control.

C. Submit the following information specifically for programmable logic controllers:
   1. Software configuration consisting of data tables, ladder logic, and other parameters.
   2. Identify coordination requirements with other sections.
1.5 FACTORY TESTING
   
   A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS
   
   A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

   B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation & Control.

   C. Submit the following information specifically for programmable logic controllers:
      1. As-built printout of all software configuration including data tables, ladder logic, passwords, and other parameters. Document software with English language descriptions and tag numbers where appropriate.
      2. Electronic documentation shall include fully annotated electronic copies of all PLC programs. As-built documentation shall include all changes made during the first year of operation.
      3. Software configuration files shall be included in the manual in two forms:
         a. CD ROM.
         b. Paper.

   D. Submit software license certificates, manufacturer provided software documentation, and software installation media.

1.7 QUALITY ASSURANCE
   
   A. All materials, equipment, and parts shall be new and unused of current manufacture.

   B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

   C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

   D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 WARRANTY
   
   A. See Division 01 for additional requirements.
1.9 EXTRA MATERIALS

A. See Division 01 for additional requirements. Extra materials to be provided if facility does not already have existing spares.

B. Supply one spare 120VAC discrete input/output module of each type supplied for this project

C. Supply one spare 24VDC analog input/output module of each type supplied for this project

D. Supply one spare processor of each type supplied for this project

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturers:
   1. Allen-Bradley/Rockwell Automation
   2. Or equal

2.2 GENERAL SYSTEM REQUIREMENTS

A. Common Hardware Specifications
   1. Environmental
      a. Ambient Temperature Rating:
         1) Operating: 0 to 60 degrees C
         2) Storage: -40 to 85 degrees C
      b. Humidity: 5 to 95 percent non-condensing
      c. Shock:
         1) Operating: 30 Gs (3 pulses, 11 mS)
         2) Non-operating: 50.0 Gs (3 pulses, 11 mS)
      d. Vibration:
         1) Vibration Operating: 1.0 G at 5 to 2000 Hz
         2) Non-operating: 2.5 Gs at 5 to 2000 Hz
      e. Free Fall (drop test):
         1) Portable, 2.268 kg (5 lbs) or less at 0.762m (Six drops)
         2) Portable, 2.268 kg (5 lbs) or more at 0.1016m (Three flat drops)
      f. Electromagnetic Compatibility:
         1) Showering Arc: 1.5 kV Per NEMA ICS 2/NEMA ICS 3
         2) Surge Withstand Capability: 3 kV per ANSI/IEEE C37.90
         3) Fast Transient Burst (impulse): 2 kV for power supplies, 1 kV for I/O and communication lines over 10m, 5 nS rise time
         4) Electrostatic Discharge: 15 kV, 100 pF/1.5 kohm model
         5) Radiated Electromagnetic Susceptibility: 5W walkie-talkie at 464.5 MHz and 153.05 MHz
6) Noise Immunity: NEMA Standard ICS 2

2. Safety:
   a. Dielectric Withstand: 1500VAC per UL 508, CSA C22.2
   b. Isolation between communication circuits: 500VDC
   c. Isolation between backplane and I/O: 1500VAC
   d. Flammability and Electrical Ignition: UL94V-0
   e. Certification:
      1) UL listed
      2) CSA certified
      3) CUL listed
      4) Class 1, Groups A, B, C or D, Division 2
      5) CE compliant for all applicable directives

B. Configuration
   1. The programmable controller, associated I/O, chassis, and power supplies shall be of a modular design. The programmable controller and I/O modules shall mount into the chassis
   2. Processor Systems shall include processor, power supply, input/output modules, communication modules, and remote interface modules as required to meet system requirements.
   3. Remote Input/Output Units shall include input/output modules, interface modules, communication modules, and power supply to meet system input and output requirements.
   4. Modules are to be supplied as specified unless system requirements dictate the use of alternative modules.

C. Selection
   1. The programmable controller shall be selected from a family of programmable controllers with memory capability ranging up to 7.5Mbytes.
   2. All system and signal power to the controller and support modules shall be distributed on a single motherboard or backplane.
   3. All system modules including the processor shall be removable from the chassis or inserted in to the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules.
   4. All system modules and chassis shall be designed to provide for free airflow convection cooling.
   5. Modules shall be designed to plug into a chassis and to be keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying shall perform an electronic check to insure that the physical module is consistent with what was configured for the corresponding slot.

D. Programming:
   1. Minimum Programming Instruction Set:
      a. Language Characteristics: Ladder diagram
      b. Logic Operations: AND, OR, XOR, NOT
c. Register Operations: Store, recall
d. Math Operations: Addition, subtraction, multiplication, division, square root, matrix operations
e. Process Control: Proportional-Integral-Derivative

2.3 PROGRAMMABLE LOGIC CONTROLLER SYSTEM, COMPACT LOGIX PLATFORM

A. Processor Unit:
1. Manufacturer:
   a. Allen-Bradley Compact Logix Model 1769-L35E
2. Processor Memory:
   a. Program memory of 1.5 Mbytes as dictated by the application. Compact flash memory card shall provide 64 Mbytes non-volatile memory.
   b. All user memory in the processor not used for program storage shall be for the purpose of data storage.
3. Performance:
   a. Capability of controlling up to (30) I/O modules
   b. Typical Throughput Time of 0.08 ms/K based upon a 1K ladder logic program consisting of simple ladder logic and communications servicing
   c. Bit Execution Time of less than 0.51 microseconds
   d. Proportional Integral Derivative Control with up to 451 microsecond execution time
   e. Online programming including runtime editing
4. Features:
   a. Standard RAM Memory Back-up provided through minimum two year lithium battery
   b. LED indicators for: POWER, RUN, CPU Fault, Forced I/O, Battery Low, DH485, RS-232
   c. One RS-232 port that supports RS-232 DF1 full-duplex or DF1 half-duplex slave, DH-485, Modbus RTU Slave and ASCII protocols
   d. One Ethernet/IP port
   e. Real Time Clock
   f. Key Switch Positions for Remote, Program and Run

B. Discrete AC Input and Output Modules:
1. Manufacturer:
   a. 16-Point, 120VAC Input Module: Allen-Bradley Model 1769-IA16
   b. 16-Point, 120VAC Output Module: Allen-Bradley Model 1769-OA16
   c. 16-Point, Contact Output Module: Allen-Bradley 1769-OW16
2. 16-Point, 120VAC Input Module:
   a. Operating voltage of 79 to 132VAC
   b. Sixteen non-isolated Inputs
   c. Removable terminal block
      1) Terminal identification diagram one each module
      2) Terminal blocks to have barriers on 3 sides
      3) Optical isolation between digital and field circuits
4) Wiring terminals with self-lifting pressure plates to secure two No.14 AWG wires

d. LEDs to indicate the status of each I/O point

e. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

3. 16-Point, 120VAC Output Module:

a. Quantity of sixteen outputs

b. Output Voltage Range of 85-265VAC

c. Output Current Rating:
   1) Per Point: 0.5A maximum at 30 degrees C; 0.25A maximum at 60 degrees C; Linear Derating
   2) Per Module: 8A maximum at 30 degrees C; 4A maximum at 60 degrees C; Linear Derating

d. Surge Current per Point of 20A for 43ms each, repeatable every 2s at 60 degrees C

e. Minimum Load Current of 10mA per point

f. Maximum On-State Voltage Drop of 1.5V peak at 2.0A and 6V peak at load less than 50mA

g. Maximum Off-State Leakage of 3mA per point

4. 16-Point, Contact Output Module:

a. Voltage rating of 5 to 265VAC

b. Sixteen individually isolated relay outputs

c. Continuous current rating per point: 2.5A ac not to exceed 1440 VA for the module

d. Continuous current rating per module: 16 A ac, 2.5A / common

e. Removable terminal block:
   1) Terminal identification diagram on each module
   2) Terminal blocks to have barriers on 3 sides
   3) Optical isolation between digital and field circuits
   4) Wiring terminals with self-lifting pressure plates to secure two No.14 AWG wires

f. LEDs to indicate the status of each I/O point

g. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

C. Analog Input and Output Modules:

1. Manufacturer:

   a. Analog Input Module, Differential: Allen-Bradley Model 1769-IF8
   b. Analog Output Module, Isolated: Allen-Bradley Model 1769-OF4CI

2. Differential Analog Input Module:

   a. Eight input channels per module

   b. Ratings:
      1) Current Rating of 0 to 20mA, 4 to 20mA
      2) Voltage Rating of Plus/Minus 10VDC, 0 to 10VDC, 0 to 5VDC, 1 to 5VDC
      3) Current Terminal Impedance:
         a) Current Rating of 250 Ohms
(b) Voltage Rating of 220 Kohm
4) Resolution of 14 bits

c. Overall Accuracy:
   1) Current Terminal Rating of Plus or Minus 0.35 percent full scale at 25 degrees C
   2) Voltage Terminal Rating of Plus or Minus 0.2 percent full scale at 25 degrees C
   3) Non-linearity of plus or minus 0.03 percent of full scale
   4) Repeatability of plus or minus 0.03 percent

d. Input channel configuration via configuration software screen or the user program

e. Input Group to Bus Isolation of 500VAC for (1) minute

f. Removable terminal block:
   1) Terminal identification diagram one each module
   2) Terminal blocks to have barriers on 3 sides
   3) Wiring terminals with self-lifting pressure plates to secure two No.14 AWG wires

g. LEDs to indicate the status of each I/O point

h. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

3. Isolated Analog Output Module:
   a. Four output channels per module, isolated

   b. Ratings:
      1) Current Rating of 0 to 20mA, 4 to 20mA
      2) Voltage Rating of Plus/Minus 10VDC, 0 to 10VDC, 0 to 5VDC, 1 to 5VDC

   c. Loading:
      1) Inductive load of 0.1mH maximum for current outputs
      2) Resistive load of 0 to 500 Ohm on current output
      3) Capacitive load of 1 degree F maximum for voltage outputs
      4) Current load of 10mA maximum on voltage output
      5) Load range of greater than 1kOhm at 10VDC

   d. Resolution of 14 bits

   e. Non-linearity (in percent of full scale) of plus or minus 0.05 percent
   f. Repeatability (in percent of full scale) of plus or minus 0.05 percent
   g. Overall accuracy:
      1) Plus or minus 0.35 percent full scale at 25 degrees C for current terminal
      2) Plus or minus 0.5 percent full scale at 25 degrees C for voltage terminal

   h. Open and short-circuit protection:
      1) Output voltage protection
      2) Input Group to Bus Isolation of 500VAC for (1) minute

   i. Removable terminal block:
      1) Terminal identification diagram one each module
      2) Terminal blocks to have barriers on 3 sides
      3) Wiring terminals with self-lifting pressure plates to secure two No.14 AWG wires

   j. LEDs to indicate the status of each I/O point
k. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

D. Power Supplies (Non-Redundant):
1. Manufacturer
   a. Allen-Bradley Model 1769-PA2
2. Selection Requirements:
   a. Select capacity of power supply for each rack based upon requirements of modules installed in rack with 20 percent of power supply capacity reserved for future.
3. Features:
   a. Line Voltage rating of 85 to 265VAC
   b. User Power Capacity of 250mA at 24VDC
   c. Short circuit protection via front access fuse with cover
   d. 5V and 24V overvoltage protection
   e. Line loss ride through of 10ms (minimum) to 10 seconds (maximum)
   f. LED to indicate that input power is available
   g. Provide terminal blocks with barriers on three sides of each terminal and finger-safe covers.
   h. Allows for bank of I/O to be connected to the processor bank I/O via expansion cable.
   i. Capability of mounting the expansion bank of I/O either vertically or horizontally in relation to the processor bank of I/O.

2.4 PROGRAMMABLE LOGIC CONTROLLER SYSTEM, MICROLOGIX PLATFORM (EXPANDABLE)

A. Processor Unit
1. Manufacturer:
   a. Allen-Bradley Micrologix 1100, 1763-L16AWA
2. Processor requirements:
   a. Input Power: 120/240VAC
   b. Memory:
      1) Non-volatile battery backed RAM
      2) User Program / User Data Space: 4 Kbytes / 4 Kbytes
      3) Data Logging / Recipe Storage: Up to 128 Kbytes for data logging and up to 64 Kbytes for recipe (recipe memory subtracted from available data logging)
      4) Battery Back-up: Yes
      5) Back-up Memory Module: Yes
   c. Communication Ports:
      1) One RS-232 / RS-485 Combo Port
         (a) DF1 Full Duplex
         (b) DF1 Half Duplex Master/Slave
         (c) DF1 Radio Modem
         (d) DH-485
         (e) Modbus RTU Master/Slave
(f) ASCII

2) One 10/100 Mbps Ethernet Port
   (a) EtherNet/IP messaging only

3. Embedded Input/Output:
   a. Digital Inputs: Ten 120VAC
   b. Analog Inputs: Two 24VDC
   c. Digital Outputs: Six relay

B. Expansion I/O:

1. Analog input module:
   a. Manufacturer: Allen-Bradley Model 1762-IF4
   b. Input points: four differential, individually selectable as current or voltage

2. Analog output module:
   a. Manufacturer: Allen-Bradley Model 1762-OF4
   b. Input points: four single-ended, individually selectable as current or voltage

3. Digital input:
   a. Manufacturer: Allen-Bradley Model 1762-IA8
   b. Voltage Category/Type: 100 to 120VAC
   c. Operating Voltage: 79 to 132VAC
   d. Signal Delay, Max.: On: 20.0 ms, Off: 20.0 ms
   e. Off-State Current, Max.: 2.5 mA
   f. IEC Input Compatibility: Type 3
   g. Number of Inputs: 8
   h. Bus Current Load, Max.: 115 mADC at 5VDC

4. Digital output:
   a. Manufacturer: Allen-Bradley Model 1762-OW8
   b. Operating Voltage: 85 to 265VAC
   c. Continuous Current per Output, Max: 0.5 at 140 degrees F; 1.0A at 86 degrees F
   d. Continuous Current per Module, Max: 16A
   e. Number of Outputs: 8 (individually isolated)
   f. Type of Contact Outputs: Normally open
   g. Bus Current Load, Max.: 125 mADC at 5VDC; 100 mADC at 24VDC

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.2 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.
3.3 INSTALLATION

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.
B. Provide interconnect cables of the appropriate type as needed.

3.4 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.5 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

END OF SECTION
SECTION 26 90 31

HUMAN-MACHINE INTERFACE EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. Applicable provisions of General Conditions shall govern the work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

   a. ANSI/NFPA 70 - National Electrical Code and state amendments thereto.

2. CE - European Community, Applicable Directives.
   a. EN50005 - for Terminal Markings.
   b. EN50081-1- Generic Emission Standard.
   c. EN50082-1 - Generic Immunity Standard.
   d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
   e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test

3. Canadian Standards Association (CSA), Specifications and Standards, current edition:
   a. CSA C22.2, Industrial Control Equipment.

4. CUL - Underwriter's Laboratories of Canada.

5. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
      4) IEC1131-5. Programmable Controllers - Part 5: Communications.
   b. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures

6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
   a. NEMA ICS 2- Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
b. NEMA ICS 3- Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.

7. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
   a. UL508 - Industrial Control Equipment.
   b. UL508A - Industrial Control Panels.
   c. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.3 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation & Control.

B. Equip human machine interface systems with memory and functional capacity to perform the specified interface, display, and data recording functions specified. Provide a minimum of 25 percent tag capacity reserved for future use for software licensed on a tag basis.

C. Configure software for use with the human machine interface systems specified and pre-load the specific configuration files for this project.

D. Software Configuration Rights:
   1. Any software configuration files shall become the property of the owner. Identify all protection methods and turn over all keys and passwords to the owner.
   2. System supplier shall draft an agreement with the owner, to be reviewed by the engineer, identifying any consequences arising from modifications to the configuration files not authorized in writing by the system supplier during the specified warranty period. This agreement will be signed by the owner and supplier and copies of the document distributed to all parties. Unauthorized modifications to software configuration during the warranty period will result in a void warranty.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Section 01 30 00.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation & Control.

C. Submit the following information specifically for human-machine interface equipment:
   1. Provide copies of all graphic screens. Each screen shall be formatted on a single page which shall include a narrative description of the parameters displayed,
ranges for adjustable parameters and recommended or typical values. The screens shall be organized in a logical fashion. An Index or Table of Contents shall be provided with a page numbering system or tabs which permit ready access to the information contained therein.

2. Software configuration consisting of data tables and other parameters.

1.5 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

1.6 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation & Control.

C. Submit the following information specifically for human-machine interface equipment:

1. Provide copies of all graphic screens. Each screen shall be formatted on a single page which shall include a narrative description of the parameters displayed, ranges for adjustable parameters and recommended or typical values. The screens shall be organized in a logical fashion. An Index or Table of Contents shall be provided with a page numbering system or tabs which permit ready access to the information contained therein.

2. As-built printout of all software configuration including data tables, passwords, and other parameters. Document software with English language descriptions and tag numbers where appropriate.

3. Electronic documentation shall include fully annotated electronic copies of all HMI programming. As-built documentation shall include all changes made during the first year of operation.

4. Software configuration files shall be included in the manual in two forms:
   a. CD ROM.
   b. Paper.

D. Submit software license certificates, manufacturer provided software documentation, and software installation media.

1.7 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.
C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 OPERATOR INTERFACE TERMINAL

A. Manufacturer:
1. Rockwell Automation/Allen-Bradley PanelView Plus 700 Color Keypad/Touchscreen/Display
2. Or equivalent.

B. Agency approvals:
1. C-UL certified
2. UL listed
3. CE marked
4. Class I Div 2, Groups A, B, C, D
5. Class II Div 2, Groups F, G
6. Class III, Div 1

C. Environmental:
1. Temperature:
   a. Operating: 32 to 131 degrees F
   b. Storage: -13 to 158 degrees F
2. Relative Humidity: 5 to 95 percent non-condensing
3. Shock:
   a. Operating: 15 g at 11 ms
   b. Non-Operating: 30 g at 11 ms
4. Vibration:
   a. 0.012 in p-p, 10 to 57 Hz
   b. 2 g peak, 57 to 500 Hz
5. Ratings: NEMA Type 12, 13, 4X, IP54, IP65

D. Electrical:
1. Input Voltage:
   a. 85 to 264VAC
   b. 47 to 63 Hz
2. Power Consumption: 160 VA maximum

E. Display:
1. Type: Color Active Matrix TFT
2. Size: 6.5 inches
3. Resolution: 640 x 480, 18-bit Color Graphics
4. Backlight: field replaceable, CCFL, 50 000 H
F. Touchscreen:
   1. Analog resistive

G. Keypad:
   1. Poly or stainless steel domed membrane
   2. Function keys: 22

H. Memory:
   1. Real-time Clock Battery-backed clock timestamps critical data
   2. Application Memory: 64 MB Flash/64 MB RAM or 128 MB Flash/128 MB RAM as needed by application

I. Communications Ports: Ethernet, RS-232, 2 USB
   1. Provide USB printer support.

PART 3 - CONSTRUCTION METHODS

3.1 FIELD MEASUREMENTS
   A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.2 DELIVERY STORAGE AND HANDLING
   A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.3 INSTALLATION
   A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.4 SOFTWARE CONFIGURATION SERVICES
   A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.5 TESTING AND START-UP SERVICES
   A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.6 TRAINING
   A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

END OF SECTION
SECTION 31 05 10

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Engineered soils and aggregates materials.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM C33 Spec. for Concrete Aggregates.
   2. ASTM C88 Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   4. ASTM C144 Spec. for Aggregate for Masonry Mortar.
   5. ASTM C207 Spec. for Hydrated Lime for Masonry Purposes.
   8. ASTM D75 Sampling Aggregates.
   10. ASTM D1140 Test for Amount of Material in Soils Finer than the No. 200 Sieve.
   16. ASTM D6913-17 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
   17. ASTM D7928-17 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
1.1 SUBMITTALS
A. Provide test reports showing the results of required material testing.
B. Provide topsoil analysis performed in accordance with ASTM D5268 and demonstrating the topsoil meets Soil Conservation Service specified soil types. Also, submit results of test for nutrient levels and provide recommendations for fertilizer type and application.
C. Daily delivery tickets for each load of material delivered to the site.

1.2 QUALITY ASSURANCE
A. An independent testing laboratory approved by the Owner shall be obtained by the Contractor and provide quality control testing.

PART 2 - PRODUCTS

2.1 ENGINEERED SOILS AND AGGREGATES (SOIL CLASS A)
A. General
1. Material shall be clean, sound, hard, dense, durable, field or quarry stone which is free from seams, cracks, or other structural defects. It shall be angular material from shot rock (blasted) or crushed rock having substantially all face of which have resulted from artificial crushing.
2. Loss due to sulfate soundness test shall not exceed 10 percent.
3. Loss due to abrasion test shall not exceed 40 percent.
4. Material shall not be frozen.
B. Gradation
1. Soil Class A-1 (Heavy Riprap Rock)

<table>
<thead>
<tr>
<th>Size of Stone</th>
<th>% Total Weight Smaller Than the Given Size</th>
</tr>
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<tbody>
<tr>
<td>500 lbs.</td>
<td>100</td>
</tr>
<tr>
<td>400 lbs.</td>
<td>90</td>
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<tr>
<td>150 lbs.</td>
<td>50</td>
</tr>
<tr>
<td>40 lbs.</td>
<td>20</td>
</tr>
</tbody>
</table>

2. Soil Class A-MR (Medium Riprap Rock)

<table>
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<tr>
<th>Size of Stone</th>
<th>% Total Weight Smaller Than the Given Size</th>
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<tbody>
<tr>
<td>400 lbs.</td>
<td>100</td>
</tr>
<tr>
<td>200 lbs.</td>
<td>90</td>
</tr>
<tr>
<td>80 lbs.</td>
<td>50</td>
</tr>
<tr>
<td>15 lbs.</td>
<td>20</td>
</tr>
</tbody>
</table>
3. **Soil Class A-2 (Light Riprap Rock)**

<table>
<thead>
<tr>
<th>Size of Stone</th>
<th>% Total Weight Smaller Than the Given Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 lbs.</td>
<td>100</td>
</tr>
<tr>
<td>60 lbs.</td>
<td>80</td>
</tr>
<tr>
<td>20 lbs.</td>
<td>20</td>
</tr>
<tr>
<td>2 lbs.</td>
<td>10</td>
</tr>
</tbody>
</table>

4. **Soil Class A-3 (Breaker Run Rock or 6" Crushed Rock)**

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<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
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<tbody>
<tr>
<td>7-inch</td>
<td>100</td>
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<tr>
<td>6-inch</td>
<td>90</td>
</tr>
<tr>
<td>4-inch</td>
<td>75</td>
</tr>
<tr>
<td>3-inch</td>
<td>10</td>
</tr>
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5. **Soil Class A-4 (3½-inch Crushed Rock - ASTM D448-No. 1)**

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<th>Sieve Size</th>
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<td>4-inch</td>
<td>100</td>
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<tr>
<td>3½-inch</td>
<td>90-100</td>
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<tr>
<td>2½-inch</td>
<td>25-60</td>
</tr>
<tr>
<td>1½-inch</td>
<td>0-15</td>
</tr>
<tr>
<td>¾-inch</td>
<td>0-5</td>
</tr>
</tbody>
</table>

6. **Soil Class A-5 (2½-inch Crushed Rock - ASTM D448-No. 2)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
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<tbody>
<tr>
<td>3-inch</td>
<td>100</td>
</tr>
<tr>
<td>2 ½ inch</td>
<td>90-100</td>
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<tr>
<td>2-inch</td>
<td>35-70</td>
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<tr>
<td>1 ½-inch</td>
<td>0-15</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>0-5</td>
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</tbody>
</table>

7. **Soil Class A-6 (1½-inch Crushed Rock - ASTM D448-No. 4)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inch</td>
<td>100</td>
</tr>
<tr>
<td>1 1/2 inch</td>
<td>90-100</td>
</tr>
<tr>
<td>1-inch</td>
<td>20-55</td>
</tr>
<tr>
<td>¾ inch</td>
<td>0-15</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>0-5</td>
</tr>
</tbody>
</table>

8. **Soil Class A-7 (¾-inch Crushed Rock - ASTM D448-No. 67)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>¾-inch</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>20-55</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-5</td>
</tr>
</tbody>
</table>
9. Soil Class A-8 (⅜-inch Crushed Rock Chips - ASTM D448-No. 8)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>½-inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>85-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 16</td>
<td>0-5</td>
</tr>
</tbody>
</table>

2.2 ENGINEERED SOILS AND AGGREGATES (SOIL CLASS B)

A. General
1. Aggregate shall be hard, strong, durable particles free from seams, cracks, and other structural defects.
2. Rounded to subangular.
3. Free from organic impurities and debris.
4. Material shall not be frozen.

B. Gradation
1. Soil Class B-1 (Coarse Aggregate - ASTM C33 - No. 3)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ½-inch</td>
<td>100</td>
</tr>
<tr>
<td>2-inch</td>
<td>90-100</td>
</tr>
<tr>
<td>1 ½-inch</td>
<td>35-70</td>
</tr>
<tr>
<td>1-inch</td>
<td>0-15</td>
</tr>
<tr>
<td>½-inch</td>
<td>0-5</td>
</tr>
</tbody>
</table>

2. Soil Class B-2 (Coarse Aggregate - ASTM C33 - No. 7)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾-inch</td>
<td>100</td>
</tr>
<tr>
<td>½-inch</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>40-70</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-15</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-5</td>
</tr>
</tbody>
</table>

3. Soil Class B-3 (Fine Aggregate - ASTM C33)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8-inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 8</td>
<td>80-100</td>
</tr>
<tr>
<td>No. 16</td>
<td>50-85</td>
</tr>
<tr>
<td>No. 30</td>
<td>25-60</td>
</tr>
<tr>
<td>No. 50</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 100</td>
<td>2-10</td>
</tr>
</tbody>
</table>
4. **Soil Class B-4 (Masonry Sand - ASTM C144)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Natural Sand</th>
<th>Manufactured Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>No. 8</td>
<td>95 to 100</td>
<td>95 to 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>70 to 100</td>
<td>70 to 100</td>
</tr>
<tr>
<td>No. 30</td>
<td>40 to 75</td>
<td>40 to 75</td>
</tr>
<tr>
<td>No. 50</td>
<td>10 to 35</td>
<td>20 to 40</td>
</tr>
<tr>
<td>No. 100</td>
<td>2 to 15</td>
<td>10 to 25</td>
</tr>
<tr>
<td>No. 200</td>
<td>---</td>
<td>0 to 10</td>
</tr>
</tbody>
</table>

2.3 **ENGINEERED SOILS AND AGGREGATES (SOIL CLASS C)**

A. General

1. Stone shall be hard, durable, granular material of uniform quality resulting from crushed rock or crushed bank run sand and gravel.

2. Material shall be free from clay lumps, organic matter, shale, excess elongated or flat pieces, and other deleterious substances.

3. Forty-five percent of the particles retained on a No. 4 sieve shall have at least one fractured face.

4. Wear shall not exceed 50 percent.

5. Loss due to sulfate soundness test shall not exceed 18 percent by weight.

6. Total moisture content shall not exceed 7 percent.

7. Filler for blending shall have a maximum liquid limit of 25 percent and a maximum plasticity index of 6.

8. Material shall not be frozen.

B. Gradation

1. **Soil Class C-1 (Crushed Stone)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½-inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>30-65</td>
</tr>
<tr>
<td>No. 4</td>
<td>25-55</td>
</tr>
<tr>
<td>No. 10</td>
<td>15-40</td>
</tr>
<tr>
<td>No. 200</td>
<td>2-12</td>
</tr>
</tbody>
</table>

2. **Soil Class C-2 (Crushed Stone)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>40-75</td>
</tr>
<tr>
<td>No. 4</td>
<td>25-60</td>
</tr>
<tr>
<td>No. 10</td>
<td>15-45</td>
</tr>
<tr>
<td>No. 200</td>
<td>3-12</td>
</tr>
</tbody>
</table>
3. **Soil Class C-3 (Crushed Stone)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>¾-inch</td>
<td>95-100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>50-90</td>
</tr>
<tr>
<td>No. 4</td>
<td>35-70</td>
</tr>
<tr>
<td>No. 10</td>
<td>15-55</td>
</tr>
<tr>
<td>No. 200</td>
<td>5-15</td>
</tr>
</tbody>
</table>

4. **Soil Class C-4 (Crushed Gravel)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2-inch</td>
<td>100</td>
</tr>
<tr>
<td>1-inch</td>
<td>75-100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>40-75</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-60</td>
</tr>
<tr>
<td>No. 10</td>
<td>20-45</td>
</tr>
<tr>
<td>No. 40</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 200</td>
<td>3-10</td>
</tr>
</tbody>
</table>

5. **Soil Class C-5 (Crushed Gravel)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>50-85</td>
</tr>
<tr>
<td>No. 4</td>
<td>35-65</td>
</tr>
<tr>
<td>No. 10</td>
<td>25-50</td>
</tr>
<tr>
<td>No. 40</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 200</td>
<td>3-10</td>
</tr>
</tbody>
</table>

6. **Soil Class C-6 (Crushed Gravel)**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>¾-inch</td>
<td>95-100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>50-90</td>
</tr>
<tr>
<td>No. 4</td>
<td>35-70</td>
</tr>
<tr>
<td>No. 10</td>
<td>20-55</td>
</tr>
<tr>
<td>No. 200</td>
<td>8-15</td>
</tr>
</tbody>
</table>

2.4 **BANK RUN SOILS**

A. Soil Class D-1 and D-2

1. Materials shall be rounded or subangular material resulting from pit run or crushed material.
2. Materials shall be free from clay lumps, organic matter, and deleterious substances.
3. One hundred percent by weight shall pass a 3-inch sieve.
4. Maximum liquid limit shall be 25 percent and maximum plasticity index shall be 6.
5. Material shall not be frozen.
6. The portion of material which passes a No. 4 sieve shall conform to the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Maximum % By Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade D-1</td>
</tr>
<tr>
<td>No. 4</td>
<td>100</td>
</tr>
<tr>
<td>No. 40</td>
<td>75</td>
</tr>
<tr>
<td>No. 100</td>
<td>15</td>
</tr>
<tr>
<td>No. 200</td>
<td>8</td>
</tr>
</tbody>
</table>

B. Soil Class D-3 (Sand)
1. Well graded, unwashed bank run or crushed bank run which is free from clay lumps, organic matter, and other deleterious substances with gradation as follows:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4-inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>90-100</td>
</tr>
<tr>
<td>No. 10</td>
<td>45-90</td>
</tr>
<tr>
<td>No. 40</td>
<td>15-45</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-10</td>
</tr>
</tbody>
</table>

C. Soil Class E-1 (Clay Soil)
1. Minimum 50 percent by weight passing the No. 200 sieve.
2. For the fraction passing the No. 40 sieve, the minimum plasticity index shall be 15.
4. Free from organic material, boulders, cobbles, excessive amounts of gravel (greater than 3/4-inch), and other deleterious substances.

D. Soil Class F-1 (Topsoil)
1. Topsoil shall meet the definition and specification stated in ASTM D5268 and meets one of the following SCS (Soil Conservation Service) soil textures:
   a. Loam.
   b. Sandy loam.
   c. Silt loam.
   d. Silty clay loam.
   e. Clay loam.
2. The topsoil shall consist of adequate mineral content to support the growth of the intended vegetation and shall not contain herbicides which would be detrimental for the intended use.
3. The topsoil shall have adequate fertility for quick establishment of vegetation.
4. The pH of the topsoil shall be between 6.0 and 7.0.
5. Topsoil shall be free from deleterious substances.
6. Pulverize and screen the topsoil such that 100 percent passes the 1-inch (25 mm) sieve and at least 90 percent passes the No. 10 (2.00 mm).

E. Soil Class G-1 (Clean Earth Fill)
1. Soil Class G-1 shall be any soil material excavated on the project site or obtained from borrow areas.
2. Soil materials unsuitable and, therefore, not approved for this classification are:
   a. Soils with high organic contents such as: topsoil, peat, muck, organic silts, and clays, marls, etc.
   b. Manmade or rubble filled soils containing such materials as: foundry sand, fly ash cinders, asphalt, and concrete rubble, etc.
   c. Silty soils such as: rock flour, loess, etc.
   d. Soils with gravel larger than 3-inch.
   e. Silty clay or clays with a high plasticity (CH soils as defined in ASTM D2487).
   f. All soil contaminated with hazardous waste materials as defined by the EPA.

F. Soils Class G-2 (Clean Earth Fill)
1. Same as G-1 above except shall not contain gravel larger than 1½-inch.

2.5 SOURCE QUALITY CONTROL

A. To establish acceptability of material, perform tests for each soils class in accordance to the following standards:
1. Soils Class A and C:
   a. ASTM C88.
   b. ASTM C131 (for coarse aggregates smaller than 1½ inches).
   c. ASTM C136.
   d. ASTM C535 (for coarse aggregates 1½ inches and larger).
   e. ASTM C117 (use when aggregate contains materials finer than No. 200 sieve).
2. Soils Class B:
   a. ASTM C88.
   b. ASTM C117.
   c. ASTM C136.
3. Soils Class D:
   a. ASTM C117.
   b. ASTM C136.
   c. ASTM D1241.
   d. ASTM D2487.
4. Soils Class E:
   a. ASTM C136 (test when gravel content is present).
   b. ASTM D422.
   c. ASTM D1140.
   d. ASTM D2216.
   e. ASTM D4318

5. Soils Class F:
   a. ASTM D2487.

6. Soils Class G:
   a. ASTM D2487.

B. In addition to the above, furnish a soil analysis of Soil Class F:
   1. Analyze for the following:
      a. pH
      b. Phosphorus
      c. Potassium
      d. Soluble Salts
      e. Calcium
      f. Magnesium

C. Source sample all soils and aggregates in accordance with ASTM D75.

D. Perform one (1) acceptable test for each type of material at each source.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use the soil classification as specified or stated on figures.

B. Place material in accordance with the figures and appropriate Specification Sections for the type of work being performed.

END OF SECTION
SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Excavation.
2. Filling and compacting.
3. Backfilling around structures.
4. Finish grading.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D698 Test for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb. (2.49-kg) Rammer and 12-in. (305-mm) Drop (Standard Proctor).
2. ASTM D1556 Test for Density of Soil In Place by the Sand-Cone Method
3. ASTM D1557 Test for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, using 10-lb. (4.5-kg) Rammer and 18-in. (457-mm) Drop (Modified Proctor)
4. ASTM D2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures
5. ASTM D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
6. ASTM D6938-07 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 CONTRACTOR QUALITY CONTROL RESPONSIBILITIES

A. Contractor will be responsible for ensuring grading meets specifications, and providing any test results to indicate as such.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Soil used for backfilling shall consist of soil excavated from the project area. Soil shall be free of organics, wood and/or other debris.
PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavation to Correct Grade
   1. Excavate site as needed to provide level base for blower/skid foundation and corresponding piping and electrical connections.

3.2 FILLING AND COMPACTING

A. Layer thickness for fill soil shall be as follows:
   1. Layer thickness shall be dependent on the soil classification type, weight, and soil contact pressure of compaction equipment being used.
   2. Layer thickness shall not exceed 12 inches.

B. Compaction
   1. Compaction method for fill soils shall be appropriate for soil material being compacted and provide sufficient soil contact pressure to thoroughly compact entire lift thickness.

C. Proper soil moisture contents for compaction shall be maintained in all soils.
   1. Optimum moisture content as determined by modified (ASTM D1557) or standard (ASTM D698) Proctor shall be used to determine acceptance moisture contents for soil compaction.
   2. Use the following guidelines to determine moisture content range for compaction of various soils:

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Soil Class</th>
<th>Tolerable Range of Moisture Content About Optimum (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse grained, cohesionless soils with less than 4% P200</td>
<td>&quot;A&quot; and &quot;B&quot;</td>
<td>Highest practical moisture content (saturation may be required)</td>
</tr>
<tr>
<td>or with less than 8% uniform gradation (i.e., clean sand or gravel).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy clays, silty clay silts, and clays</td>
<td>&quot;E&quot; and &quot;G&quot;</td>
<td>-2 to +4</td>
</tr>
<tr>
<td>All other soil types</td>
<td>All other soil classes.</td>
<td>-1 to +3</td>
</tr>
</tbody>
</table>

Note: The above requirements are general guidelines for soil moisture content which may or may not apply to a specific soil material. In some circumstances, the required density may be attained at moisture contents outside the ranges indicated above.

3. If soil material has excessive or deficient moisture, dry out or add moisture to the degree necessary for the required compaction. Determine moisture content in accordance with ASTM D2216.
D. Compaction requirements for all fill soils unless specified elsewhere shall be as follows:
   1. Class 1:
      A.

<table>
<thead>
<tr>
<th>Compaction Requirements for Various Soil Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Class</td>
</tr>
<tr>
<td>Class 1</td>
</tr>
<tr>
<td>Class 2</td>
</tr>
<tr>
<td>A, B, C, D, E, and G</td>
</tr>
<tr>
<td>90/95</td>
</tr>
<tr>
<td>90/95</td>
</tr>
</tbody>
</table>

3.3 BACKFILLING AROUND STRUCTURES

A. Do not backfill any foundation, wall, or structure prior to inspection by the Engineer.

B. Backfilling under pipes or conduits in areas excavated due to construction.
   1. Contractor shall furnish and compact Soil Class C-3 under all piping or conduits.
      a. Compact fill shall extend from undisturbed earth to grade.
      b. Place and compact fill in all areas disturbed by construction.

3.4 FINISH GRADING

A. Grade, trim, and shape subgrade similar to existing conditions, ensuring proper drainage of disturbed areas.
   1. Adjust slopes by grading so that transition is smooth and gradual.
   2. The crests of cut banks shall be rounded and shaped.
   3. Refill, regrade and compact washouts and ruts.
   4. Remove all stones 12 inches or larger from grading limits.

B. Grading Tolerances
   1. Vertical tolerance - +/- 0.1’ at all locations.
   2. Horizontal tolerance - +/- 0.5’ for all features.

END OF SECTION
SECTION 31 23 33

TRENCHING, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Obstruction removal.
2. Dewatering.
3. Disposal of surplus material.
4. Sheeting and bracing.
5. Trenching, backfilling and compacting.
6. Restoration.
7. Materials testing.

B. This section applies to below ground pressure and gravity pipe lines.

C. Allowances
1. If so stated in specification section "Allowances," installation testing will be paid as an allowance. All other testing shall be incidental to the work.
2. If there is no reference in the specification section "Allowances" to trenching, backfilling and compacting testing, then testing costs shall be included in the cost for trenching, backfilling and compacting.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM D1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-Lb. (4.54 kg) Rammer and 18-In. (457 mm) Drop
2. D6938-07 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 SUBMITTALS

A. Submit two (2) copies of the results of quality control testing (include location where test was done):
1. Materials source testing.
1.4 QUALITY ASSURANCE

A. Material Testing Requirements
   1. Source Testing:
      a. Test select soils and aggregates as required by section "Soils and Aggregates."

B. Installation quality assurance will be performed by the contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide material types as listed on the Drawings.

B. Conform to Section "Soils and Aggregates".

2.2 SOURCE QUALITY CONTROL

A. Test soil and aggregate material in accordance with Section "Soils and Aggregates."

PART 3 - EXECUTION

3.1 EXISTING UTILITIES

A. Contractor shall locate and protect all existing utilities and landfill gas piping.

3.2 DEWATERING

A. Determine groundwater conditions.

B. Provide and maintain necessary means and methods to dewater excavations as required.

C. Dispose of water.

D. Prevent runoff and dewatering system discharge from entering excavation.

E. Secure permits from regulatory and governmental agencies governing dewatering.

F. Maintain dewatering operation until backfill and compaction procedures are completed.

G. Groundwater Disposal
   1. Convey groundwater to point of discharge through pipelines.
   2. Maximum Sediment Content: 10 milligrams per liter.
3.3 TRENCH EXCAVATION

A. Excavate trench to sufficient width and depth to permit proper utility construction as shown on the drawings.

B. The bottom of the excavation shall conform to the pipe embedment details with a minimum width of the pipe outside diameter plus 24 inches.

C. The maximum trench width at the surface for payment purposes is the greater of:
   1. The pipe outside diameter plus 24 inches, or
   2. The distance from the surface to the top of the pipe embedment.

D. Do not open more than 200 feet of trench at any one time.

E. Place excavated material in a location that will minimize inconvenience to public travel, adjacent property owners and other contractors.

F. Sheeting and Bracing
   1. Sheet and brace trenches and excavations as required by applicable federal and state codes, by the Contract Documents, and as necessary to protect life and property.
      a. When close sheeting is required, prevent soil from entering the trench either below or through such sheeting.
   2. Removal of Sheeting and Bracing:
      a. Remove sheeting and bracing as the excavation is backfilled in such a manner to avoid disturbance of adjacent structures and to insure adequate protection of the completed pipe section.
      b. If the sheeting and bracing cannot be removed without damage to the pipe or adjacent areas, leave in place.

G. Portable Trench Shoe Shield (Shoe)
   1. A shield may be used with the following restrictions.
      a. Construct as required by State or Federal authority.
      b. Do not exceed trench limits.
      c. Do not disturb or alter pipe and bedding.

3.4 TRENCH BACKFILLING AND COMPACTION

A. Provide pipe foundation material below the bedding as directed by the Engineer.

B. Provide pipe embedment as required for the type of pipe installed per the appropriate Section.

C. Backfill the trench with excavated material in layers not exceeding 12 inches unless select backfill material is specified elsewhere or ordered.
D. Backfill Compaction
   1. Compact trenches using mechanical compaction methods.
   2. Compact backfill in layers not exceeding 12 inches to the following densities:

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Density Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Material</td>
<td>Equal to adjacent undisturbed material</td>
</tr>
<tr>
<td>Select Backfill</td>
<td>Minimum of 90 percent of the modified Proctor Density or</td>
</tr>
<tr>
<td></td>
<td>95% of the Standard Proctor Density</td>
</tr>
</tbody>
</table>

E. Provide select backfill material as directed by the Engineer or as specified elsewhere.

END OF SECTION
SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Erosion Bales and Bags
2. Inlet Protection
3. Silt Fence
4. Riprap and Breaker Run Stone
5. Erosion Mats
6. Flexamat
7. Tackifiers
8. Soil Stabilizers
9. Ditch Checks
10. Sediment Control Practices
11. Vegetative Buffers
12. Stone Tracking Pad
13. Mulching
14. Seeding for Erosion Control
15. Dewatering for Erosion Control
16. Construction Site Diversion
17. Grading Practices for Erosion Control
18. Dust Control

1.2 REFERENCES


B. American Society for Testing and Materials (ASTM)
1. ASTM D1388 Test Method for Stiffness of Fabrics
2. ASTM D2487 Test Method for Classification of Soils for Engineering Purposes
3. ASTM D3776 Test Method for Mass Per Unit Area (Weight) of Woven Fabric
4. ASTM D4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
5. ASTM D4491 Test Method for Water Permeability of Geotextiles by Permittivity
6. ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles
7. ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile
9. ASTM D5035 Test Method for Breaking Strength and Elongation of Textile Fabric (Strip Method)
10. ASTM D5338 Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions


1.3 SYSTEM DESCRIPTION

A. Select and design method of erosion and sediment control in accordance with the Contract Documents and state and local erosion control ordinances and standards.

B. Provide additional erosion and sediment control to prevent erosion which may be caused due to selected construction methods.

1.4 SUBMITTALS

A. Manufacturer’s certification for manmade products.

PART 2 - PRODUCTS

2.1 EROSION BALES AND BAGS

A. Sand Bags
   1. Minimum unfilled size of 16 by 26 inches.
   2. Completely filled with a granular soil (P200 <50%).

B. Rock Filled Filter Bags
   1. Minimum unfilled size of 18” x 30”.
   2. Construct bag of high density polyethylene as manufactured by Erotex.
   3. Seal bag with a high density polyethylene draw string knitted directly into the bag opening in a rolled seam using minimum of 480 denier polyester sewing yarn.
   4. Fill bag with well graded coarse aggregate conforming to the following AASHTO M43 Size No. 76:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inch</td>
<td>---</td>
</tr>
<tr>
<td>1½-inch</td>
<td>---</td>
</tr>
<tr>
<td>1-inch</td>
<td>100</td>
</tr>
<tr>
<td>¾-inch</td>
<td>90-100</td>
</tr>
<tr>
<td>⅜-inch</td>
<td>20-55</td>
</tr>
<tr>
<td>Sieve Size</td>
<td>Percent Passing by Weight</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-5</td>
</tr>
</tbody>
</table>

C. Erosion Bales
1. Tightly compacted bales of grain straw or hay.
2. Use straw, if required to function for more than 15 days.

D. Support Post
1. Wood or steel construction, minimum length 4 feet.
2. Wood Posts: 2" x 2" or equivalent steel posts.

2.2 INLET PROTECTION

A. Inlet protection shall conform to the Wisconsin Department of Natural Resources Conservation Practice Standard #1060 "Storm Drain Inlet Protection for Construction Sites."

2.3 SILT FENCE

A. Geotextile Fabric
1. Fabric shall be either woven or non-woven polyester, polypropylene, stabilized nylon, polyethylene or polyvinylidene chloride.
2. Fabric shall have the minimum strength values in the weakest principal direction.
3. Non-woven fabric may be needle punched, heat bonded, resin bonded or combination thereof.
4. Fabric shall meet the following requirements:
   a. If silty soils on-site then the following can be used:
      1) Grab Tensile Strength ASTM D4632 101 lbs. (450 N)
      2) Apparent Opening Size ASTM D4751 0.3 mm
      3) UV Resistance Strength Retained ASTM D4355 70 at 500 Hours (%)
      4) Permittivity (per second) ASTM D4491 0.14
   b. If sandy soils on-site then the following can be used:
      1) Grab Tensile Strength ASTM D4632 101 lbs. (450 N)
      2) Apparent Opening Size ASTM D4751 0.3 mm to 0.8 mm
      3) UV Resistance Strength Retained ASTM D4355 70 at 500 Hours (%)
      4) Permittivity (per second) ASTM D4491 0.14

B. Support Posts
1. Wood or steel construction minimum length 5 feet.
2. Wood posts - 2" x 2" or equivalent steel posts.

C. Silt fence shall conform to the Wisconsin Department of Natural Resources Conservation Practice Standard #1056 "Silt Fence."
2.4 RIPRAP

A. Riprap may be used for permanent erosion control or for construction of temporary ditch checks, provide as follows:
   1. Provide minimum thickness of 1.0 feet measured perpendicular to the base.
   2. More than 50 percent of stones shall weigh more than 50 lb.
   3. If severe erosion is anticipated, submit riprap design to the engineer.

2.5 VEGETAL COVER

A. Temporary Seed Mixture Components

<table>
<thead>
<tr>
<th>Species</th>
<th>Min. % Purity</th>
<th>Min. % Germ.</th>
<th>Lbs. per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats</td>
<td>98</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>Rye</td>
<td>98</td>
<td>85</td>
<td>100</td>
</tr>
</tbody>
</table>

B. Use rye grass when permanent seeding is to follow within one (1) year.

C. Refer to Section "Turf and Grasses" for permanent vegetal cover.

2.6 EROSION MATS

A. General
   1. Netting, if used, shall not exceed 15% of the total blanket weight.
   2. Bond the netting to the parent material to prevent separation for the life of the project (minimum two months).

B. Types
   1. Non-channel erosion mat shall conform to the Wisconsin Department of Natural Resources Conservation Practice Standard #1052 "Non-Channel Erosion Mat."
   2. Channel erosion mat shall conform to the Wisconsin Department of Natural Resources Conservation Practice Standard #1053 "Channel Erosion Mat."

C. Anchoring Devices
   1. Anchoring and components for temporary erosion mats shall be completely biodegradable as determined by ASTM D5338.
   2. Materials shall be environmentally safe for soil and groundwater.
   3. Do not use petroleum based plastics or composites.
   4. Do not use materials which may present a hazard from splintering or spearing.
   5. Design anchors to hold a minimum of two months and be substantially degraded within four months during the summer (warm soil conditions).

D. Material Properties
   1. Porosity Calculated: 85-90%.
   2. Stiffness ASTM D1388 2,000 mg-cm (maximum).
4. Tensile Strength ASTM D5035 (2 inch strip).
   a. Length Direction: 15 lb.
   b. Width Direction: 5 lb.
5. Elongation ASTM D5035 (2 inch strip).
   a. Length Direction: 150%
   b. Width Direction: 100%
6. Use flexible mat of polyvinyl chloride monofilaments bonded together into a three-dimensional web designed exclusively to serve as an erosion control and revegetation mat.

E. Staples
1. Staples for anchoring erosion mat shall meet the following minimum requirements:
   a. U-shaped.
   b. No. 11 gage or larger diameter steel wire.
   c. Width of one to two inches.
   d. Length:
      1) Not less than six (6) inches for firm soil.
      2) Not less than twelve (12) inches for soft or loose soils.
      3) Not less than eight (8) inches where erosion mat is placed over sod.
2. Pins shall have a 3/16 inch shank diameter with attached 1½ inch washer.
3. Staples shall have a ¾ inch shank diameter with a 1" minimum top width.

2.7 FLEXAMAT

A. Flexamat shall consist of standard type supplied by Motz Enterprises, Inc. – 1-513-772-6689.

2.8 TACKIFIERS

A. Latex Base
1. Latex emulsion polymer by weight shall consist of:
   a. Styrene (%): 48
   b. Butadien (%): 50
   c. Additive (%): 2
   d. Percent Solids: 42 to 46
   e. pH (as shipped): 8.5 to 10.0
2. Emulsion shall not be frozen at any time or exposed to sunlight for extended periods of time.

B. Guar Gum
1. Minimum of 95% guar gum by weight.
2. Remaining weight shall consist of dispersing and cross-linking additives.
C. Other Tackifiers
   1. Other tackifiers shall include the following, but not limited to:
      a. Water soluble natural vegetable gums.
      b. Guar gums blended with gelling and hardening agents.
      c. Water soluble blend of hydrophobic polymers, visosifers, sticking aids, and other gums.

2.9 SOIL STABILIZERS

A. Soil Binder/Fiber Stabilizer
   1. Shall be a cementitious soil binder added to wood cellulose fiber mulch or a bonded fiber matrix.
   2. Shall show similar vegetative density and sediment loss standards as temporary erosion mats.

B. Installation of anionic polyacrylamine (PAM) as a soil binding agent shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1050 "Erosion Control Land Application of Anionic Polyacrylamide."

2.10 DITCH CHECKS

A. Ditch checks shall conform with the Wisconsin Department of Natural Resources Conservation practice Standard #1062 "Ditch Check (Channel)."

B. Submit a list of ditch checks materials to the Engineer for review.

2.11 GEOTEXTILE FABRICS

A. In accordance with section "Geosynthetic Soil Stabilization and Layer Separation."

PART 3 - EXECUTION

3.1 GENERAL

A. Keep disturbed areas to a minimum.

B. Stabilize and protect disturbed areas with temporary seed and mulch within 14 days of active disturbance of the soil surface.

C. Place excavated trench material on the high side of the trench where appropriate.

D. Discharge trench water to filter barrier prior to release into a drainage way.

E. Install gravel mats at site vehicle entrance and site exit locations to prevent tracking of soil.
F. Collect tracked soil and clean from paved roads near the construction site the same day it occurs.

G. Sediment control measures shall be in place at the end of each working day.

H. Locate soil stockpiles no closer than 25 feet of a roadway, wetland, or drainage control channel and control by covering the pile with tarpaulins, temporary seed and mulch or other suitable means, if the pile is exposed for 14 days or more.

I. Protect storm inlets including inlets in paved roadways with erosion bales, geotextile fence or other suitable approved barriers.

J. When it is necessary to cross waterways, provide crossing structures for machinery.

K. Repair, replace, and maintain erosion and sedimentation structures until vegetation is re-established or permanent structures are installed.

L. Remove temporary erosion control structures and accumulated sediment and/or debris when vegetation is established.

3.2 EARTH STRUCTURES

A. Utilize one or more of the following:
1. Earth Structures:
   a. Berms or embankments.
   b. Sedimentation basins and traps.
   c. Temporary diversion ditches.
   d. Temporary chutes and ditches.
   e. Grade control structures.
2. Construct earthen structures using standard net weights and techniques including fine grading and compaction.

3.3 EROSION AND SEDIMENTATION CONTROL DEVICES

A. Installation of erosion bales shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1055 "Sediment Bale Barrier (Non-Channel)."

B. Erosion Bags
1. Place type (sand or rock filled) where shown on the Drawings at a minimum.
2. Place bags end to end across surface water flow path.
3. Place bags at right angles to the direction of water flow.
4. Excavate shallow sump on the upstream side of bags.
5. Entrench bags at least 4 inches into the ground.
6. Place bags prior to disturbing upslope areas.
7. Drive support posts a minimum of 12 inches into the subgrade and extend to the top of the bags.
8. Remove from the site after final stabilization.

C. Inlet Protection
1. Installation of inlet protection shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1060 "Storm Drain Inlet Protection for Construction Sites."

D. Silt Fences
1. Installation of silt fence shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1056 "Silt Fence."

E. Riprap
1. Place riprap by mechanical methods.
2. Place riprap upon appropriate geotextile fabric.

F. Erosion Mats
1. Installation:
   a. See plan details for anchor trench (at ends, checks and edges) installation procedures.
      1) Anchor trenches shall be 12" deep.
      2) Compact anchor trench backfill.
      3) Place staples in end and check trenches spaced at 12".
   b. Follow manufacturer's specifications and instructions for placement unless project documents are more stringent.
   c. Roll width overlaps shall be 12" at edges. Pin or staple every 3 feet along overlap length.
   d. Roll end overlaps may be spliced by overlapping (in the direction of water flow) two feet with the upstream portion of the mat on top of the downstream portion. This overlap shall receive at least three pins or staples with a maximum spacing of 12".
   e. Pins or staples shall be 18" in length minimum driven flush with the mat.
   f. Place mat flat conforming to contours in soil surface. Do not stretch mat.
   g. Place mat from toe of slope toward top of slope.
   h. Mat can be placed from downstream toward upstream or from upstream toward downstream.

   2. Site Preparation:
      a. Place seed and fertilizer prior to placing permanent erosion geomat.
      b. Seed and fertilizer may be placed after permanent erosion mat installation with Engineer's approval.
      c. Ground surface shall be smooth and compact.
      d. Remove all rocks, dirt clods, stumps, roots, grass clumps, trash and other obstructions from lying in direct contact with the soil surface and the erosion mat.

   3. Erosion Control Revegetative Mats (ECRM):
      a. ECRM are placed on top of the soil.
4. Turf Reinforcement Mats (TRM):
   a. TRM are buried below the surface.

5. Wisconsin Department of Natural Resources:
   a. Non-channel erosion mat shall be installed in accordance with the Wisconsin
      Department of Natural Resources Conservation Practice Standard #1052
      "Non-Channel Erosion Mat."
   b. Channel erosion mat shall be installed in accordance with the Wisconsin
      Department of Natural Resources Conservation Practice Standard #1053
      "Channel Erosion Mat."

G. Flexamat – Install in accordance with manufacturer’s recommendations.

H. Tackifiers
   1. Installation:
      a. Spray tackifiers immediately after installation of the mulch.
      b. Do not apply tackifier during periods of windy conditions which effect proper
         placement.
      c. Protect signs, structures and other items not related to mulch.
      d. Latex-base tackifier application per hectare shall be as follows:
         1) Latex Base: 37 gallons of adhesive (or manufacturer’s recommendation
            rate).
         2) Paper Filter: 620 lbs. of newsprint with 925 gallons of water.
      e. Guar Gum Tackifier: Mix 120 pounds of dry adhesive and a minimum of
         620 pounds of recycled newsprint as a tracer with 3,225 gallons of water.
      f. Other Tackifiers (Hydrophobic Polymers): Mix 240 pounds of dry adhesive
         or the manufacturer’s recommended rate, whichever is greater and a minimum
         of 620 pounds of recycled newsprint as a tracer with 3,225 gallons of water.

I. Soil Stabilizers
   1. Installation:
      a. Install soil stabilizers using conventional hydraulic seeding equipment.
      b. Follow manufacturer’s recommendations for application rates.
      c. Application of PAM, in its pure form, shall not exceed 200 lbs/acre (225
         kg/ha).
      d. Do not use asphalt based products as soil stabilizers.
      e. Do not place soil stabilizers in channels.

J. Ditch Checks
   1. Ditch check work shall be performed in accordance with the Wisconsin
      Department of Natural Resources Conservation practice Standard #1062 "Ditch
      Check (Channel)."

K. Sediment Control
   1. Sediment control shall be done in accordance with the Wisconsin Department of
      Natural Resources Conservation Practice Standard #1051 "Interim Sediment
      Control: Water Application of Polymers."
L. Vegetative Buffer
   1. Vegetative buffers shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1054 "Vegetative Buffer for Construction Sites."

M. Stone Tracking Pad
   1. Stone tracking pad work shall be performed in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1057 "Stone Tracking Pad and Tire Washing."

N. Mulching
   1. Mulching shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1058 "Mulching for Construction Sites."

O. Seeding
   1. Seeding shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1059 "Seeding."

P. Dewatering
   1. Dewatering shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1061 "Dewatering."

Q. Sediment Trap
   1. Sediment trap work shall be performed in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1063 "Sediment Trap."

R. Sediment Basin
   1. Sediment basin work shall be performed in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1064 "Sediment Basin."

S. Construction Site Diversion
   1. Construction site diversion practices shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1066 "Construction Site Diversion."

T. Grading Practices
   1. Grading Practices shall be done in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1067 "Grading Practices for Erosion Control – Temporary."
U. Dust Control
   1. Dust control work shall be performed in accordance with the Wisconsin Department of Natural Resources Conservation Practice Standard #1068 "Dust Control."

3.4 MAINTENANCE

A. Inspect silt fences and filter barriers immediately after each rainfall and at least daily during prolonged rainfall.
   1. Make any required repairs immediately.
   2. Maintain temporary erosion and sedimentation control structures until permanent soil erosion controls are completed and/or vegetation is established.
      a. Repair damaged structures.
      b. Replace lost structures.
      c. Remove sediment from deposition areas adjacent to erosion control structures without damaging structures on a regular basis.
      d. Refill eroded areas as required for grade stabilization.

B. If the fabric on a silt fence or filter barrier decomposes or becomes ineffective prior to the end of the expected usable life and the barrier still be necessary, replace the fabric promptly.

C. Remove sediment deposits after each major storm event and when deposits reach approximately one-half the height of the barrier.

D. Remove any sediment deposits remaining in place after the silt fence or filter barrier is no longer required and dress to conform with the existing grade, prepared and seeded.

E. Repair/restore any washed out areas.

F. Maintenance period to be entire project period including the one year warranty.

G. Owner may direct Contractor to remove the temporary erosion control measures any time during the one year correction period.

H. Construct permanent erosion control measures immediately after earthwork is completed.

END OF SECTION
SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Topsoiling
2. Fertilizing
3. Seeding/Planting
4. Mulch
5. Goose Discouragement
6. Sodding/Planting
7. Mulching
8. Monitoring
9. Performance Criteria
10. Maintenance

1.2 SUBMITTALS

A. Product technical data:

1. Acknowledgement that products submitted meet requirements of standards referenced.
2. Manufacturer's installation instructions.

B. Certification:

1. Certification of seed from seed vendors stating the botanical and common name, percentage by weight of each species and variety, place of origin, strain, percentage of purity, germination, and amount of Pure Live Seed (PLS) per bag. Include the year of production and date of packaging.
   a. Furnish certification of conformance with AOSA “Rules for Testing Seed” and attest to mix, age, weed content.

2. Certify each container of seed delivered will be labeled in accordance with Federal and State Seed Laws and equals or exceeds Specification requirements.

3. Furnish certification of fertilizer from supplier attesting to brand name, chemical analysis, and guarantee of analysis.

4. Furnish sample of mulch material when requested by Owner's representative.
C. Other documents:

1. Copies of invoices for fertilizer used on Project showing grade furnished, along with certification of quality and warranty. If site restoration manager and/or Project Engineer determines fertilizer requires sampling and testing to verify quality, testing will be done at Contractor's expense, in accordance with current methods of Association of Official Agricultural Chemists. Upon completion of Project, a final check of total quantities of fertilizer used will be made against total area seeded. If minimum rates of application have not been met, Contractor will be required to distribute additional quantities to make up minimum application specified.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. Association of Official Seed Analysis (AOSA):
   a. Rules for testing seed.
4. United States Department of Agriculture, (USDA):
5. American Association of State Highway and Transportation Officials (AASHTO):
   a. AASHO M140 Emulsified Asphalt.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Seed:

1. Furnish seed in sealed standard containers labeled with producer's name and seed analysis.
2. Seed temporarily stored on site shall be held off the ground in a cool (<60º F) dry location, protected from inclement weather.
3. Remove seed from the site that has become wet, moldy, or otherwise damaged in transit.

B. Fertilizer:

1. Furnish fertilizer uniform in composition, free flowing, and suitable for application with approved equipment, delivered to site in bags or other containers, each fully labeled and bearing the name, and warranty of the producer.

C. Erosion Control Blankets:

1. Deliver materials to site immediately prior to installation.
2. Temporarily store materials indoors or outdoors above the ground and covered with a tarp or other device to protect from saturation, mold, and physical damages.
1.5 TOPSOIL
   A. Consist of original topsoil from onsite excavations.
   B. If excavation exposes subsoils that are difficult to use for planting (such as clay or gravel fill), contractor to supply and apply additional material to establish a minimum of 6 inches of topsoil to the new surface.

1.6 FERTILIZER AND AGRICULTURAL LIMESTONE
   A. Commercial fertilizer meeting applicable requirements of State and Federal law.
   B. Formulations containing total nitrogen, available phosphoric acid, and soluble potash (N-P-K), with at least 50 percent of the nitrogen in a slow-release form derived from organic sources.
   C. Cyanic compound or hydrated lime not permitted in mixed fertilizers.
   D. Fertilizer shall be 19-19-19 at a rate of 420 lbs. per acre.
   E. Agricultural Limestone
      1. Shall conform to Soil Class J-1 as defined in section "Soils and Aggregates for Earthwork."

1.7 WisDOT MIX NO. 20
   A. Conform with the requirements of the governing authority for seeding and for restrictions on noxious weed seed.
   B. Minimum seeding rates and procedures for establishment and maintenance are described in UWEX publication A3434 Lawn Establishment & Renovation (2000).
   C. Seed mixture shall be composed of seeds of the purity, germination, and proportion by weight as follows:

<table>
<thead>
<tr>
<th>Percent</th>
<th>Variety</th>
<th>Min. % Purity</th>
<th>Min. % Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Kentucky Bluegrass</td>
<td>98</td>
<td>85</td>
</tr>
<tr>
<td>15</td>
<td>Red Fescue</td>
<td>97</td>
<td>85</td>
</tr>
<tr>
<td>24</td>
<td>Hard Fescue</td>
<td>97</td>
<td>85</td>
</tr>
<tr>
<td>40</td>
<td>Tall Fescue</td>
<td>98</td>
<td>85</td>
</tr>
<tr>
<td>15</td>
<td>Perennial Ryegrass</td>
<td>97</td>
<td>90</td>
</tr>
</tbody>
</table>

100% Total
Turf type tall fescue varieties: choose two of the five:

- Tulsa turf type tall fescue
- Regiment turf type tall fescue
- Crossfire turf type tall fescue
- Shortstop turf type tall fescue
- SR8200 turf type tall fescue

Seeding rate of 150 lbs. per acre.

D. Temporary Nurse Crop

1. When required the Contractor shall furnish one of the following seed mixtures:

<table>
<thead>
<tr>
<th>Species</th>
<th>Min. % Purity</th>
<th>Min. % Germ</th>
<th>Lbs. per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats</td>
<td>98</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>Rye</td>
<td>98</td>
<td>85</td>
<td>100</td>
</tr>
</tbody>
</table>

1.8 MULCH

A. Mulch shall consist of straw, hay, marsh hay, or wood chips which are free of noxious weeds and other objectionable foreign matter.

1. If wood chips are used, the mulch area shall be treated with one (1) pound of available nitrogen per 1,000 square feet.

B. Mulch binder shall conform to one of the following:

1. Emulsified asphalt shall meet the requirements for Type SS-1 AASHTO M140.
2. Terra Tack I, or equal.

PART 2 - EXECUTION

2.1 SEQUENCING AND SCHEDULING

A. Installation Schedule:

1. Contractor shall provide a schedule for plant installations and seeding.
   a. Contractor shall be responsible for notifying and coordinating planting schedule with Project Engineer and/or site restoration manager.
   b. Planting shall be scheduled to avoid severe meteorological conditions (high winds and heavy rains).
2. Schedule shall indicate anticipated dates when Engineer and/or site restoration manager will be required to review installation for initial acceptance and final acceptance.
2.2 PRECAUTIONS AND RESTRICTIONS

A. The Contractor shall verify the locations of all utilities prior to mobilizing on-site and conducting any site excavations.

B. The Contractor is responsible for all construction activities that take place within the project area and liable for repairing any off-site construction related damages.

2.3 SOIL PREPARATION FOR LANDSCAPING

A. General:
   1. Limit preparation to areas that will be planted immediately.
   2. Provide facilities to protect and safeguard all persons on or about premises.
   3. Protect any existing vegetation designated to remain.
   4. Contractor shall verify location and existence of all underground utilities. Take necessary precaution to protect existing utilities from damage due to construction activity. Repair all damages to utility items at sole expense.
   5. Provide facilities such as protective fences and/or watchmen to protect work from vandalism. Contractor to be responsible for vandalism until work has been accepted either in whole or in part.

B. Site Grading and Shaping
   1. Topsoil all areas which are required to be seeded in uplands. Place topsoil to 6 inches in depth when settled in uplands.
   2. Grading and shaping shall be limited to the area inside the limit of disturbance lines as shown on the project plans.
   3. Limit surface preparation in wetland areas to the extent practicable. Use shallow tilling or raking or other minimally invasive techniques.
   4. Contractor shall adhere to the final elevations shown in the Plans and Sections, unless otherwise pre-approved by the site restoration manager and/or the Project Engineer.

C. Preparation for Seeding:
   1. Lightly rake the seedbed to remove all weeds, sticks, roots, rubbish, all debris over 2 inches in size, and other matter.
   2. Leave surface irregular on sloped bank areas to receive seed mixtures.
   3. Final grade of all seedbeds shall be as shown on the design plans and sections.

2.4 FERTILIZING AND LIMING

A. Fertilize and lime all areas to be seeded or sodded.

B. Incorporation shall be performed by mechanical means during seeding operation.

C. Commercial fertilizer meeting applicable requirements of State and Federal law.
D. Formulations containing total nitrogen, available phosphoric acid, and soluble potash (N-P-K), with at least 50 percent of the nitrogen in a slow-release form derived from organic sources.

E. Slow release type of the following brands (or approved equal) containing the total nitrogen, available phosphoric acid, and soluble potash (N-P-K) in the ratios stated.
   1. Wetland live plant stock: Agriform 20-10-5, 2-year release, 10 g tablets.

2.5 UPLAND (TURF & GRASS, WILDFLOWER & PRAIRIE) SEEDING AND PLANTING

A. General:

1. Do not use seed that is wet, moldy, or otherwise damaged.
2. Employ satisfactory methods of sowing using hydro-seeder or mechanical hand seeders, or other approved equipment.
3. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds, excessive moisture, or other factors. Resume work only when favorable conditions develop.
4. Avoid compaction by avoiding construction on wet soil whenever possible, avoiding excessive foot traffic on the planting bed prior to the application of soil stabilizers, and avoid the use of heavy construction equipment on the planting bed.
5. Protect seeded areas against traffic or other use by erecting barricades and placing warning signs.
6. If compaction is known to have occurred, apply compost to the soil surface and rototill it into the soil as deeply as possible.
7. Utilize a machine or combination of machinery which will produce the following:
   a. Apply seed uniformly at the rate specified.
   b. Cover seed with approximately 1/4 inch of topsoil.
   c. Roll lightly.
   d. Apply seed at right angles to surface drainage.

B. WisDOT Mix No. 20

1. WisDOT Mix No. 20 seed mixture shall be applied as a permanent cover to all disturbed roadside, pathway, or fence line replacement/installation areas following construction.
2. Seeding Rate: 150 lbs. per acre
3. WisDOT Mix No. 20 seed mixture can be applied from March 15th to May 15th for spring planting, or August 15th to September 30th for fall planting, unless otherwise approved by Project Engineer and/or site restoration manager.
4. Sod must be tamped into place with edges tight and lightly watered daily for two weeks.
2.6 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by planting work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period until plants and seeded areas are established and accepted by site restoration manager and/or Project Engineer.

C. Repair and pay for all damaged items.

2.7 MULCHING

A. Complete mulching as follows in upland areas (Turf and Grass areas and Wildflower/Prairie areas):

1. Within 48 hours after seeding has been completed.
2. Place all mulch uniformly to a loose depth of 1 to 1½ inches (2 to 3 tons per acre).
3. Mulching operation shall begin at the top of slopes and proceed downward.

B. Mulching shall be secured using one of the following methods:

1. Method "A": Secure mulch with heavy twine or netting.
   a. Twine to be fastened with pegs or staples to form a grid of 6- to 10-foot spacing.
2. Method "B":
   a. Apply emulsified asphalt at the rate of 200 to 300 gallons per acre.
   b. Machinery used for placing mulch and emulsified asphalt shall produce a spotty tack sufficient enough to hold together and retain in-place the deposited mulch material.
3. Method "C":
   a. Anchor mulch in soil by means of a mulch tiller.
   b. Mulch shall be impressed in the topsoil to a depth of 1½ to 2½ inches in one pass of the tiller.
4. Method “D”:
   a. For all seeded slopes steeper than 3:1 (3 feet horizontal to 1 foot vertical), cover immediately after application with erosion control blanket.
      i. ii. Areas seeded to Turf and Grasses seed mix shall be covered with Jute mesh or ECS-1.
      i. Erosion control blankets shall be fastened to the soil surface with galvanized pins following blanket manufacturers pattern and rate.

C. Mulching can be discontinued at plant maturity provided that the soil surface is fully covered with dense vegetation.
2.8 MONITORING

A. The Contractor shall coordinate implementation of any remedial actions identified during site monitoring inspections with the Project Engineer and/or site restoration manager.

2.9 PERFORMANCE CRITERIA

A. The following performance criteria will be utilized for each community during the monitoring inspections:

1. Turf and Grass
   a. Greater than 80% total absolute areal vegetative cover within the first full growing season

2.10 MAINTENANCE

A. General:

1. Begin maintenance of all seeded and planted areas immediately after each portion is installed. The Contractor shall maintain all seeded areas until final acceptance.
2. Maintain as necessary to sustain good vigorous growth until project acceptance by the Engineer and/or site restoration manager.
3. Replace in kind and size all plant material that is dead or not in a healthy vigorous condition as determined by the Engineer and/or site restoration manager.
4. Complete all replacement plantings not later than next succeeding planting season.
5. Project Engineer and/or site restoration manager will review completed planting for acceptability of installation. Approval of planting denotes initial acceptance and beginning of maintenance period.

B. Seeded Areas:

1. Provide watering equipment as required to convey water from water sources and to keep planted areas uniformly moist as required for proper growth.
2. Replace unacceptable materials with materials and methods identical to the original specifications unless otherwise approved by the Engineer and/or site restoration manager.
3. Maintain all seeded and sodded turf areas until the stand meets all performance criteria.
4. Mowing Option – Mow one to three times during the first growing season to a height of 8 to 10 inches above ground surface. First year growth energy is concentrated to the root system in native plants. Mowing during the first year will help suppress non-native growth without impacting root growth of planted natives.
5. Non-mowing Option - Clip weeds with a sickle-bar, rotary shredder, or portable weed whip at least 3 to 4 times the first year during seedling emergence. When weeds reach a minimum height of 6 inches or are shading out 50 percent of the native grass seed mixture, shred weeds just above the grass leaves. Do not allow weeds to exceed a height of 8 inches above set seed. Lightly rake and remove any weed seed heads.

6. Water sparingly, enough to maintain survival of grass seedlings; yet discourage weed re-growth.

7. Prepare site and reseed eroded or bare areas immediately if evident within specific planting season, but not later than the next succeeding planting season throughout the maintenance period. Specified erosion control blankets shall be replaced on all re-seeded areas steeper than 1H: 3V.

8. All areas to be resistant to erosion throughout and after maintenance.

9. Warranty the seeded areas for one year following substantial completion.

END OF SECTION
SECTION 33 00 10

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work under this section includes material and performance requirements for high density polyethylene pipe and fittings.

1.2 REFERENCES STANDARDS

A. American Society for Testing and Materials (ASTM)
   4. ASTM D1248 Spec. for Polyethylene Plastics Molding and Extrusion Materials.
   5. ASTM D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
   7. ASTM D1693 Test for Environmental Stress – Cracking of Ethylene Plastics.
   8. ASTM D2657 Practice for Heat Joining Polyolefin Pipe and Fittings.

1.3 QUALITY ASSURANCE

A. Pipe shall be available to Owner’s representative for inspection.

B. Pipe shall be considered defective and will be rejected when:
   1. Not homogeneous throughout.
   2. Contains crack, holes, or foreign inclusions.
   3. Not utilized within six (6) months of date of production.
   4. Improperly stored.

C. Material brands and/or pipe classes not to be mixed.

D. All fusion welding shall be performed by personnel who have been certified to use the equipment being used.
E. Perform test welds at request of Engineer.

1.4 PRODUCT DELIVERY

A. Pipe Marking
Pipe shall be marked as follows:
1. Manufacturer's name, trademark or logo.
2. Nominal size.
3. National Sanitation Foundation designation.
4. ASTM cell classification or Plastic Pipe Institute designation.
5. Dimension ratio, schedule size, or pressure rating.
6. Production date.

B. Storage
1. Provide a protected storage area.
2. Keep pipe material safe from damage and theft.

1.5 SUBMITTALS

A. Submit following:
1. Shop drawings on pipe and fittings.
2. Manufacturer's certification of the following:
   a. Production date of all materials.
   b. That material comply with the requirements of this section.
3. Evidence of certification of personnel performing thermal butt fusion.

PART 2 - PRODUCT

2.1 MATERIAL REQUIREMENTS (PIPE AND FITTINGS)

A. Shall conform to the following:
1. Meet the requirements of Plastic Pipe Institute Designation PE4710.
2. Comply with requirements for Type III, Class C, Category 5, Grade P34 in accordance to ASTM D1248.
3. Cell classification of 445474C in accordance to ASTM D3350 and limits and test methods shall be as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>Limits</th>
<th>Test</th>
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<tbody>
<tr>
<td>Density</td>
<td>0.941 – 0.955</td>
<td>ASTM D1505</td>
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<tr>
<td>Melt Index</td>
<td>&lt;0.15</td>
<td>ASTM D1238</td>
</tr>
<tr>
<td>Flexural Modulus (PSI)</td>
<td>80,000 - &lt;110,000</td>
<td>ASTM D790</td>
</tr>
<tr>
<td>Tensile Strength at Yield (PSI)</td>
<td>3,000 - &lt;3,500</td>
<td>ASTM D638</td>
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<td></td>
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<tr>
<td>Test Condition</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Test Duration, Hours</td>
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<td></td>
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<tr>
<td>Failure, Max. Percentage</td>
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<tr>
<td>Hydrostatic Design Basis (PSI at 23°C)</td>
<td>1,600</td>
<td>ASTM D2837</td>
</tr>
</tbody>
</table>

HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

33 00 10 - 2
B. Double Encased Pipe

C. Fittings and Custom Fabrications
   1. Polyethylene fittings and custom fabrications shall be molded or fabricated by the pipe manufacturer. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe. Pressure de-rated fabricated fittings are prohibited.

D. Molded Fittings
   1. Molded fittings shall be manufactured in accordance with ASTM D 3261, and shall be so marked. Each production lot of molded fittings shall be subjected to the tests required under ASTM D 3261. The Manufacturer shall submit samples from each molded fittings production lot to x-ray inspection for voids, and shall certify that voids were not found.

E. Fabricated Fittings
   1. Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full service pressure rating of the mating pipe.

F. Polyethylene Flange Adapters
   1. Flange adapters shall be made with sufficient through-bore length to be clamped in a butt fusion joining machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves to provide gasketless sealing, or to restrain the gasket against blow-out.

G. Back-up Rings and Flange Bolts
   1. Flange adapters shall be fitted with back-up rings pressure rated equal to or greater than the mating pipe. The back-up ring bore shall be chamfered or radiused to provide clearance to the flange adapter radius. Flange bolts and nuts shall be Grade 2 of higher.

H. Butterfly Valves
   1. Standard Service Butterfly Valves
      a. Butterfly valves 2 inches to 72 inches shall conform to AWWA C504.
      b. Valve bodies shall be ASTM A126 Class B cast iron lugged style suitable for use between ANSI 125 or 150 pound flanges.
      c. Valves shall be rated at 175 psi and conform to 75B rating.
      d. Valves shall have retained seat providing tight shut off up to the full valve rating on dead end or isolation service without the use of downstream flanges.
      e. Discs shall be 316 stainless steel.
      f. Shafts shall be stainless steel supported on self-lubricating bronze or TFE coated stainless steel sleeve type bearings.
g. Valve seats not molded to the body shall be molded to a rigid corrosive reinforcing ring. Seats shall be 18-8 stainless (castings conforming to ASTM A743).

h. Seats shall be natural or synthetic rubber suitable for the specified pipeline applied to disc with clamps or applied to the body by cementing and clamping, bonding or vulcanizing.

i. Valves through 6 inches shall have an infinite position lever with adjustable position memory stop for balancing service or have a 10 position, latch lock lever for on-off service.

j. Valves 8 inches and larger shall have enclosed handwheel or chain wheel operated gear actuators with adjustable open position stop if for balancing service.

PART 3 - EXECUTION

3.1 POLYETHYLENE PIPE INSTALLATION

A. In addition to the applicable sections for installing piping, the Contractor shall conform to the following:
   1. Thermal butt fuse all joints as per ASTM D2657.
   2. Utilize certified personnel for jointing operation.
   3. Laterals shall be connected to liner with a polyethylene.
      a. Any saddle to be secured by heat fusion.
      b. If extreme conditions prevent the use of heat fusion, saddle may be secured with stainless steel bands and neoprene gasket.
         1) Engineer's approval is required for this method.

B. Size and class (SDR rating) shall be as shown on drawings.

END OF SECTION
SECTION 40 05 13.13

CARBON STEEL PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. General service carbon steel pipe.
   2. High temperature service carbon steel pipe.
   3. High pressure carbon steel pipe.

B. The products described are not installed under this Section.

1.2 STANDARDS

A. American National Standards Institute (ANSI):
   1. B1.20.1 Pipe Threads, General Purpose.
   2. B16.1 Cast Iron Pipe Flanges and Flanged Fittings, 25, 125, 250, and 300 lbs.
  10. B36.10 Welded and seamless Wrought Steel.
  11. G17.3 Specifications for Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

B. American Society for Testing and Materials (ASTM):
   1. A53 Specification for Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
   2. A105 Carbon Steel Forgings for Piping Applications.
   4. A120 Specification for Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless for Ordinary Uses.
   5. A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   8. A194 Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Carbon Steel Process Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>D3308</td>
<td>PTFE Resin Skived Tape.</td>
</tr>
</tbody>
</table>

C. American Water Works Association (AWWA):
1. C200 Standard for Steel Water Pipe, 6 inches and larger.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements
1. The type of pipe, thickness, fittings, linings, and coatings required shall be as shown on the drawings or as scheduled elsewhere.
2. The pressure ratings and materials specified represent minimum acceptable standards for piping systems.
3. The piping systems shall be suitable for the services specified and intended.
4. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

1.4 SUBMITTALS

A. Submit the following:
1. Certification of production date of all materials.
2. Manufacturer's certification that the materials delivered were manufactured, sampled, tested, and inspected in accordance with this specification and appropriate referenced standards.
4. Manufacturer's recommendations for assembly.

1.5 QUALITY ASSURANCE

A. Make pipe available to Owner's Representative for inspection.

B. Pipe shall be rejected for any of the following:
1. Variations in any dimension exceeding that allowed in the manufacturer's specifications and when these allowances become excessive in the opinion of the Engineer to the point that a proper installation cannot be had.
2. Straightness varying more than ½ inch measured as an outside midordinate for lengths of 10 feet or ⅝ inch for lengths of 13 feet. Other lengths shall have the variance in proportion.

3. Any defects that indicate imperfect workmanship or materials or that will not allow a proper installation to be made.

C. Material brands and/or pipe classes shall not be mixed.

1.6 DELIVERY, STORAGE AND HANDLING

A. Marking:
The following shall be painted in white on each piece of pipe:
1. Weight per foot.
2. Identifying serial number.
3. Thickness.
4. Date manufactured.

B. Shipping:
1. Pipe and fittings shall be packaged to prevent damage during shipping.
2. Fittings shall be on pallets.
3. Loading or unloading shall be done with lifts to avoid shock.
4. Wrapped or coated pipe shall be lifted so that the wrapping or coating is not damaged.
5. No materials shall be dropped.

C. Storage:
1. Provide safe storage for material.
2. Interior of pipe, fittings, and other accessories shall be kept free from dirt and foreign matter.
3. Fittings shall be stored in a manner that will allow them to drain and protect them from freezing.
4. Pipe shall be neatly piled and blocked with strips between tiers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General Service Carbon Steel Pipe
1. Use for ordinary use in water, gas, and air lines.
2. Meet the requirements of ASTM A53.
3. Buried carbon steel piping and fittings shall be Schedule 80.
4. Carbon steel piping shall be joined by threaded couplings or welding fittings as required.

B. General Service Carbon Steel Pipe 6" Diameter and Greater.
1. Conform to AWWA C200.
2. Flanges shall meet specification AWWA C207.
3. Grooved and shouldered ends shall meet AWWA C606.
4. Class D flanges shall be standard unless other classes are called for in the pipe schedule.
5. Gaskets: Ring type ⅛-inch sheet rubber.
7. Fittings shall meet specification AWWA C208.
8. Welded joints shall conform to AWWA C206.

C. High Temperature Service Carbon Steel Pipe
   1. Conform to ASTM A106 seamless.
   2. Piping and fittings shall be Schedule 80 with dimensions conforming to ASME B36.10M.

D. High Pressure Carbon Steel Pipe
   1. Pipe shall seamless conforming to ASTM A106 and ANSI B31.1.0.
   2. Fittings and flanges shall conform to ASTM A193 and ANSI G17.3.

E. Threaded Fittings
   1. Threaded fittings shall be malleable iron, ASTM A 47, conforming to ASME B16.3, black or forged carbon steel ASTM A105, conforming to ASME B16.11.
   2. Threaded, rigid couplings shall be seamless, carbon steel in accordance with ASTM A865 and threaded in accordance with ASME B1.20.1.
   3. Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308 shall be used for lubricant/sealant.

F. Coating
   1. Underground piping and fittings shall be coated.
   2. Coating shall conform to AWWA C203.

G. Interior Lining
   1. Concrete lining shall conform to AWWA C205.
   2. Fusion-bonded epoxy in accordance with AWWA C213 where shown on the drawings or specified elsewhere.
   3. Do not provide an interior lining for air service.

PART 3 - EXECUTION

3.1 JOINTS

A. Joints shall be welded except fitting, valve, and equipment connections.

B. Fitting, valve, and equipment connections shall be flanged.

C. Grooved and shouldered couplings may be used rather than flanged where the pipe thickness within the groove is a minimum of ¼".

D. Coating damaged adjacent to a welded joint shall be recoated to the original specification.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Stainless steel pipe for above ground application.
2. Stainless steel fittings.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
3. ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Both.

B. American Society of Manufacturing Engineers

1.3 SYSTEM DESCRIPTION

A. Performance Requirements
1. The type of pipe, thickness, fittings, linings, and coatings required shall be as shown on the drawings or as scheduled elsewhere.
2. The pressure ratings and materials specified represent minimum acceptable standards for piping systems.
3. The piping systems shall be suitable for the services specified and intended.
4. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.
1.4 SUBMITTALS

A. Product Data
   1. Manufacturer's certification that the materials delivered were manufactured,
      sampled, tested, and inspected in accordance with this specification and
      appropriate referenced standards.
   3. Manufacturer's recommendations for assembly.

B. Quality Assurance/Control Submittals
   2. Results of Radiographic Examination.

1.5 DELIVERY, STORAGE AND HANDLING

A. Marking
   The following shall be painted in white on each piece of pipe:
   1. Weight per foot.
   2. Identifying serial number.
   3. Thickness.
   4. Date manufactured.

B. Shipping
   1. Pipe and fittings shall be packaged to prevent damage during shipping.
   2. Fittings shall be on pallets.
   3. Loading or unloading shall be done with lifts to avoid shock.
   4. Wrapped or coated pipe shall be lifted so that the wrapping or coating is not
      damaged.
   5. No materials shall be dropped.

C. Storage
   1. Provide safe storage for material.
   2. Interior of pipe, fittings, and other accessories shall be kept free from dirt and
      foreign matter.
   3. Fittings shall be stored in a manner that will allow them to drain and protect them
      from freezing.
   4. Pipe shall be neatly piled and blocked with strips between tiers.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Stainless Steel Pipe
   1. Stainless steel pipe intended for general corrosive service shall meet the
      requirements of ASTM A312 welded, ASTM A813 for fit-up and alignment
      quality, Class SW (single weld), Grade TP 304L, Schedule 10S.
   2. Stainless Steel tubing less than 1-inch diameter shall be schedule 40S, seamless,
      corrosion-resistant steel, conforming to ASTM A312, Grade TP 304L.
B. Fittings ½ inches through 1 inch: 3,000-pound, forged corrosion-resistant steel, socket weld, conforming to ASTM A182, Grade F 304.

C. Fittings 1 inch through 10 inches: Schedule 10S, long radius, butt weld, corrosion-resistant steel, conforming to ASTM A403, WP 304.

D. Flanges 1 inch through 10 inches: 150-pound, forged corrosion-resistant steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A182.

E. Gaskets
   Spiral wound, full face, filled with chloride ion-free non-asbestos materials, corrosion resistant-steel, with centering provisions, conforming to ASME B16.5, Group 1.

F. Bolting
   Heavy hex-head corrosion-resistant steel bolts or bolt studs conforming to ASTM A193, Grade BB, and semi-finished heavy hex nuts, conforming to ASTM A194, Grade 8A.

2.2 FABRICATION

A. Welding
   1. Pipe welding shall comply with the provisions of the latest revision of the applicable code, whether ASME Boiler and Pressure Vessel Code, ASA Code for Pressure Piping or such state or local requirements as may supersede codes mentioned above.
   2. Welders shall follow Standard Procedure Specifications and be qualified by the National Certified Pipe Welding Bureau.
   3. Joining welds shall be made by a fully automatic, inert gas process.
      a. Before the butt seam is welded, starting and run-off tabs shall be heliarc spot welded to each end of pipe or fitting.
      b. Ends of pipe shall be true to the axis.
      c. Add filler wire of the same grade as the parent metal to all gauges of material such that a cross-section of weld metal is equal to or greater than the parent metal.
   4. The welds shall be a fully penetrated, sound and uniform bead.
   5. Heavy wall tubular products may be welded on the inside.
   6. Circumferential welds shall be made using the tungsten shielded arc process with full penetration to the interior surface of the pipe.

B. Weld Finish
   1. Interior welds shall have a surface finish equal to the smoothness of a 2D sheet finish.
      a. Interior weld beads shall be smooth, evenly distributed with an interior projection not exceeding 1/16 inch beyond the I.D. of the pipe or fitting.
      b. The exterior weld area shall be wire brushed with stainless steel and used only on stainless steel.
c. Remove discoloration and deposits left by welding by pickling or sandblasting.

2.3 SOURCE QUALITY CONTROL

A. Tests, Inspection
   1. Provide tests and inspections of the pipe in accordance with ASTM A312.
   2. Provide Radiographic Examination in accordance with ASTM A312 Supplementary Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Joints
   1. Joints shall be welded except fitting, valve, and equipment connections.
   2. Fitting, valve, and equipment connections shall be flanged.

B. Piping shall be of the size and material as shown on the figures.
SECTION 40 14 00

ABOVE GRADE PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes exposed piping.
   2. Stainless Steel Piping Systems.
   5. Couplings and Adapters.
   6. Flexible Connectors.
   7. Tapping Saddles.
   8. Wall Sleeves, Wall Pipe and Seals.

1.2 REFERENCES

A. American Water Works Association (AWWA)
   1. AWWA C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   2. AWWA C110 Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in. for Water.
   3. AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   6. AWWA C151 Ductile-Iron Pipe, Centrifugally Cast, for Water.
   7. AWWA C200 Steel Water Pipe - 6 in. and larger.
   8. AWWA C208 Dimensions for Fabricated Steel Water Pipe Fittings.
   9. AWWA C606 Grooved and Shouldered Joints.
   10. AWWA C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4-in. through 12-in. for water.

B. American Society for Testing and Materials (ASTM)
9. ASTM D1785 Spec. for Poly (Vinyl Chloride) (PVC) Plastic Pipe Schedules 40, 80, and 120.
16. ASTM F477 Spec. for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

C. American National Standards Institute (ANSI)
1. ANSI B16.1 Cast Iron Flanges and Flanged.
2. ANSI B16.5 Pipe Flanges and Flanged Fittings NPS ½ through NPS 24.
3. ANSI B 16.11 Forged Fittings, Socket-Welding and Threaded.
4. ANSI B 36.10 Welded and Seamless Wrought Steel Pipe.

D. American Society of Mechanical Engineers (ASME)
1. ASME B31.3 Process Piping.

E. Manufacturers Standardization Society of Valve and Fittings Industry, Inc. (MSS)
1. MSS SP-69 Pipe Hangers and Supports - Selection and Application.
3. MSS SP-89 Pipe Hangers and Supports - Fabrication and Installation Practices.
1.3 SUBMITTALS

A. Submit product data for couplings, expansion joints and wall seals.

B. Submit drawings for all types of hangers, joints, supports, and materials used in the piping system.

C. Submit results of test data.

D. Submit record drawings of piping system.

E. Submit manufacturer’s recommendations for use and installation of piping materials.

1.4 QUALITY ASSURANCE

A. Make pipe and materials available to Owner's Representative for inspection.

B. Material brands and/or pipe classes shall not be mixed.

C. Pipe Marking

Pipe and fittings shall be marked as follows:
1. Manufacturer's name, trademark or logo.
2. Nominal size.
3. ASTM or AWWA or other specification designation.
4. All other markings required for the specification designation.
5. Production date.

1.5 DELIVERY, STORAGE AND HANDLING

A. Inspect the pipe shipment to identify shifted loads, broken packaging or rough treatment, which could be an indication of damage.

B. Unload the pipe in a manner which will not put stress on the pipe or strike anything causing damage.

C. Store piping materials with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminates.

D. Store gaskets away from excessive exposure to heat, direct sunlight, ozone, oil or grease.

E. Store solvent cement in tightly sealed containers away from excessive heat.

F. Handle pipe in a manner to prevent impact blows, abrasion damage, gouging or cutting.

G. Store pipe and fittings in accordance with the manufacturer’s recommendation.
H. Any material found to be damaged shall be removed from the site and replaced.

1.6 EXISTING CONDITIONS

A. Verify existing piping conditions and penetrations prior to ordering materials.
B. Expose existing pipes which are to be connected to new pipelines.
C. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes.
D. Inspect size and location of structure penetrations to verify adequacy of wall sleeves and other openings before installing connecting pipes.

1.7 SEQUENCING AND SCHEDULING

A. For slab, floor, wall, and roof penetrations, make pertinent wall pipes and sleeves available prior to when they are required for placement in concrete forms.
B. Verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

PART 2 - PRODUCTS

2.1 CARBON STEEL PIPING SYSTEM

A. Carbon Steel (CS) Pipe
   1. Pipe used for general service shall meet the requirements of ASTM A53, Type E or S.
   2. Seamless carbon steel pipe for high temperature service shall conform to ASTM A106 with dimensions conforming to ANSI B36.10.
   3. Unless otherwise specified, pipe shall be Schedule 40.
   4. Electrically butt-welded straight-seam and seamless pipe shall conform to AWWA C200.

B. Carbon Steel Joints
   1. Join piping with straight-threaded couplings or grooved joints conforming to AWWA C-606.
   2. Piping joined by welding shall meet AWWA C200.

C. Carbon Steel Fittings
   1. Fittings shall be carbon steel.
   2. Threaded fittings shall conform to ASTM A105 and ANSI B16.11.
   3. Polytetrafluoroethylene (PTFE) pipe-threaded tape conforming to ASTM D3308 shall be used for lubricant/sealant.
   4. Fabricated fittings shall conform to AWWA C208.
2.2 STAINLESS STEEL PIPING SYSTEM

A. Stainless Steel (SS) Pipe
   1. Stainless steel pipe intended for general corrosive service shall meet the requirements of ASTM A312 welded, ASTM A813 for fit-up and alignment quality, Class SW, Grade TP 304L, Schedule 10S.

B. Stainless Steel Joints
   1. Joints shall be welded connections conforming to ANSI B2.1 or flanged where attached to equipment.
   2. Provide dielectric fittings or isolation joints between dissimilar metals.

C. Stainless Steel Fittings
   1. Flanges shall be 150 pound, forged type 304 stainless steel, welding neck, with raised face and concentric serrated finish, conforming to ASTM A182.
   2. Grout rings shall be 11 gauge, 304L flat face rings continuously welded on one side of the pipe and stitch welded on the opposite side.

2.3 POLYVINYL CHLORIDE PIPING SYSTEMS

A. Polyvinyl Chloride (PVC) Pipe 3 in. Diameter or Less
   1. Polyvinyl Chloride (PVC) Pipe:
      a. PVC pipe shall conform to ASTM D1784, minimum cell classification 12545-C.
      b. PVC pipe shall be Schedule 40 or 80 as specified elsewhere conforming to ASTM D1785.
   2. Polyvinyl Chloride Pipe Joints:
      a. Join the piping system using socket-weld connections except where unions, valves, and equipment require threaded connections for future disassembly.
      b. Connections at unions, valves, and equipment shall be threaded and back-welded.
   3. Polyvinyl Chloride Fittings:
      a. The schedule rating for the fittings shall not be less than that for the associated pipe.
      b. Fittings shall conform to ASTM D1784, minimum cell classification 12545-C.
      c. Socket type fittings shall conform to ASTM D2466 for Schedule 40 and ASTM D2467 for Schedule 80.
      d. Threaded type fittings shall conform to ASTM D2464, Schedule 80.
   4. PVC Solvent Cement:
      a. Socket connections shall be joined with PVC solvent cement conforming to ASTM D2564.
      b. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility.

B. Polyvinyl Chloride (PVC) Pipe 4-in. Diameter or Greater
   1. Polyvinyl Chloride (PVC) Pipe:
      a. PVC pipe sizes 4-in. through 12-in. shall conform to AWWA C900, pressure Class 150, thickness Class DR 18.
b. PVC pipe sizes 14-in. through 36-in. shall conform to AWWA C905, pressure Class 165, thickness Class DR 25.

2. Polyvinyl Chloride Pipe Joints:
   a. Joints shall have a working pressure rating equal to the pressure rating of the connected pipe.
   b. Joints at connections to fittings, valves, and equipment shall be EBAA Iron Sales, Inc. wedge style flange adapter.
   c. Intermediate joints where restraint is not required shall conform to ASTM D3139 with elastomeric gaskets conforming to ASTM F477.

3. Fittings:
   a. Fittings shall be ductile iron conforming to AWWA C110.
   b. Provide with standard cement lining conforming to AWWA C104.
   c. Provide fusion-bonded epoxy exterior coating in accordance with AWWA C116.

2.4 RELATED PIPING MATERIALS

A. Bolts and Nuts
   1. Carbon steel standard treated bolts and studs conforming to ASTM A307, Grade B, cadmium plated and nuts conforming to ASTM A563, Grade B, cadmium plated.

B. Gaskets
   1. Type GT: Gore Tex™ expanded PTFE ⅛-in. thick sheet or insertable gaskets.
   2. Type RR: Blended natural/SBR red rubber, ⅛-in. thick sheet packing 70-85 shore durometer.
   3. Type AR: EPDM, 350°F temperature rating.
   4. Gaskets for flanges shall be full face.

2.5 COUPLINGS AND ADAPTERS

A. Mechanical couplings for joining plain end pipe of same diameter:
   1. Dresser Style 38.
   2. Smith-Blair No. 411.
   3. An approved equal.

B. Mechanical couplings for joining pipe with diameters differing up to ¾ in.:
   1. Dresser style 162.
   2. Smith-Blair No. 413.
   3. An approved equal.

C. Mechanical couplings for joining pipe with diameters differing more than ¾ in.:
   1. Dresser style 62.
   2. Smith-Blair No. 415.
   3. An approved equal.

D. Expansion joint couplings for absorbing concentrated pipe movement.
   1. Dresser style 63.
2. Smith-Blair No. 611.
3. An approved equal.

E. Flanged coupling adapters for joining plain end pipe to flanged pipe, valves or fittings:
   1. Dresser style 128 with two anchor pins.
   2. Smith-Blair No. 913 with two anchor pins.
   3. An approved equal.

2.6 FLEXIBLE CONNECTORS

A. Provide flexible connectors as necessary for all pumps, blowers, and other items of equipment which may induce vibration to the piping system.

B. Joints shall allow a minimum of 0.625 in.es pipe expansion, 0.25 in.es pipe compression. Construct flexible connectors with a filled arch to eliminate sedimentation of solids in the arch area.

C. Provide tie rods at all flexible connectors and expansion joints on pump discharge. Tie rods shall be of sufficient number and strength to restrain the connection at test pressure. Use a minimum of two ⅝-in. diameter tie rods at all connections.

D. Approved manufacturers of flexible connectors to isolate vibration:
   1. Redflex
   2. Metraflex
   3. General Rubber
   4. Goodall
   5. An approved equal.

E. Approved manufacturers of reducing flanged flexible connectors:
   1. Redflex J-10
   2. Metraflex
   3. An approved equal.

2.7 TAPPING SADDLES

A. Bodies
   Malleable iron, ASTM A47, grade 32510 or ASTM A536, ductile iron.

B. Straps
   2. Quantity:
      a. Two straps per saddle for pipe up to 19.25 in. O.D.
      b. Three straps per saddle for pipe larger than 19.25 in. O.D.
   3. Gaskets:
      a. Rockwell grade 60, chemical resistant.
      b. Minimum Pressure Rating: 250 psi
   4. Saddles shall wrap from 160° to 180° around pipe.
   5. Acceptable Manufacturers: Rockwell or equal.
2.8 WALL SLEEVES, WALL PIPE AND SEALS

A. Wall Sleeves
   1. Mechanical joint Clow or equal with glands and gaskets.

B. Wall Pipe
   1. Clow or equal with joints to match pipeline.

C. Wall Seals
   1. Interlocking synthetic rubber link shaped to continuously fill annular space between pipe and wall opening. Connecting bolts and pressure plates cause rubber seal to expand when tightened.
   2. Recess seal and grout annular space in exposed areas.

2.9 PIPE SUPPORTS AND ANCHORS

A. Manufacturers shall be Lee & Mason, Grinnel, Unistrut, Elcan, or equal.

B. Horizontal Piping Hangers and Supports
   1. Adjustable Steel Clevis Hanger, MSS Type 1: For suspension of noninsulated or insulated stationary pipelines 4 to 30 in.es in diameter.
   2. Yoke Type Pipe Clamp, MSS Type 2: For suspension of insulated pipe, 4 to 16 in.es in diameter.
   3. Adjustable Steel Band Hanger, MSS Type 7: For suspension of noninsulated stationary pipelines ½ to 8 in.es in diameter.
   4. U-bolt, MSS Type 24: For support of heavy loads ½ to 30 in.es in diameter.
   5. Pipe Stanchion Saddle, MSS Type 37: Including steel pipe base support, cast iron floor flange and U-bolt pipe retainer.
   6. Adjustable Roller Hanger, MSS Type 43: For suspension of pipe from a single rod where horizontal movement may occur because of expansion or contraction, 2½ to 20 in.es in diameter.
   7. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

C. Vertical Piping Clamps
   1. Extension Pipe or Riser Clamp, MSS Type 8: For supporting noninsulated or insulated pipe risers, ¾ to 20 in.es in diameter.

D. Hanger Rods
   1. Shall be electro-galvanized or cadmium plated after threads are cut.

E. Building Attachment
   1. Steel or Malleable Concrete Inserts, MSS Type 18: For suspending pipe hangers from concrete ceiling.
   2. Top Beam C-Clamp, MSS Type 19: For under roof installations with bar joist construction for attachment to top flange of structural shapes.
3. Center-Beam Clamp, MSS Type 21: For attachment to center of bottom flange of beams.
4. C-Clamp, MSS Type 23, for attachment to structural shapes.
5. Top Beam Clamp, MSS Type 25: For attachment to top of beams when hanger rod is required tangent to edge of flange.
6. Side Beam Clamp, MSS Type 27: For attachment to bottom of steel I-beams.
7. Welded Steel Brackets: For supporting from above or below:
   a. MSS Type 31, Light: 750 lb. load
   b. MSS Type 32, Medium: 1,500 lb. load
   c. MSS Type 33, Heavy: 3,000 lb. load

F. Insulation Shields
1. Protection Shield, MSS Type 40: Of length recommended by manufacturer to prevent crushing of insulation.
2. Shields shall be galvanized coated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close pipe and equipment openings with caps or plugs during installation to protect from dirt and other debris from entering.

B. Clean ends of pipes, remove foreign matter and dirt from inside of pipes prior to installation.

C. Coordinate the work with all trades to insure proper scheduling of inter-related work so as not to cause unnecessary delays or upset the treatment plant process to the extent that they violate their permit.

D. Before fabrication, verify all measurements at the site and obtain all necessary additional information required for the completion of the Work.

E. The figures are diagrammatic representing what is required. Coordinate the architectural, structural, electrical and other mechanical site conditions to determine true dimensions, details, obstructions, and conflicts.
   1. Figures are drawn for maximum clarity and are not necessarily intended to indicate a dimensional location.
   2. Group piping on walls and ceilings and coordinate and run with other mechanical and electrical work to allow a neat finished appearance.
   3. Install pipe runs in straight lines parallel to or at right angles to the walls, floors or other pipe runs.

3.2 INSTALLATION

A. General Requirements
   1. Maintain at the site a record set of Drawings.
      a. Clearly and accurately record all approved changes and/or additions made to meet field conditions.
b. Use the Drawings for this purpose only, and delivered to the Engineer in good condition at the completion of the work.

2. Perform the necessary Work required to provide a complete and functioning system. If there are specific work items which the Contractor believes are not specifically identified, but are required to provide a functionally complete Project, then the identified specific work items shall be included in the Work.

3. Make connections to existing systems without damage to existing systems and equipment. Repair any systems and equipment he damages.

4. Provide access to gauges, valves or any other equipment located in walls, above ceilings or in any other inaccessible location.
   a. In plaster or masonry, provide metal access doors.
   b. Provide acoustical ceilings with removable panels and marker tabs on each panel.

5. Do not run pipe through structural beams.

6. Field route piping in nominal size 2 in.es and smaller, unless otherwise indicated.

7. Install piping so not to interfere with the operation or accessibility of doors or windows, encroachment on aisles, passageways and equipment, and the servicing or maintenance of any equipment.

8. Provide flashing and sealant for pipe passing through the roof.

B. Grooved and Shouldered Coupling System

1. Locate and install grooves so coupled keys bear against shoulder of groove nearest each end of pipe or fitting being connected so as to prevent separation of joints or longitudinal movement.

2. Cut grooves to produce clean and sharp grooves without burrs or check marks.

3. Tighten joint bolts sufficiently so housing bolt pads meet.

C. Coupling and Adapters

1. Cut pipe clean with smooth ends.

2. Space pipe a minimum of $\frac{1}{2}$ in. to a maximum of 1 in..

3. Install mechanical couplings in accordance with manufacturer's recommendations.

4. Restrain to prevent movement.

D. Wall Pipe, Sleeves and Seals

1. Provide wall pipe for process piping passing through below ground or water bearing concrete walls.

2. Provide wall sleeves for process piping passing through above ground concrete or masonry walls.

3. Where pipes pass through interior metal or exterior metal walls, use 18 gauge galvanized sheet steel sleeves 1-in. larger than outside diameter of pipe. Seal the gap between the sleeve and the pipe.

4. Rotary drilled holes can be used for pipe penetrations through existing walls. For exterior of water bearing walls, provide wall seals in the annular space between pipe passing through the drilled hole and the interior surfaces of the wall sleeves.
   a. Compress the rubber sealing elements to expand and provide a watertight seal.
   b. Wall pipe castings shall have mechanical joints for all below ground exterior connections.
5. Provide flanged joint wall pipe castings for all other connections as necessary. To insure correctly installed flanged wall pipe, install the wall pipe set in the forms with the bolt holes and flanges straddling the centerlines horizontally and vertically.

E. Pipe Supports and Anchors
1. Concrete Inserts:
   a. Provide at locations where structural steel supports cannot be used.
   b. Install inserts before placing concrete, fasten to forms.
2. Precast Prestressed Concrete:
   a. Fasten anchors only with methods approved by the precast manufacturer.
3. Pipe Hangers:
   a. Install so pipe will be free to expand and contract.
   b. Hangers shall be adjustable and allow for required pitch.
   c. Provide hangers in a sufficient number to ensure safe support of the piping system.
   d. Hangers for fiberglass reinforced (FRP) pipe shall be provided with a saddle.
4. Hanger and Support Spacing:
   a. Maximum horizontal pipe hangers and support spacing in accordance with MSS SP-69.
   b. Minimum hanger rod diameter in accordance with MSS SP-69.
   c. Plastic pipe shall be supported in accordance with manufacturer’s recommendations for the service conditions.
   d. In addition to the spacing schedule, provide additional support as follows:
      1) At each change in direction.
      2) On each side of large valves.
      3) Within 5 feet of each equipment connection.
      4) At all branches or risers.
      5) At all floor openings.
      6) Minimum of one support for each length of cast iron or ductile iron pipe.
   e. Expansion joints shall be adequately supported to prevent stress on joint:
      1) Vertical supports shall be located within 3 pipe diameters of the connection and shall be provided on both sides of the connection.
5. Anchors:
   a. For suspended piping, anchors shall be centered as closely as possible between expansion joints and between elbows and expansion joints. Anchors shall hold the pipe securely and shall be sufficiently rigid to force expansion and contraction movement to take place at expansion joints and elbows.
   b. Anchorage shall be provided as required to resist thrusts due to changes in diameter or direction or dead ending of pipeline. Anchorage shall be required wherever bending stresses exceed the allowable for the pipe.

F. Piping Identification
1. Identify piping and direction of flow so piping and support system can be painted and labeled in accordance with Section "High Performance Coatings."

G. Dielectronics
1. Use dielectric unions at the junction of all dissimilar piping.
H. Clean-up
   1. Clean and degrease surfaces required to be painted.
   2. Remove all debris, tools, scaffolding, trash and excess materials from the site.

3.3 FIELD QUALITY CONTROL

A. Hydrostatic Testing
   1. Conduct hydrostatic testing in accordance with ASME B31.3 in the presence of the Engineer.
   2. Conduct tests after the piping has been completely installed, including all supports, hangers, and anchors, but prior to installation of insulation.
   3. Test piping systems under normal service conditions as indicated in the Pipe Schedule to demonstrate compliance.
   4. The pressure test shall not be less than 1.5 times the design pressure or 50 psi whichever is greater.
   5. Use water as the hydrostatic test fluid.
      a. Provide clean test water of such quality to prevent corrosion of the piping system materials.
      b. Open air release vents at high points of the piping system in order to purge air pockets while filling the piping system.
      c. The maximum velocity during filling shall be 0.25 fps.
   6. Calculate the maximum test pressure in accordance with ASME B31.3
   7. Test all parts of the piping system.
   8. Maintain the hydrostatic pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
   9. Examine all joints and connections for leakage.
   10. Correct visible leakage and retest.

B. Pneumatic Testing
   1. Conduct pneumatic testing in accordance with ASME B31.3 in the presence of the Engineer.
   2. Provide a pressure relief device for each section being tested, with the set pressure not higher than the test pressure plus 10 percent.
   3. Use air as the test fluid with the test pressure 110 percent of the design pressure.
   4. Incrementally increase the gage pressure until it reaches 50 percent of the test pressure.
   5. Examine the piping joints for leakage.
   6. If no leakage is occurring, continue to increase the pressure incrementally, while maintaining each incremental increase long enough to equalize pipe stains, until the test pressure is reached.
   7. Reduce the test pressure to the design pressure and maintain for 10 minutes without additional energy expenditure.
   8. If the pneumatic pressure remains steady, then no leakage is indicated.
   9. Inspect for and repair leaks, and retest.
C. Valve Testing
1. Demonstrate in the presence of the Engineer that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications.
2. Count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer’s data.
3. Examine air and vacuum relief valves as the associated pipe is being filled to verify venting and seating is fully functional.
4. Set, verify and record set pressures for all relief and regulating valves.

3.4 SCHEDULES

A. Process piping to be installed on the blower/flare skid shall be supplied by the equipment package vendor and is not included in this schedule.
   1. Refer to Section 44 10 01 for equipment skid piping requirements.
   2. The existing propane tanks will be included on skid and piping to connect flare pilot to the propane supply system shall be provided by the contractor or vendor.

B. Provide above grade process piping in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Location</th>
<th>Flow Substance</th>
<th>Pressure/ Temperature</th>
<th>Pipe Material</th>
<th>Pipe Size</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Header</td>
<td>Landfill Gas</td>
<td>-50 in. w.c./90 degrees F</td>
<td>SDR 17 HDPE</td>
<td>4 in.</td>
<td>Transition to stainless on skid</td>
</tr>
<tr>
<td>Pilot Flame</td>
<td>Propane</td>
<td>schedule</td>
<td>10 304L stainless steel</td>
<td>Contractor to determine appropriate piping</td>
<td></td>
</tr>
<tr>
<td>Supply Line</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condensate Drain</td>
<td>Landfill Gas</td>
<td>-50 in. w.c./90 degrees F</td>
<td>SDR 17 HDPE</td>
<td>2 in.</td>
<td>Transition to dual encased HDPE from skid</td>
</tr>
<tr>
<td></td>
<td>Condensate</td>
<td></td>
<td></td>
<td></td>
<td>Heat trace/insulate exterior piping</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 40 40 00
PROCESS PIPING HEAT TRACE AND INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Heat Tracing
2. Piping insulation
4. Accessories.

B. Project Work
1. Heat trace and insulation of landfill gas blower/flare skid assembly and all associated process piping.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
1. ASTM C534 Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
2. ASTM E84 Test Method for Surface Burning Characteristics of (NFPA 255) Building Materials
3. ASTM C547 Specification for Mineral Fiber Pipe Insulation

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the heat trace and insulation system.

C. Submit manufacturer’s isometric drawings detailing the layout of heat tracing system. Drawings shall include design parameters and complete bill of materials. Drawings must be approved prior to installation.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. The following design criteria shall be used
1. Maintain Temperature 40 degrees F
2. Minimum Ambient Temperature -30 degrees F
3. Maximum Exposure 150 degrees F
4. Insulation Thickness & Type  
2” Fiberglass

5. Area Classification  
Class 1, Division 1

6. Operating Voltage  
120V

7. Maximum Sheath Temperature (T-rating)  
185 degrees F (T6)

2.2 HEAT TRACING

A. General
1. Furnish a complete UL or FM approved system of pipe heating cable for freeze protection complete with components installation accessories, and controls in strict accordance with Article 427 of the NEC.

B. Heating Cable
1. The self regulating header shall consist of two (2) 16 AWG tinned-copper bus wires embedded in a self regulating polyolefin core that is radiation cross linked to prevent melting.
2. The heater shall vary its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked dielectric jacket, tinned copper braid, and outer fluoropolymer jacket.
3. The heater shall have a self-regulating factor of at least 90 percent defined as the power output of the heater at 150 degrees F shall be less than 10% of the power output at 40 degrees F. The thermal output of the heater shall not be reduced by more than 15% of its original power in a 20 year life rating as established by Arrenhius accelerated heat aging tests as outlined UL Standard for Polymeric Materials, UL 746B.
4. The heating cable shall be suitable for continuous temperature exposure of 150 degrees F, and intermittent exposure to 185 degrees F.
5. The heater shall be self-regulating type Raychem HBTV as manufactured by Pentair Thermal Management. Cable shall operate at the voltage available and shall be designed to maintain 40 degrees F in an ambient temperature of -30 degrees F.
6. Heat tracing shall come, as standard, with a 10-year warranty against manufacturing defects.
7. Heat tracing equipment manufacturer shall retain a sample of every batch of cable manufactured for future comparison testing.
8. Heat tracing manufacturer shall provide a written warranty that the thermal output of the heating cable shall not be reduced by more than 25 percent of its rated power output in a 20 year life rating as established by Arrenhius accelerated heat aging tests as outlined in UL Standard for Polymeric Materials, UL746B.
9. Heat tracing manufacturer shall certify in writing that the long term functional capability of the heater is routinely verified in standard manufacturing tests by cycling the heater a minimum of 300 thermal cycles between a low temperature of 50 degrees F and a high temperature of at least 60 degrees higher than the maximum continuous rated temperature for that cable.
C. Heat Trace Components
   1. Heat trace components shall be approved for the Division 1 hazardous area.
      a. Heating cable shall begin and end in cast aluminum junction boxes mounted to the piping on universal mounting brackets. Power connection boxes and end seals shall be Raychem HAK-JB3-100.
      b. Each entry into the components shall use a connection kit approved for the area of classification. Connection kits shall be Raychem HAK-C-100.

D. Heat Trace Accessories
   1. Heat trace components shall be approved for the Division 1 hazardous area.
   2. Heating cable shall begin and end in cast aluminum junction boxes mounted to the piping on universal mounting brackets. Power connection boxes and end seals shall be Raychem HAK-JB3-100.
   3. Each entry into the components shall use a connection kit approved for the area of classification. Connection kits shall be Raychem HAK-C-100.

E. Heat Trace Controls
   1. Heat trace shall be controlled by an ambient-sensing mechanical thermostat set at 40 degrees F. Thermostat shall be approved for the area of classification. Thermostat shall be Raychem AMC-1H.
   2. Provide ground fault equipment protection breakers in panel for heat trace circuits.

2.3 THERMAL PIPE INSULATION

A. General
   1. Insulation products shall be manufactured by Armstrong, Certain Teed, Knauf, Manville, Owens-Corning, Partek, Pittsburgh Corning, Rubatex, Spoule or Engineer approved equal.
   2. Insulation materials shall be compatible with stainless steel, carbon steel, equipment, tanks and piping and shall be guaranteed not to cause stress corrosion cracking of stainless steel or copper tubing.
   3. Asbestos and asbestos bearing materials shall not be used.
   4. All products including vapor barriers and adhesives shall conform to NFPA 90A and 255 and shall have a flame spread rating less than 25, fuel contributed rating less than 50 and a smoke developed rating less than 50.
   5. All material shall be fire retardant, moisture resistant, mildew resistance, vermin proof, and suitable for the temperatures to which they are applied.
   6. All material shall be delivered in good condition, and the packages and insulation shall be plainly marked with manufacturer’s identification label.
   7. Pipe insulation shall be preformed in two half cylinders and furnished in three foot long sections with ends cut square. The inside diameter of the insulation shall fit firmly on specified pipe size.

B. Type FG
   1. Glass fiber piping insulation; ANSI/ASTM C547; "k" value of 0.24 at 75°F.; non-combustible.
2.4 JACKETS

A. Exterior Above Grade Applications
   1. Type AL - aluminum jacket shall be 0.016” aluminum smooth finish. Provide
      field fabricated elbows from material or matching smooth finish fittings.

2.5 ACCESSORIES

A. Adhesives: Compatible with insulation.

B. Valves and Fittings
   1. Fittings and valves less than 4” shall be insulated with Insul-Constic or approved
      equal premolded or mitered segments of insulation. The insulation shall be
      fastened with stainless steel wire, glass cord, or stainless steel bands. The
      thickness of the fitting insulation shall be the same as that of the adjoining pipe
      insulation.
   2. Flanges, unions and valves 4” and larger shall have removable Silverjac 1700 or
      approved equal silicone impregnated fiberglass fabric jackets with thermal wool
      insulation.

C. Equipment
   1. Equipment shall be heat traced and insulated in accordance with the
      manufacturer’s instructions.
   2. The blower shall be insulated with a removable Silverjac 1700 or approved equal
      silicone impregnated fiberglass fabric jacket with thermal wool insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Install the heater linearly (no spiraling) on the pipe after the piping has been
   successfully pressure tested and approved.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instruction/recommendation and
   current National Electric Code for the area classification.

B. Allow for extra cable for heat sinks such as valves, pipe supports, etc. in accordance
   with the manufacturer’s recommendation.

C. Apply “Electric Traced” labels to the outside of thermal insulation.

D. After cable installation and before and after installation of the thermal pipe insulation,
   the heating cable shall be tested to a specified voltage using a megger. Minimum
   electrical insulation resistance shall be 1000 megohms regardless of circuit length.
   Both bus wires shall be tested to verify the connection of all splices and tees.
E. Heat trace supplier shall provide isometric drawings for each heat trace circuit as well as installation drawings.

F. Continue insulation through penetrations.

G. In exposed piping, locate insulation and cover seams in least visible locations.

H. Neatly finish insulation at supports, protrusions, and interruptions.

I. Provide an insert, not less than 6 inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be cork or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used.

J. In cases where the insulation extends below grade to cover heat traced lines, the insulation shall be covered with 0.016" thick 316 stainless steel jacket. All joints on the jacket shall be sealed with waterproof mastic and then the jacket shall receive two coats of tar or "Tape Coat" to make the underground portion of the insulation completely watertight.

K. No drain plug or drain openings shall be insulated.

L. Any protrusions through pipe insulation such as instrumentation connections, uninsulated pipe connections, supports or electrical tracing cables shall be carefully sealed for the appropriate service.

M. Certain smaller piping systems (or smaller sized pipe runs) are only shown diagrammatically, or may be specified to terminate at a certain point not shown physically on the figures. Contractor shall furnish and install insulation for such piping in order to complete the system whether physically shown or not.

N. Insulation three (3) inches and over in total thickness shall be applied in two layers with staggered joints unless otherwise specifically approved.

O. All projecting hanger lugs on piping for working temperatures of 300°F and above shall be properly covered with insulation to maintain an outside surface temperature of not more than 175°F.

P. Provide necessary flashings, sleeves, boots, clamps, sealants, etc. for roof, floor and wall penetrations requiring a watertight or weather tight seal.

Q. Lap and seal all seams with silicone caulk for watertight finish.

R. Installation of the heat trace cable and insulation shall be the responsibility of a single supplier in order to maintain continuity of the system. Supplier shall offer a guarantee that the system will prevent freezing of the piping and equipment to the specified temperatures.
3.3 SCHEDULE

A. Equipment shall be heat traced to prevent freezing.
   1. Knock out pot up to highest liquid level.
   2. Piping and fittings.
   3. Condensate drainage pipe.
   4. And any other components to prevent system from freezing.

END OF SECTION
SECTION 43 08 00

START-UP AND COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide supervision, specialized personnel, labor, coordination, tools, material, equipment, and services required to prepare for start-up of each respective item of equipment and systems and to completely commission equipment and systems furnished and installed or installed as a part of this Contract until such time equipment and systems are "accepted for operation" by Owner. Start-up refers to equipment checkout, startup, adjusting, and instructing Owner’s operation and maintenance personnel including:
1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

B. Section includes, but is not limited to installation support, inspection, testing, start-up, commissioning, and training for the following items.
1. Existing LFG blower/flare system modifications.
3. New gas blower/flare skid systems.
4. Flow metering systems.
5. Gas safety equipment.
6. Control and data acquisition systems.

1.2 SUBMITTALS

A. Contractor shall make submittals relating to testing, checkout, operation and maintenance, startup and commissioning as outlined in various specification sections including but not limited to;
1. Division 26 – Electrical
2. Division 33 – Utilities
3. Division 40 – Process Integration
4. Division 43 – Process Gas Equipment
5. Division 44 – Blower/Flare Skid

B. Provide three (3) copies of a written report of the results of equipment checkout, startup, adjusting, and operation and maintenance training including:
1. Date of services performed.
2. Project title and number.
3. Name, address, and telephone number of manufacturer/supplier.
4. Names of individuals providing the services.
5. Equipment functions performed and results.
6. Adjustments to equipment.
7. Calibration of controls and equipment.
8. Identify any lubrication provided.
9. Complete test data and operating characteristics and interpretation of results.
10. Ambient conditions at the time of services.
11. Identify equipment and specification section.
12. List of participants at training session and length of instruction time.
13. List of items covered during training.

C. Equipment will not be considered complete and operational until the proper report is completed and submitted to the Engineer.

1.3 QUALITY ASSURANCE

A. Contractor shall provide a factory-authorized service representative, experienced in equipment and appurtenances installation, checkout, servicing, startup, and operation and maintenance procedures.

Contractor shall provide a qualified instructor experienced in training or educating maintenance personnel in a training program similar in content and extent to that required for this Project, and whose work has resulted in training or education with a record of successful learning performance.

1.4 AUTHORIZATION

A. The Owner or his authorized representative shall be notified of the completion of any portion of the system which is ready for checkout. Systems or items SHALL NOT BE PRESSURIZED NOR ENERGIZED until the Engineer has approved the installations as being ready for calibration and testing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate startup and instruction schedule with Owner’s operations. Adjust schedule as required to minimize disrupting Owner’s operations.

B. Provide at least seven days advance notification of dates, times, and equipment for startup and training.

C. Coordinate content training with submittal of approved operation and maintenance manuals. Do not schedule training program until operation and maintenance manuals have been reviewed and approved.

D. For equipment that requires seasonal operation, provide similar instruction for each season.
3.2 EQUIPMENT CHECKOUT, STARTUP, AND ADJUSTING

A. Remove shipping, packing, tags, and stops from instruments before starting with procedures specified. Contractor shall have instruction manuals available, and shall install miscellaneous components such as charts, illumination, mercury, linkages, etc., which have been supplied separately but are integral parts of the equipment.

B. Follow manufacturer's printed recommendations for calibrating or checking calibration of instruments.

C. Following installation, check-out and final adjustment of all panels, instruments, meters, monitoring, and control devices, a performance check shall be made on each. Meters shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of scale, as required. All status and alarm switches as well as all monitoring and control functions shall also be checked. Each device on the Loop Diagrams/Instrument Tabulation must be signed-off by the Engineer as being acceptable. Testing shall be done from the signal source to the final element or device including all field wiring.

D. If, during running of the tests, one or more points appear to be out by more than the specified amount, the System Supplier's servicemen shall make such adjustments or alterations as are necessary to bring equipment up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to ensure compliance.

E. Inspect field-assembled components and equipment installation to verify proper installation. Correct improper installation.

F. Provide initial field servicing of equipment and components, where required, including lubrication, changing of fluids, etc.

G. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

H. Adjust equipment and operating components for proper operation.

I. Test each piece of equipment to verify proper operation. Test and adjust controls, safety interfaces, and etc. Replace damaged and malfunctioning controls and equipment.

J. Provide startup services by a factory-authorized service representative to include tests, inspections, procedures, and related actions required to ensure that completed installation of equipment and components complies with design and performance requirements.

K. The factory-authorized representative shall remain on-site and/or provide as many site trips as are necessary to demonstrate in the Engineer’s presence that all equipment
functions are operating as specified and the equipment complies with design and performance requirements.

3.3 CONTROLS AND INSTRUMENTATION SYSTEMS

A. Check out controls and instruments prior to start-up to assure in situ performance in accordance with Contract Documents under simulated operating conditions. Contractor to determine initial start-up conditions.

B. Many instruments contain small supply pressure gauges or output pressure gauges. Calibration of these gauges will not be required. However, if gauge is found to be defective, instrument involved shall be immediately called to attention of Owner and reporting of its condition confirmed in writing.

C. If any instrument cannot be properly adjusted, it shall be immediately called to attention of Engineer and report of its condition confirmed in writing.

D. Instrument Check
   1. Verify data on nameplate with respect to conditions of range, operating temperature, specific gravity, and components as stated on unit specifications. Any discrepancies shall be immediately called to attention of Owner and report of its condition confirmed in writing.

E. Verify that control valve seats are free of foreign material, and properly positioned for intended service.

F. Test Procedures
   1. Check control wiring for proper operation of pushbuttons, hand switches, pilot lights, and other control devices.
   2. Place equipment installed or wired under this Contract in initial operation following instructions and recommendations of equipment manufacturers.
      a. After energizing and prior to start-up, check control circuits and programs for proper sequence of operation and interlocking functions.
      b. Any wiring changes required as a result of such checks shall be properly identified by changing terminal strip and/or wiring markers.
   3. Provide necessary construction labor to make equipment final adjustment necessary to place plant in good operating condition, and furnish labor to assist in solving instrument or control problems.
   4. Calibrate instruments and components in accordance with manufacturer's calibration data over full operational range, prove instruments to be within published specifications, accuracy, and affix calibration sticker. Instruments shall be calibrated individually and where applicable, as system (i.e., control loop transmitter, controller, and valve). Components which have adjustable features shall be carefully set for specific conditions and applications of this Project. Each calibration sticker shall be signed by Contractor's representative witnessing test.
   5. Calibration sticker shall contain the following information: equipment identification tag number, range of calibration, and date and name of person performing calibration.
6. Pressure gauges shall be checked at 10 percent, 50 percent, and 90 percent of ranges for linearity within manufacturer’s stated specifications. Gauges not meeting manufacturer’s specifications shall be repaired or replaced.

7. Dial thermometers shall be checked at mid-range and ambient temperature. Thermometers not meeting manufacturer’s specifications shall be repaired or replaced.

8. Temperature Switches: Calibrate in accordance with manufacturer’s specifications.

9. Valves and Operators:
   a. Valve Action: Check valve action for conformance to specifications (open or closed on air failure).
   b. Valve Positioner: Check for conformance to specifications relative to spring action and input range (particularly for split range applications), valve action, and length of stroke. If valve positioner is fitted with standard characterized cam, check to see if proper cam is mounted. If specifications call for specially cut cam, refer this item in writing to Engineer for handling. Do not cut or modify standard cam.

10. Panel Mounted Instruments:
    a. Receiver Instruments: Check zero and span at 10 percent, 50 percent, and 90 percent of range by impressing measured signal into input or signal connections or instrument.
    b. Controllers (Panel or Control Room Mounted):
       1) Check for proper operation and adjust in accordance with manufacturer’s instructions. Vary process input signal and check output signal for either indirect or direct action.
       2) Set initial proportional band, reset rate, and rate time as recommended by manufacturer. It may be necessary to determine process dynamics in actual operation before settings can be made.
       3) Control loops shall be observed for operability and conformance to specifications by impressing simulated input signal at primary element and checking response of final control element.
    c. Integrators, Ratio Relays, Etc.: Check in conformance to manufacturer’s recommendations. Receiver integrators shall be calibrated for proper operation and multiplication factor by feeding maximum input signal (16 psig, 20 mA, etc.) for specified period of time with stop watch. Check in conformance to manufacturer’s recommendations. Ratio signals shall be simulated to check proper ratio settings and output.
    d. Graphics Panel: If possible, trip each alarm actuator (field device) in sequence and observe graphics. Check "acknowledge" and "test" pushbuttons.
    e. Annunciator: Check each window by tripping its respective interlock or trip point.

3.4 OPERATION AND MAINTENANCE TRAINING

A. Provide an instruction program that includes individual training for each system and for equipment not part of a system, as required by individual Specification Sections.
B. Provide operation and maintenance training by a factory-authorized qualified instructor to instruct Owner’s personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system, including but not limited to the following:

1. Existing LFG blower/flare system modifications.
3. New gas blower/flare skid systems.
4. Flow metering systems.
5. Gas safety equipment.
6. Control and data acquisition systems.

C. Include the following in the training program for each system:

1. **Basis of System Design, Operational Requirements, and Criteria:**
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Equipment function.
   e. Operating characteristics.
   f. Limiting conditions.
2. **Emergencies:**
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Special operating instructions and procedures.
3. **Operations:**
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Normal shutdown instructions.
   h. Operating procedures for emergencies.
   i. Operating procedures for system, subsystem, or equipment failure.
   j. Seasonal and weekend operating instructions.
   k. Required sequences for electric or electronic systems.
   l. Special operating instructions and procedures.
4. **Adjustments:**
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.
5. **Troubleshooting:**
   a. Diagnostic instructions.
   b. Test and inspection procedures.
6. Maintenance:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. Procedures for routine cleaning, types of cleaning agents to be used and methods of cleaning.
   d. Procedures for preventive/routine maintenance.
   e. Instruction on use of special tools.

7. Repairs:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

D. The factory-authorized qualified instructor shall remain on-site and/or provide as many site trips as are necessary to demonstrate to the Engineer the participant's mastery of the training program by use of an oral, written or demonstration performance-based test.

END OF SECTION
SECTION 44 10 01
LANDFILL GAS BLOWER AND FLARE SYSTEM

PART 1 - GENERAL

1.1 EXISTING CONDITIONS

A. The Brown County Port & Resource Recovery Department (BCPRRD) owns and operates the closed West Landfill located in Hobart, Wisconsin. The landfill utilizes an active landfill gas (LFG) extraction system. A vacuum is applied to the LFG extraction system from an on-site LFG blower and flare system. The existing LFG flare and blower skid was installed in the 1990s with a few updates since, and has a blower flow range of approximately 400 standard cubic feet per minute (scfm) and a flare capacity of approximately 2,000 scfm of LFG. The landfill generally produces under 200 scfm and BCPRRD is seeking to replace the existing enclosed flare, blowers, and controls with a candlestick flare and blower to account for the lower flows.

B. The enclosed figures show the existing blower/maintenance building, and blower/enclosed flare components and piping layout and the proposed changes as outlined in these specifications.

C. The existing utility locations shown on the enclosed figures are approximate. The Contractor shall utilize a field utility location service prior to beginning any work below existing grade.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install a skid-mounted blower/flare system, piping and piping components, freeze protection, and condensate removal components. Contractor shall be responsible for installation, start-up, and testing of all furnished components per the specification and figures to provide a complete and operable landfill gas blower/flare system. Vendor shall supply blower/flare skid to meet design requirements. Contractor shall provide all components to connect to blower/flare skid as detailed in this specification and required by the vendor. Contractor shall also be responsible for disconnecting the electrical and gas supply piping for the existing flare/blower system and abandoning any electrical and gas supply piping components in-place.

B. The new landfill gas blower and flare installation shall include the items listed below in accordance with these specifications and the attached figures.
   1. Install and properly secure new pre-fabricated blower/flare skid containing a blower and flare that meets the design parameters.
2. Modify the existing 12” HDPE header piping outside of the blower control/maintenance building as indicated on the figures. Install a 6” diameter HDPE pipe connection to the new skid.

3. The new 6” diameter piping should include a manual shut-off valve and flexible connection to the blower/flare skid, as well as all appropriate reducers and fittings. Vendor to approve of the header connection design prior to construction.

4. Provide and install power and controls for the new blower/flare skid.

5. Disconnect existing unused equipment to install the new electrical equipment as specified and as shown in the figures.

6. Start-up, commissioning, and training.

C. The new flare shall be capable of combusting landfill gas from the West Landfill in accordance with the specifications and figures.

D. The new flare and associated components must be designed for continuous operation in all local weather conditions.

E. The following blower/flare skid and components must be provided by a single vendor:

1. Open (candlestick) flare and ignition components.
2. Pilot gas control system components (excluding propane tanks, as existing propane tanks will be utilized. Existing tanks will be mounted on skid).
3. Flame arrester.
5. Multi-stage centrifugal blower.
6. Thermal mass flow meter.
8. Control panel for blower and flare.
9. Rack/strut-mounted weather proof power distribution panel to contain the following pre-wired components:
   a. Power distribution panel and power disconnect.
   b. Blower VFD.
   c. Ambient thermostat and contactor for heat tracing.
   d. At least two (2) GFI breakers for the heat trace circuit.

F. The blower and flare components shall be provided by one of the following manufacturers:

1. Aptim (Findlay, OH)
2. Perennial Energy (West Plains, MO)
3. No alternatives will be considered unless approved by the Owner in writing prior to submittal of proposal.

G. The existing enclosed landfill gas flare and associated blowers shall be disconnected and abandoned in place.
1.3 REFERENCES

A. American National Standards Institute (ANSI)
   1. ANSI B16.5 - Pipe Fittings and Flanged Fittings

B. American Society of Mechanical Engineers (ASME)
   1. ASME B31.3 - Process Piping
   2. ASME Section VIII, Division 1 - Pressure Vessels

C. National Electrical Manufacturer Association (NEMA)

D. National Electric Code (NEC)

E. National Fire Protection Association (NFPA)
   1. NFPA 820 - Fire Protection in Wastewater Treatment and Collection Facilities

F. Underwriters Laboratories Inc.
   1. UL 508A - Industrial Control Panels

G. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

1.4 QUALIFICATIONS

A. The Contractor shall have knowledge and experience with the installation of similar landfill gas or biogas blower/flare and/or systems. To be considered as qualified, contractor/vendor must have successfully installed a minimum of five (5) industrial gas process systems of similar operation within the last five (5) years. Experience of contractor/vendor’s project manager will be considered for qualification.

1.5 SUBMITTALS

A. The Contractor shall submit three copies of all shop drawings, manufacturer’s literature, and other information as necessary for engineer’s approval.
   1. Provide the following shop drawings and/or any other information required to determine conformance with the Specifications:
      a. Blower.
      b. Flare.
      c. Flame arrester.
      d. Knock out pot.
      e. Drip traps.
      f. Valves.
      g. Control panels and components (including all internal devices).
      h. Instrumentation (including all panel mounted and field mounted devices).
      i. Display devices (i.e., digital and analog meters and data displays).
      j. Sensing devices (i.e., level, pressure, temperature, moisture, etc.)
      k. Power supplies.
      l. Surge suppressors.
2. Include outlines and general arrangement drawings, data sheets, and wiring diagrams of all complex systems and equipment.

3. Provide the following information in conformance with applicable ANSI, ISA, and NEMA standards:
   a. Job index sheets.
   b. Specification check sheets.
   c. Dimension drawings, wiring and/or piping drawings for field and pipeline mounted equipment.
   d. Equipment specification sheets (two reference sets only).
   e. Where panels are to be provided, fabrication (front and internal equipment arrangement drawing) and nameplate legend drawings, bill of materials, internal wiring, and piping schematic drawings. Per ISA RP60-3, 6, 8 and 9.
   f. Schematic drawings illustrating all components being supplied complete with hydraulic, pneumatic, and electrical interconnections.
   g. Termination diagrams for instrumentation wiring with at least one end connected to equipment furnished in this section.

4. Provide control logic and diagram connection for each control system.

B. The Contractor shall submit complete blower and flare performance data that will indicate compliance with these specifications. This information shall include blower characteristic curves indicating capacity for flow versus pressure head and efficiency as tested at the factory, flare NMOC destruction efficiency, and flare compliance with 40 CFR 60.18.

C. The Contractor shall furnish three (3) copies of an Operation and Maintenance manual prepared specifically for this installation. The manual shall include all required catalog cuts, plans, equipment lists, descriptions, and information necessary to instruct operating personnel unfamiliar with such equipment. The manual shall include a maintenance schedule and a list of recommended spare parts for the blower and flare system.

1.6 DESIGN REQUIREMENTS

A. The new blower shall be designed for continuous operation in an outdoor environment (Class 1, Division 2), and shall conform to the following requirements measured at standard conditions of 14.7 psia and 68 degrees F:

1. Design Capacity (average): 110 scfm
2. Gas Flow Range: 0-300 scfm
3. Gas Composition:
   a. Methane: 30 percent – 55 percent, (50 percent average)
   b. Carbon Dioxide: 25 percent – 50 percent, (45 percent average)
   c. Oxygen: 0 percent – 20 percent, (0-5 percent typical)
   d. Nitrogen: 0 percent – 50 percent, (0-20 percent typical)
   e. Trace Gases: 0 percent – 1 percent
   f. Moisture: Saturated
4. Site Elevation: 655 ft. M.S.L.
5. LFG Pressure Requirements (at 110 scfm):
   a. Design Inlet - 50” of water
   b. Design Outlet + 15” of water
6. LFG Specific Gravity ~1.0

B. The new flare shall be designed to conform with the requirements in subsection A
above (as applicable), and the following requirements:
1. Design Wind Speed: 100 mph
2. Pressure Drop: < 5” water from inlet through outlet of the flare
3. Inlet Flange Size: 4 inches, or as specified by flare manufacturer
4. NMOC destruction efficiency: 98 percent
5. Radiant Heat: < 500 Btu/hr-ft² when firing at maximum design
   heat release with a 20 mph wind

1.7 SAFETY REQUIREMENTS

A. The landfill gas blower/flare system shall be furnished with adequate protective
devices in accordance with Occupational Safety and Health Act (OSHA) and local
safety code requirements.

B. Moving parts which are hazardous to personnel shall be suitably guarded. Electrical
shock protection shall be provided. Hot surfaces shall be labeled.

C. Adequate safety alarms and automatic shut-down devices shall be provided to prevent
over-pressure, over-temperature, or other hazardous events.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment shall not have been in service, except for shop tests, at any time prior
to delivery.

B. All parts of equipment shall be amply proportioned for all stresses which may occur
during operation, and for any additional stresses which may occur during fabrication,
transportation, handling, and erection.

C. The equipment shall be factory assembled to the maximum extent possible. Field
assembly is permissible if disassembly is required for safe transport.

2.2 BLOWER/FLARE SKID EQUIPMENT AND DESCRIPTION

A. The landfill gas blower/flare skid shall incorporate the following as a minimum:
   1. Galvanized or painted structural steel skid.
   2. Blower and motor.
   3. Flare.
   4. Flame arrester.
   5. Knockout pot.
7. Piping.
9. Pressure indicator and transmitter.
10. Control panel.

B. Structural Steel Skid
1. Heavy duty AISC designed structural steel skid, designed to structurally support blower and flare components.
2. Skid to be completely galvanized or painted after fabrication.
3. The blower/flare skid assembly is to be completely fabricated, assembled, pre-wired, and thoroughly tested before the unit is to ship.

C. Thermal Mass Flow Meter.
1. Flow meter to be adequately sized to fit in landfill gas supply pipe.
2. Flow meter to be short stock as necessary.
3. Flow meter to be placed in accessible location.
4. Data to be recorded on local chart recorder.

D. Blower and Motor
1. Blower shall be supplied in accordance with the design flow and pressure requirements, taking into account a 100% saturated gas, site elevation, and appropriate gas composition. Blower shall be multi-stage centrifugal, direct drive type with shaft seals.
2. Blower motor shall be speed controlled using a variable frequency drive (VFD). The VFD will control the motor speed by the following options:
   a. Manual speed control by operator control from the control panel.
   b. Automatic speed control using a control loop and controlling to an inlet pressure set point. Set point shall be operator adjustable from the control panel.
   c. The VFD shall be pre-mounted on the power distribution control panel to be pre-mounted on skid (See Section 2.5 - INSTRUMENTATION AND CONTROLS).
3. The blower shall include a casing drain with a manual shut-off valve. Drain lines from the blowers to the edge of the skid shall be included as part of the skid package.

E. Piping
1. All landfill gas piping shall be schedule 10 304L stainless steel.
2. Gaskets shall be a synthetic fiber type with an NBR binder, Donex 660 or equal.
3. All flanges to be 150# RF SO.
4. All landfill gas piping shall be welded fabrication in accordance with ASME B31.3.
5. All skid piping to be fully assembled, mounted, and supported.
F. Manual Valves, Check Valves and Expansion Joints
   1. Cast iron wafer body valves shall be supplied at the inlet and outlet of the blower complete with ductile iron nickel plated disc, buna-n seat, and complete isolation of cast iron from the landfill gas. For valves 8" and above, a gear operator to be provided. For valves 6" and less, lever handles to be provided.
   2. Flanged, aluminum check valve to be provided at the outlet of the blower.
   3. Flanged, reinforced, hypalon material flexible expansion joints to be provided at the inlet and outlet of the blower.

G. Pressure Indicator and Transmitter
   1. The blower/flare skid piping shall include a pressure indicator and transmitter on the inlet side of the blowers.
   2. The pressure indicator and transmitter shall be pre-wired by the flare manufacturer to be integrated into the control panel.

2.3 OPEN FLARE

A. The landfill gas open candlestick flare shall have the following items at a minimum:
   1. Structural support provided by skid.
   2. Carbon steel stack.
   4. Flare tip.
   5. Flame arrester.

B. Stack
   1. The flare stack shall be fabricated from standard weight carbon steel pipe internally coated with high solid epoxy coating or schedule 10 304L stainless steel.
   2. The inlet shall be a 90 degree entrance into the stack.
   3. The inlet shall project a minimum of 10” from the stack and terminate with a 150# ANSI FFSO flange.
   4. A carbon steel inclined floor plate at least 4” below the lowest part of the inlet connection shall be seal welded to the interior of the stack with one (1) 1” 3000# FNPT connection located as a low point drain.

C. Spark Ignited Pilot Assembly
   1. The pilot shall be spark ignited.
   2. The spark plug shall be located no closer than 5' from the end of the flare tip and shall be located in a position that is not considered a “low point” that can collect water.
   3. The pilot shall consist of an ignition rod internal to the pilot assembly and shall be weatherproof.
   4. The arc that ignites the flare pilot shall be located at the pilot tip, such that the base of the pilot flame is directly adjacent to the arc.
   5. The pilot shall consist of a cast iron assembly capable of achieving the air/gas mixture required for proper pilot flame stability. The pilot assembly shall have a windshield around the inlet air opening such that a cross-wind will not affect the operation of the pilot.
6. The gas inlet connection to the pilot assembly shall be ½" FNPT.
7. The pilot tip shall be stainless steel and shall be positioned such that the main flare tip is easily ignited.

D. Flare Tip
1. The flare tip shall be a minimum length of 5'.
2. The flare tip shall be schedule 10 304L stainless steel pipe of the same diameter as that of the stack.
3. The flare tip shall incorporate integral flame retention for increased flare stability.
4. The flare tip wind shield shall be fabricated from 304L stainless steel.
5. The wind shield shall be designed to allow the proper amount of air into the flame zone for stable combustion throughout the flow range.
6. The flare tip shall have two (2) type K thermocouple assemblies with 304L stainless steel sheathing mounted to the stack.
   a. One (1) thermocouple shall be located such that it detects the main flame throughout the entire design operating range.
   b. One (1) thermocouple shall be located such that it detects the pilot flame throughout the entire design operating range.
7. All electrical components at the flare tip shall be Class I Division I in accordance with the National Electric Code.

E. Flame Arrester
1. A flame arrester with aluminum body and removable, internal aluminum element shall be installed at the flare inlet flange.

F. Pilot Gas and Piping Components
1. The propane tank currently utilized for the existing flare shall continue to be used for the new flare pilot system.
2. The blower/flare skid should contain location for two (2) existing 100-lb propane tanks to be mounted and connected to the pilot system.
3. The pilot gas control system components, including pressure regulator, fail-closed shutdown valve, manual block valve, and pressure indicator, shall be supplied by the flare vendor.
4. The propane supply line between the existing propane tank and the blower/flare skid connection should be schedule 10 304L stainless steel or equivalent.

2.4 PROCESS PIPING AND ASSOCIATED COMPONENTS

A. The piping and piping components shall consist of the following items at a minimum:
1. Landfill gas piping.
2. Natural gas piping.
4. Landfill gas pipe auto-block valves.
5. Landfill gas pressure gauges

B. Landfill Gas Piping
1. All landfill gas piping shall be schedule 10 304L stainless steel.
2. All landfill gas piping shall be supported where necessary.

C. Landfill Gas Pipe Fittings and Manual Valves
   1. All landfill gas pipe fittings shall be schedule 304L stainless steel.
   2. Gaskets shall be a synthetic fiber type with an NBR binder, Donex 660 or equal.
   3. All stainless steel flanges to be 150# RFSo.
   4. Manual valves shall be cast iron wafer body valves complete with ductile iron nickel plated disc, buna-n seat, and complete isolation of cast iron from the landfill gas. For valves 8" and above, a gear operator to be provided. For valves 6" and less, lever handles to be provided.
   5. Joints shall allow a minimum of 0.625 inches pipe expansion, 0.25 inches pipe compression. Construct flexible connectors with a filled arch to eliminate sedimentation of solids in the arch area.

D. Landfill Gas Pipe Auto-Block Valves
   1. Automatic block valve assemblies shall consist of a high performance butterfly valve with 316L stainless steel disc and Teflon seal, and a fail-closed pneumatic actuator.
   2. Automatic block valve pneumatic actuators to be operated using compressed air supply currently provided in the existing compressor building.

E. Landfill Gas Pressure Gauges and Transmitters
   1. Contractor shall provide and install a landfill gas pressure gauge on the landfill gas discharge line.

F. Knock out Pot/Moisture Separator
   1. The moisture separator shall be sized for 99 percent removal of all liquid droplets to 10-micron and larger.
   2. The moisture separator shall be mounted upstream of the gas blower assemblies to remove free moisture from the incoming gas and consist of the following:
      a. Material of construction shall be 304L stainless steel.
      b. Side inlet and outlet connections shall be 150# ANSI B 16.5 flange connections.
      c. Fasteners shall be Grade 5 zinc-plated steel.
      d. Pad/filter element shall be a composite polypropylene, structured and multi layered mesh element of cleanable and reusable design.
      e. Rated for 100% removal efficiency of 6 micron droplet size.
      f. Filter element shall include a differential pressure gauge across the filter.
      g. Sight glass for liquid level indication.
      h. Filter shall be fitted with a bottom drain connection. The drain connection shall include a solenoid valve with manual bypass, strainer, and piping to the edge of the skid for discharge to gravity drain piping.
      i. The condensate level shall be controlled with three level sensors. Low (valve closed), high (valve open) and high-high (valve fail alarm).
      j. The condensate piping on the skid shall be schedule 10 304L stainless steel and off the skid should be HDPE.
2.5 INSTRUMENTATION AND CONTROLS

A. Provide a complete and operational control system designed for 460V/3 phase/60 Hz incoming power and step down as required to successfully operate the blower(s), flare and control instrumentation system.

B. General Operation
   1. The blower/flare system shall run in manual mode or an automatic control modes that shall be selectable by an O/I touch screen selection at the control panel to be located on the blower/flare skid.
   2. The manual mode shall allow the flare system to run continuously for system testing including:
      a. Manual mode requires interaction at the control panel to start and stop operation.
      b. Allow for manual control and setting of the blower motor VFD speeds.
      c. In manual mode the blower/flare system shall run with all safety features engaged including run permissives, alarms and auto-shutdown features.
   3. Automatic mode allows start and stop operation without interaction at the control panel.

C. Automatic Operating Mode Logic
   1. The automatic operating mode shall operate in accordance with the following sequence.
      a. Initiate lighting the pilot flame.
      b. Proof the pilot flame through the pilot thermocouple.
      c. Open the auto-block valve.
      d. Start the selected blower to begin sending landfill gas to the flare.
      e. Proof the main flame through the flare thermocouples.
   2. The blower inlet pressure shall be controlled and maintained at an adjustable inlet pressure set-point using the blower VFD motor speed.
      a. The PLC shall provide for an operator adjustable inlet pressure set-point.
      b. The PLC shall include an alarm and auto-shut down switch for low inlet pressure conditions (high vacuum).

D. Operating Permissives
   1. System operation is permitted only after confirming safety conditions exist.
      a. The closed limit switch for the automatic block valve must be satisfied, proving a closed valve position.
      b. The pilot and main thermocouples must not detect the presence of flame.

E. Ignition Sequence
   1. When the flare "Start" switch is selected, the pilot gas solenoid valve opens automatically, supplying gas to the pilot, the "Pilot Gas ON" status is indicated, and the ignition transformer energizes. The ignition transformer continues for ten seconds and then the pilot thermocouple verifies flame is present. The "Pilot Proved" status indicates and the pilot gas solenoid valve remains open.
F. Gas Supply
   1. Once pilot flame is detected, the automatic block valve opens, operation of the selected gas blower begins, supplying gas to the flare, and the "Blower On" status is indicated. After the open limit switch for the automatic block valve is achieved, the pilot gas solenoid valve closes and the "Igniter OFF" status is indicated. While the main thermocouple verifies flame is present, system operation continues. If the open limit switch for the automatic block valve is not achieved within twenty seconds, the "Auto Valve" failure alarm is indicated on the display, and system operation discontinues.

G. System Failure
   1. Automatic Block Valve Failure
      a. If the open or closed limit switch on the automatic block valve indicates improper valve position at any time during start up or operation, the Automatic Block Valve Failure alarm will be indicated on the display and the unit will shut down.
   2. Pilot Flame Failure and Shutdown
      a. Pilot Flame Failure occurs, during the ignition sequence, when the pilot thermocouple is unable to detect the presence of pilot flame. When Pilot Flame Failure occurs, system operation is interrupted momentarily. Then the entire ignition sequence is repeated automatically.
      b. A shutdown occurs only after three consecutive failures, or unsuccessful attempts. Once Pilot Flame Shutdown occurs, the "Pilot Flame Failure" alarm is indicated and system operation discontinues.
   3. Main Flame Failure and Shutdown
      a. Main Flame Failure occurs, once the ignition sequence is complete, when the main thermocouple is unable to detect the presence of main flame. When Main Flame Failure occurs, system operation is interrupted momentarily. Then the entire ignition sequence is repeated automatically.
      b. A Shutdown occurs only after three consecutive Failures, or unsuccessful attempts. Once Main Flame Shutdown occurs, the "Main Flame Failure" alarm is indicated and system operation discontinues.
   4. Flame Arrester High Temperature
      a. Flame Arrester High Temperature occurs when the temperature switch on the face of the flame arrester detects the presence of a flame, indicating a flash back. This will immediately cause a shutdown and the "Flame Arrester High Temp" alarm will be indicated.
   5. Blower Bearing High Temperature
      a. Blower bearing high temperature occurs when the temperature readings on the blower bearings is higher than the high set point. This will cause a high bearing temperature alarm and timed shut-down.
   6. Low Inlet Pressure
      a. Low inlet pressure occurs when the inlet pressure readings are lower than the low setpoint. This will cause a low inlet pressure alarm and timed shut-down.
H. Control Panels/Instrumentation

1. All enclosures shall be NEMA 4X 304L stainless steel. Enclosures shall include air conditioning and heater for closed loop temperature control of components when required.

2. Contractor to provide one (1) 100 amp main breaker adequately sized for full operation of blower/flare skid and components, to be mounted in maintenance building as indicated on existing figures.

3. Provide one (1) weatherproof power distribution control panel rack preassembled on a structural steel rack to be mounted outside as shown on the figures, including at a minimum;
   a. The main disconnect.
   b. One (1) weatherproof single phase power transformer to convert electrical power service from 460V to 120V.
   c. One VFD. The VFD shall include a local display and operator interface.
   d. One (1) ambient thermostat with contactor to control heat trace.
   e. Two (2) GFI breakers, one (1) 30 amp and one (1) 15 amp or as needed to provide adequate power for the heat trace on the landfill gas blower/flare skid and condensate removal piping.

4. The power distribution panel shall be equipped with a heat trace ambient thermostat manufactured by Tyco (AMC-1A). This ambient thermostat shall be mounted on the side of the control cabinet away from cabinet venting to eliminate the false readings from heat generated inside of the enclosure. This thermostat shall control a three-pole, 600 volt, 30 amp contactor with 120 volt coil. The 120 volt control cabinet power shall be used to power this contactor. One contact shall be used for the 15 amp heat trace, the second contact shall be used for the 30 amp heat trace and the third contact shall be a spare. The wiring between the thermostat and the contactor shall be pre-wired. The wiring from the breakers to the contactor shall also be pre-wired (provide #12 Black colored wiring for the 15 amp heat trace circuit and #10 Red colored wiring for the 30 amp heat trace circuit).

5. One (1) weatherproof blower/flare control panel including the following instrumentation for safe, overall system operation and control to be mounted in an accessible location on the skid.
   a. Automation Direct or Flame Troll III automatic programmable logic controller (PLC) with Ethernet port
   b. GE Versa Max or C-More PLC touchscreen interface or equivalent.

6. High-performance gauge pressure transmitter to be mounted on the inlet piping to the blower.

7. One (1) pilot gas control system including pressure regulator, fail-closed shutdown valve, manual block valve, and pressure indicator.
I. Panel Lights/Switches
   1. The following switch and lights are required on the front of the control panel at a minimum:
      a. Panel Power (On/Off) Switch
      b. Power On Light (White)
      c. Flare Operating Light (Green)
      d. Flare Shutdown Light (Red)
      e. Emergency Shut-down (Red button)

J. Touchscreen Switches/Settings
   1. The following switches/settings are required on the touch screen display at a minimum:
      a. System Control (Manual– Off – Auto)
      b. Blower Control (Hand – Off – Auto)
      c. Bearing temperature set points.
      d. Main thermocouple setpoint.
      e. Pilot thermocouple setpoint.
      f. Flame arrestor thermocouple set point.
      g. Inlet Pressure setpoint.
      h. Low inlet pressure setpoint and timer.
      i. Flame failure reset switch.
      j. Alarm acknowledgement switch.
      k. VFD controls.

K. Operating Status
   1. The following flare system status is required on the touch screen display and shall be available for communication to other PLCs and/or SCADA systems, at a minimum:
      a. Operating Mode (Manual– Off – Auto)
      b. Flare start-up status.
      c. Thermocouple status (normal or cooling).
      d. Pilot gas On/Off status.
      e. Igniter On/Off status.
      f. Pilot proved status.
      g. Auto block valve status.
      h. Blower status and run time indication.
      i. Blower bearing temperatures.
      j. Flame proved status.
      k. Flare thermocouple temperatures.
      l. Flame arrester thermocouple temperature.
      m. Inlet pressure status.
      n. Knockout pot condensate level status.

L. Alarms
   1. The following alarms are required on the touch screen display and shall be available for communication to other PLCs and existing systems, at a minimum:
      b. Pilot flame failure.
c. Flame arrester high temperature.
d. Auto valve failure.
e. Low landfill gas flow rate annunciation.
f. Blower failure.
g. Blower bearing high temperature.
h. Blower high vibration annunciation.
i. Blower motor low current (surge) annunciation.
j. Inlet low pressure.
k. Thermocouple failure.
l. Main flame failure.
m. High condensate level annunciation.

2.6 ELECTRICAL

A. See figures for details on the existing electrical conditions and proposed changes related to this proposal. All electrical components shall be installed as outlined in the electrical division specifications provided.

2.7 WARRANTY

A. Guarantee work for a period of one (1) year from the date of Substantial Completion. Guarantee shall include all labor and materials necessary to correct work found to be defective during the one year warranty period.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. Install in accordance with shop drawings and manufacturer's recommendations.
2. During the time of installation of the instrumentation and controls equipment, provide at the project site qualified personnel to install equipment herein specified and make final electrical connections to the terminals of all instrumentation equipment.
3. Systems Integrator shall provide any required equipment for, certifying the correctness of, installing, adjusting, starting up, testing, demonstrating, and documenting the equipment.
4. For instrumentation equipment specified elsewhere requiring direct interface to other instrumentation and controls, verify the proper installation for operation and control; verify the proper interfacing of signal connections; verify the adjustment; and provide start-up and testing of equipment, to demonstrate proper I & C system interface and operation.
5. Provide all taps, valves, piping and fittings required to conduct process signals to the instrumentation equipment. Coordinate with specified equipment the installation of all in-line devices and taps.
6. Provide instrumentation in accordance with the figures, specifications, and recommendations of the equipment manufacturer.
7. Install the instrumentation system in a testable configuration with test connections provided for all instrumentation equipment for the calibration and testing of all equipment in place.

B. Blower/Flare Skid

1. Install blower/flare skid in accordance with manufacturer's specifications.
2. Provide all necessary accessories, electrical connections and transformers to produce a working system.
3. Provide space on skid to mount two (2) existing 100-lb propane tanks and proper connections.
4. Provide one eight hour training session for landfill personnel with a qualified technician from the manufacturer.
5. Provide soil/aggregate foundation for blower/flare skid support, with a minimum of 4” compacted gravel, as specified by vendor.
6. Heat trace and insulate external landfill gas supply pipe, flame arrester, flare base, and external condensate drain lines and structures, in accordance with these specifications.
7. Provide condensate removal and management as follows:
   a. Provide a means for condensate removal from the flame arrester, base of flare, and landfill gas supply line low point.
   b. Discharge condensate in a 2” HDPE pipe encased in a 4” HDPE pipe from blower/flare skid to existing cleanout, HR-L2 with a 4” x 4” weld connection, as indicated in the figures.
   c. Alternative measures for collecting and disposing of condensate may be approved by engineer.
8. The flare system shall safely destroy 98% of nonmethane organic compounds (NMOC).
9. The system shall be controlled by a programmable logic controller (PLC) which receives and transmits signals with respect to operating conditions. If an unacceptable operating condition occurs, the system shall discontinue operation.
10. System operation shall include an initial timed ignition sequence and fail-safe controls.
11. System shutdown shall result from pilot flame failure, main flame failure, automatic block valve failure, flame arrester high temperature, and blower bearing high temperature.
12. Individual thermocouples shall monitor both pilot flame and main flame.
13. Install lighting as necessary at site to provide control panel access.

C. Install all piping, fittings, valves, and gauges in accordance with industry standards.

D. Disconnection of Existing Flare and Blower

1. Disconnect the existing 12” landfill gas supply header line at the 90 degree bend where pipe come out of ground for connection to new blower/flare skid. Removal of 12” pipe to blower control room. Removal and decommissioning of butterfly valve located within the blower control room. Add flange cap to remaining piping, leaving blowers in-place. Patch block wall where 12” header entered building with materials like existing. Dispose/repurpose materials as desired by Owner.
2. Disconnect and abandon in-place any remaining control connections to the blower or flare any electrical components as necessary.
3. Existing propane piping and control system to be disconnected and removed. Propane tanks for existing flare pilot gas shall be retained and used for the new flare in accordance with these specifications.

3.2 COORDINATION

A. The BCPRRD will operate the existing landfill gas blower and flare system during construction of the new blower skid and flare. This will allow for construction of the new equipment without interrupting gas collection from the landfill.

B. Contractor shall coordinate flare start-up with systems to integrate data collection from the new flare and blower system control panel and existing auto-dialer alarm system.

3.3 FIELD QUALITY CONTROL

A. Conduct field tests.
   1. Field test shall be conducted by manufacturer's representative in the presence of the Engineer.
   2. Perform field amperage test to determine motor horsepower for comparison to blower curves and rated capacity.
   3. Demonstrate conformance with design requirements.

B. Correct all defects identified during tests.
   1. Field test shall be repeated until requirements of specifications have been met.

C. If field tests by the manufacturer are unable to demonstrate by test results that equipment conforms to requirements of specifications, then the equipment will be rejected and shall be replaced with acceptable units at the manufacturer's expense.

3.4 START-UP, OPERATION AND MAINTENANCE TRAINING

A. Provide start-up, operation and maintenance training.

B. Coordinate the time for start-up, operation and maintenance training with the Owner.

C. Flare manufacturer shall provide a qualified technician for four days to include installation assistance, start-up and training, and final check of systems integration.

END OF SECTION