BIDDING REQUIREMENTS, CONTRACT FORMS,
CONTRACT CONDITIONS AND SPECIFICATIONS FOR
CITY OF ST. CHARLES, ILLINOIS

2018 7TH & DIVISION LIFT STATION REPLACEMENT
VOLUME II

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September 7, 2018

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I hereby certify that this engineering document was prepared by me, Jerry M. Ruth, P.E., under the professional supervision and that I am a duly licensed Professional Engineer under the laws of the State of Illinois.

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DIVISION 02
EXISTING CONDITIONS
SECTION 02 41 16 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolishing designated structures.
2. Demolishing designated foundations.
3. Demolishing designated slabs-on-grade.
4. Disconnecting and capping designated utilities.
5. Demolishing/Filling designated underground tanks.
6. Removing designated items from site.
7. Protecting items designated to remain.
8. Removing demolished materials.

B. Related Requirements:

1. Section 02 41 19 - Selective Structure Demolition: Demolishing designated components.
2. Section 31 05 13 - Soils for Earthwork: Backfill materials.
4. Section 31 10 00 - Site Clearing: Clearing outside periphery of structures.
5. Section 31 23 23 - Fill: Backfill materials.

1.2 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate:

1. Demolition and removal sequence and location of salvageable items.
2. Location and construction of barricades, fences and temporary Work.

C. Existing Building Documentation: Submit the following for existing buildings indicated to remain.

1. Survey indicating position and elevation of exterior building features.
2. Photographic survey indicating conditions before, during, and after demolition Work.
D. Permits: Submit copies of permits required by regulatory agencies for demolition and sidewalk and street closings.

E. Qualifications Statements:

1. Submit qualifications for demolition firm and licensed professional.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Accurately record actual locations of capped utilities, subsurface obstructions, and unexpected items.

C. Operation and Maintenance Data: Submit description of system, inspection data, and parts lists.

1.5 QUALITY ASSURANCE

A. Conform to applicable code for demolition of structures, safety of adjacent structures, dust control, and runoff control disposal.

B. Permits: Obtain required permits from authorities having jurisdiction.

C. Maintain one copy of each document on-Site.

1.6 QUALIFICATIONS

A. Demolition Firm: Company specializing in performing Work of this Section with minimum 5 years' documented experience.

B. Licensed Professional: Design shoring, bracing, underpinning, and under direct supervision of professional engineer experienced in design of this Work and licensed Illinois.

1.7 EXISTING CONDITIONS

A. Buildings indicated to be demolished will be vacated before start of Work.

B. Owner assumes no responsibility for actual condition of buildings to be demolished.

C. Cease operations immediately when hazardous or contaminated materials are discovered. Notify Engineer upon discovery of hazardous materials.

D. Do not sell demolished materials on-Site.
PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Fill Material: As specified in Section 31 05 13 - Soils for Earthwork and 31 05 16 - Aggregates for Earthwork.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine existing buildings indicated to be demolished before demolition.

B. Determine where removals may result in structural deficiency or unplanned building collapse during demolition. Coordinate demolition sequence and procedures to prevent structures from becoming unstable.

C. Determine where demolition may affect structural integrity or weather resistance of adjacent buildings indicated to remain.

   1. Identify measures required to protect buildings from damage.
   2. Identify remedial Work including patching, repairing, bracing, and other Work required to leave buildings indicated to remain in structurally sound, weathertight, and watertight condition.

D. Verify hazardous material abatement is complete before beginning demolition.

E. Existing Building Documentation:

   1. Document condition of adjacent structures indicated to remain.
   2. Make arrangements with building owners and occupants to survey interior and exterior of existing buildings.
   3. Employ land surveyor as specified in Section 01 33 00 - Submittal Procedures to provide following documentation:
      a. Survey building exterior for position and elevation of principal elements before and after completion of demolition.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Call local utility line information service (J.U.L.I.E.) at 1-800-892-0123 not less than two working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

C. Notify affected utility companies before starting Work, and comply with utility's requirements.

D. Do not close or obstruct roadways, sidewalks, or hydrants without permits.

E. Erect and maintain temporary barriers and security devices, including warning signs and lights, and similar measures, for protection of the public, Owner, and existing improvements indicated to remain.

F. Protect existing landscaping materials, trees, appurtenances, and structures indicated to remain.

G. Prevent movement or settlement of adjacent structures. Provide bracing and shoring.

H. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.

3.3 DEMOLITION

A. General:

1. Use of explosives is not permitted.
2. Conduct demolition to minimize interference with adjacent structures.
3. Cease operations immediately when adjacent structures appear to be in danger. Notify Engineer immediately. Do not resume operations until directed.
4. Conduct operations with minimum interference to public or private accesses to occupied adjacent structures. Maintain protected continuous egress and access from adjacent structures at all times.
5. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or limit access to their property.
6. Sprinkling:

   a. Sprinkle Work with water to minimize dust.
   b. Provide hoses and water connections required for this purpose.

B. Capped Utilities:

1. Disconnect remove and cap designated utilities within demolition areas.
2. Identify utilities at termination of demolition.
3. Record termination or capped location on Record Documents.

C. Remove foundation walls and footings to the limits indicated on the plan sheets.

D. Remove concrete slabs-on-grade.

E. Break up concrete slabs-on-grade to permit natural moisture drainage.
F. Empty underground tanks, wet wells and manholes located within demolition area.

G. Remove underground tanks, wet wells, manholes, components, and piping from Site.

H. Remove materials to be re-installed or retained in manner to prevent damage; store and protect according to requirements of Section 01 60 00 - Product Requirements.

I. Backfill areas excavated open pits and holes resulting from demolition according to Section 31 23 23 - Fill.

J. Rough grade and compact areas affected by demolition to maintain Site grades and contours.

K. Continuously clean up and remove demolished materials from Site. Do not allow materials to accumulate on-Site.

L. Do not burn or bury materials on-Site. Leave Site in clean condition.

M. Provide for visual inspection of bearing surfaces.

END OF SECTION 02 41 16
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SECTION 02 41 19.13 - SELECTIVE BUILDING DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolishing designated building equipment and fixtures.
   2. Demolishing designated construction.
   3. Cutting and alterations for completion of the Work.
   4. Protecting items designated to remain.
   5. Removing demolished materials.

B. Related Sections:
   1. Section 02 41 16 - Structure Demolition.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Demolition Schedule: Indicate overall schedule and interruptions required for utility and building services.

C. Shop Drawings:
   1. Indicate demolition and removal sequence.
   2. Indicate location and construction of temporary work.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Accurately record actual locations of capped utilities, concealed utilities discovered during demolition, subsurface obstructions, and other unexpected items.

C. Operation and Maintenance Data: Submit description of system, inspection data, and parts lists.

1.4 QUALITY ASSURANCE

A. Conform to applicable code for demolition work, dust control, products requiring electrical disconnection.

B. Obtain required permits from authorities having jurisdiction.

C. Perform Work in accordance with all applicable governing agencies.
1.5 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
   B. Convene minimum one week prior to commencing work of this section.

1.6 SEQUENCING
   A. Section 01 10 00 - Summary: Requirements for sequencing.

1.7 SCHEDULING
   A. Section 01 30 00 - Administrative Requirements and 01 32 16 - Construction Progress Schedule: Requirements for scheduling.
   B. Schedule Work to coincide with new construction.
   C. Cooperate with Owner in scheduling noisy operations and waste removal that may impact Owners operation and in adjoining spaces.
   D. All work shall be limited between the hours of 7:00 a.m. and 5:00 p.m. Monday through Saturday. Additional restrictions may be placed by other governing jurisdictional agencies. The Contractor will be responsible for abiding by all additional restrictions placed by these agencies.

1.8 PROJECT CONDITIONS
   A. Conduct demolition to minimize interference with adjacent building areas.
   B. Cease operations immediately if structure appears to be in danger and notify Engineer. Do not resume operations until directed.
   C. Cease operations immediately when hazardous or contaminated materials are discovered and notify Engineer.

PART 2 - PRODUCTS

2.1 Fill Materials
   A. All fill materials shall be in accordance with Section 31 05 13 – Soils for Earthwork and 31 05 16 – Aggregates for Earthwork.
PART 3 - EXECUTION

3.1 PREPARATION

A. Notify affected utility companies before starting work and comply with their requirements.
B. Mark location and termination of utilities.
C. Erect, and maintain temporary barriers and security devices, including warning signs and lights, and similar measures, for protection of the public, Owner, and existing improvements indicated to remain.
D. Erect and maintain weatherproof closures for exterior openings.
E. Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued Owner occupancy.
F. Prevent movement of structure; provide temporary bracing and shoring required to ensure safety of existing structure.
G. Provide appropriate temporary signage including signage for exit or building egress.
H. Do not close or obstruct building egress path.
I. Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.

3.2 DEMOLITION

A. Conduct demolition to minimize interference with adjacent building areas.
B. Maintain protected egress from and access to adjacent existing buildings at all times.
C. Do not close or obstruct roadways and sidewalks without permits.
D. Cease operations immediately when structure appears to be in danger and notify Engineer.
E. Disconnect and remove utilities within demolition areas.
F. Cap and identify abandoned utilities at termination points when utility is not completely removed. Annotate Record Drawings indicating location and type of service for capped utilities remaining after demolition.
G. Demolish in an orderly and careful manner. Protect existing improvements, supporting structural members.
H. Remove concrete elements and structures to limits indicated on plans.
I. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
J. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

K. Remove temporary work signage and barriers after completion.

L. Provide for visual inspection of bearing surfaces.

END OF SECTION 02 41 19.13
DIVISION 03
CONCRETE
SECTION 03 05 05 - CONCRETE TESTING AND INSPECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Contractor requirements for testing of concrete.
   2. Acceptance criteria for concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 - Reinforcement.
   4. Section 03 31 30 - Concrete, Materials and Proportioning.
   5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
   6. Section 03 41 33 - Precast and Prestressed Concrete.

1.2 RESPONSIBILITY AND PAYMENT

A. Contractor shall hire a qualified testing agency to perform the following testing and provide test results to the Engineer.
   1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
   2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
   3. Testing and inspection of concrete produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
   4. Additional testing or retesting of materials occasioned by their failure, be test or inspection, to meet requirements of the Contract Documents.
   5. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
   6. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may removed.
   7. Contractor shall pay for services defined in this Paragraph.

B. Duties and Authorities of Testing Agency/Service Provider:
   1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
   2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.
   3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.
      a. All test reports to include exact location in the work at which batch represented by a test was deposited.
      b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
   2. ASTM International (ASTM):
      a. ASTM Cement and Concrete Reference Laboratory (CCRL).
      b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
      f. C138, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
      h. C172, Standard Practice for Sampling Freshly Mixed Concrete.
      i. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
      j. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
      k. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.

B. Qualifications:
   1. Contractor’s Testing Agency:
      a. Meeting requirements of ASTM E329 and ASTM C94.
      b. Provide evidence of recent inspection by CCRL of NBS, and correction of deficiencies noted.

C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Concrete materials and concrete mix designs proposed for use.
1) Include results of all testing performed to qualify materials and to establish mix designs.
2) Place no concrete until approval of mix designs has been received in writing.
3) Submittal for each concrete mix design to include:
   a) Sieve analysis and source of fine and coarse aggregates.
   b) Test for aggregate organic impurities.
   c) Proportioning of all materials.
   d) Type of cement with mill certificate for the cement.
   e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03 31 30.
   f) Slump.
   g) Brand, type and quantity of air entrainment and any other proposed admixtures.
   h) Shrinkage test results.
   i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.
   j) 28-day compression test results and any other data required by Specification Section 03 31 30 to establish concrete mix design.

3. Certifications:
   a. Testing Agency qualifications.
   b. Test results:
      1) Strength test results on concrete placed during construction including slump, air content, and concrete temperature.
      2) Strength test results on concrete core samples of in-place construction if required.
      3) Results of load testing in-place concrete construction when load testing is required.

PART 2 PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

A. The following concrete testing will be performed by the Service Provider/Testing Agency:
   1. Concrete strength testing:
      a. Secure concrete samples in accordance with ASTM C172.
         1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
      b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
         1) Record any deviations from requirements on test report.
            a) 4 IN cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 IN.
            b) Use the same size cylinder for all tests for each concrete mix.
      3) Quantity:
         a) 6 IN DIA by 12 IN high: Four (4) cylinders.
         b) 4 IN DIA by 8 IN high: Six (6) cylinders.
         c) Field cure one (1) cylinder for the seven (7) day test.
1) Laboratory cure the remaining.

d. Test cylinders in accordance with ASTM C39.
   1) 6 IN DIA cylinders:
       a) Test two (2) cylinders at 28 days for strength test result and the one (1) field
          cured sample at seven (7) days for information.
       b) Hold remaining cylinder in reserve.
   2) 4 IN DIA cylinders:
       a) Test three (3) cylinders at 28 days for strength test result and the one (1) field
          cured cylinder at seven (7) days for information.
       b) Hold remaining cylinders in reserve.

e. Strength test result:
   1) Average of strengths of two (2) 6 IN DIA cylinders or three (3) 4 IN DIA
      cylinders from the same sample tested at 28 days.
   2) If one (1) cylinder in a test manifests evidence of improper sampling, molding,
      handling, curing, or testing, discard and test reserve cylinder(s); average strength
      of remaining cylinders shall be considered strength test result.
   3) Should all cylinders in any test show any of above defects, discard entire test.

f. Frequency of tests:
   1) Concrete topping and concrete fill: One (1) strength test for each 10 CY of each
      type of concrete or fraction thereof placed.
   2) Precast concrete: Frequency per Specification Section 03 41 33.
   3) All other concrete:
       a) One (1) strength test to be taken not less than once a day, nor less than once
          for each 60 CY or fraction thereof placed in any one (1) day.
       b) Once for each 5000 SQ FT of slab or wall surface area placed each day.
       c) If total volume of concrete on Project is such that frequency of testing
          required in above paragraph will provide less than five (5) strength tests for
          each concrete mix, tests shall then be made from at least five (5) randomly
          selected batches or from each batch if fewer than five (5) batches are
          provided.

2. Slump testing:
   a. Determine slump of concrete sample for each strength test.
      1) Determine slump in accordance with ASTM C143.
   b. If consistency of concrete appears to vary, the Engineer or Owner’s Representative
      shall be authorized to require a slump test for each concrete truck.
      1) This practice shall continue until three consecutive batches are determined to be
         consistent and meet the slump requirements specified.

3. Air content testing: Determine air content of concrete sample for each strength test in
   accordance with either ASTM C231, ASTM C173, or ASTM C138.

4. Temperature testing: Determine temperature of concrete sample for each strength test.

5. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

A. See Section 01 40 00.

B. Formwork Special Inspections:
   1. Shape, location, and dimensions.
      a. Inspect in accordance with dimensions and details on Drawings.
      b. Frequency: Inspect prior to each concrete pour.
C. Reinforcing Special Inspections:
   1. Reinforcing size, spacing, lap length and concrete cover.
      a. Inspect in accordance with Drawings and Specification.
      b. Frequency: Inspect prior to each concrete pour.
   2. Reinforcing adhesive anchoring system:
      a. Inspect in accordance with ICC-ES report.
      b. Frequency:
         1) Inspect all adhesive anchors for the first 4 HRS of installation.
         2) Inspect approximately 25 percent of adhesive anchors thereafter.
         3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
   3. Mechanical splices:
      a. Inspect in accordance with ICC-ES report.
      b. Frequency:
         1) Inspect all mechanical splices prior to placing concrete.
         2) Additional inspection will be required for different installer or if the quality of installation appears to vary.

D. Mixing, Placing, Jointing, and Curing Special Inspections:
   1. Perform concrete tests per the requirements of this Specification Section.
   2. Verification of proper mix design.
      a. Frequency: Periodically, prior to each concrete pour.
   3. Proper concrete placement techniques.
      a. Inspect per requirements of Section 03 31 31.
      b. Frequency: During each concrete pour.
   4. Proper curing temperature and techniques.
      a. Inspect per requirements of Section 03 31 31.
      b. Frequency: Periodically, but not less than every third day.
   5. Joints:
      a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
      b. Frequency: Prior to each concrete pour.
   6. Waterstops:
      a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
      b. Frequency:
         1) Prior to each concrete pour.

E. Anchorage to Concrete Special Inspection:
   1. Post installed anchors as required by the Building Code, ICC-ES Evaluation Reports, and as specified by the Engineer.
   2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
      a. Frequency: Prior to each concrete pour.

3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

A. To facilitate testing and inspection, perform the following:
   1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.

3. Take samples at point of placement into concrete member.

B. Notify Engineer and Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow for assignment of personnel and for scheduled completion of quality tests.

3.4 ACCEPTANCE

A. Completed concrete work which meets applicable requirements will be accepted without qualification.

B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.

C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
   1. In this event, modifications may be required to assure that concrete work complies with requirements.
   2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.

D. Dimensional Tolerances:
   1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
   2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
      a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
   3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
   4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
      a. Repair or remove and replace if required.
   5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
      a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

E. Appearance:
   1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
   2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the long-term strength or function of the member.

F. High Water-Cement Ratio:
1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.

G. Strength of Structure:
1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
   a. Low concrete strength:
      1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
         a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
         b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three (3) strength tests.
         c) A strength test shall be the average of two (2) 6 IN diameter cylinders or three (3) 4 IN diameter cylinders from the same sample tested at 28 days.
   2) Acceptance:
      a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
         (1) Average of all sets of three (3) consecutive strength tests equal or exceed the required specified 28 day compressive strength.
         (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 psi.
   b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 or requirements of the Contract Drawings or approved Shop Drawings.
   c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
   d. Curing time and procedure not meeting requirements of this Specification Section.
   e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
   f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
   g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
   a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.
      1) Such tests shall not be used as a basis for acceptance or rejection.
   b. Core tests:
      1) Where required, test cores will be obtained in accordance with ASTM C42.
         a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DegF, relative humidity less than 60 percent) for seven (7) days before test then test dry.
b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet.

c) Testing wet or dry to be determined by Engineer.

2) Three (3) representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
   a) Location of cores shall be determined by Engineer so as least to impair strength of structure.
   b) If, before testing, one (1) or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.

3) Concrete in area represented by a core test will be considered adequate if average strength of three (3) cores is equal to at least 85 percent of specified strength and no single core is less than 75 percent of specified strength.

4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.

4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 20.

5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.

6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION
SECTION 03 11 13 - FORMWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Formwork requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   5. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 347R, Guide to Formwork for Concrete.
   2. Building Code:
      a. International Code Council (ICC):
            amendments, referred to herein as Building Code.

B. Qualifications:
   1. Formwork, shoring and reshoring to be designed by a licensed professional engineer
      currently registered or having a minimum of three (3) years experience in this type of
      design work.
      a. Above qualifications apply to slabs and beams not cast on the ground.

C. Miscellaneous:
   1. Design and engineering of formwork, shoring and reshoring as well as its construction is
      the responsibility of the Contractor.
   2. Design requirements:
      a. Design formwork for loads, lateral pressures and allowable stresses outlined in
         ACI 347R and for design considerations, wind loads, allowable stresses and other
         applicable requirements of the controlling local Building Code.
         1) Where conflicts occur between the above two (2) standards, the more stringent
            requirements shall govern.
      b. Design formwork to limit maximum deflection of form facing materials reflected in
         concrete surfaces exposed to view to 1/240 of span between structural members.
      3. For slabs and beams not cast on the ground, develop a procedure and schedule for
         removal of shores and for calculating the loads transferred to the structure during this
         process in accordance with ACI 347R.
         a. Perform structural calculations as required to prove that all portions of the structure
            in combination with remaining forming and shoring system has sufficient strength to
            safely support its own weight plus the loads placed thereon. Calculations shall be
            performed by a licensed Professional Engineer.
b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:

1) The structural system that exists.
2) Effects of all loads during construction.
3) Strength of concrete.
4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for the requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Manufacturer and type of proposed form ties.

B. Samples:
   1. A 12 IN SQ sample of each of the following form finishes.

PART 2 PRODUCTS

2.1 MATERIALS

A. Forms for Surfaces Exposed to View:
   1. Wood forms:
      a. 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
      b. Built-in-place or prefabricated type panel.
   2. Metal forms:
      a. Metal forms may be used except for aluminum in contact with concrete.
      b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:
   1. Wood or metal sufficiently tight to prevent leakage.
   2. Do not use aluminum forms.

2.2 ACCESSORIES

A. Form Ties:
      a. Field fabricated ties are unacceptable.
2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
3. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.
4. Cone size:
   a. 3/4 IN minimum diameter cones on both ends.
   b. Depth of cone not to exceed the concrete reinforcing cover.
5. Provide ties with built-in waterstops in all walls that will be in contact with process liquid during plant operation and for all wall where waterstops are indicated in construction joints.
6. Through-wall ties that are designed to be entirely removed are not allowed in all walls that will be in contact with process liquid during plant operation.

PART 3 EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:
   1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
      a. A field applied form release agent or sealer of approved type or a factory applied non-absorptive liner may be used.
   2. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
   1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 FT apart.

C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:
   1. Conform to ACI 117.
   2. Variation from plumb:
      a. In lines and surfaces of columns, piers, walls, and in risers.
         1) Maximum in any 10 FT of height: 1/4 IN.
         2) Maximum for entire height: 1/2 IN.
      b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
         1) Maximum in any 20 FT length: 1/4 IN.
         2) Maximum for entire length: 1/2 IN.
   3. Variation from level or from grades specified:
a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
   1) Maximum in any 10 FT of length: 1/4 IN.
   2) Maximum in any bay or in any 20 FT length: 3/8 IN.
   3) Maximum for entire length: 3/4 IN.

b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
   1) Maximum in any bay or in 20 FT length: 1/4 IN.
   2) Maximum for entire length: 1/2 IN.

4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
   a. Maximum in any bay: 1/2 IN.
   b. Maximum in any 20 FT of length: 1/2 IN.
   c. Maximum for entire length: 1 IN.

5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.

6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 IN.

7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 IN, +1/2 IN.

8. Footings and foundations:
   a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
   b. Misplacement or eccentricity:
      1) 2 percent of footing width in direction of misplacement but not more than 2 IN.
   c. Thickness:
      1) Decrease in specified thickness: 5 percent.
      2) Increase in specified thickness: No limit except that which may interfere with other construction.

9. Variation in steps:
   a. In a flight of stairs:
      1) Rise: +1/8 IN.
      2) Tread: +1/4 IN.
   b. In consecutive steps:
      1) Rise: +1/16 IN.
      2) Tread: +1/8 IN.

10. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.

11. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.

12. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.
1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.

F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 FT wide.
   1. Brace and tie formwork to maintain correct position and shape of members.

G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
   1. Securely brace forms against lateral deflection.
   2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.
   1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
   1. For walls of water containing structures, leave forms in place for a minimum of 72HRS.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength.
1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshole.
   1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
   2. Locate reshores directly under a shore position above.

H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

3.5 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Section 01 40 00.
   2. See Section 03 05 05.

END OF SECTION
SECTION 03 15 19 - ANCHORAGE TO CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for all cast-in-place anchor bolts, anchor rods, reinforcing adhesive anchorage, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
   2. Design of all concrete anchors not indicated on the Drawings including, but not limited to, installation of anchors into concrete for the following structural and nonstructural components:
      a. Structural members and accessories.
      b. Metal, wood, and plastic fabrications.
      c. Architectural components.
      d. Mechanical and electrical equipment and components.
      e. Plumbing, piping, and HVAC work.
      f. All other components requiring attachment to concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 09 96 00 – High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete and Commentary.
   2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
   3. American Institute of Steel Construction (AISC):
   4. ASTM International (ASTM):
      e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.

5. ICC Evaluation Service (ICC-ES):
   a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

6. Building code:
   a. International Code Council (ICC):

B. Qualifications:
   1. Anchor designer for Contractor-designed post-installed anchors and cast in place anchorage shall be a Professional Structural Engineer licensed in the State of Illinois.
   2. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.
   3. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Post-installed anchors and related materials shall be listed by the following agencies:
   1. ICC-ES.
   2. Engineer approved equivalent.

1.3 DEFINITIONS

A. Adhesive Anchors:
   1. Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
   2. Includes anchors using acrylics, epoxy and other similar adhesives.

B. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.

C. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.

D. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.

E. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

F. Hardware: As defined in ASTM A153.

G. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

H. MPII: Manufacturer’s printed installation instructions.
I. Mechanical Anchors:
   1. Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
   2. Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
   3. Drop-in anchors and other similar anchors are not allowed.

J. Post-Installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that submitted products meet requirements of referenced standards.
      b. Manufacturer material data sheet for each anchor.
         1) Clearly indicate which products on the data sheet are proposed for use on the Project.
      c. Manufacturer's printed installation instructions.
      d. Current ICC-ES report for each post-installed anchor system indicating the following:
         1) Certification that anchors meet all requirements indicated in this Specification.
         2) Performance data showing that anchor is approved for use in cracked concrete.
         3) Seismic design categories for which anchor system has been approved.
         4) Required installation procedures.
         5) Special inspection requirements for installation.
      e. Anchorage layout Drawings and details:
         1) Indicate anchor diameter, embedment, length, anchor type, material and finish.
         2) Drawings showing location, configuration, spacing and edge distance.
      f. Contractor Designed Post-Installed Anchors:
         1) Show diameter and embedment depth of each anchor.
         2) Indicate compliance with ACI 318.
         3) Design tension and shear loads used for anchor design.
         4) Engineering design calculations:
            a) Indicate design load to each anchor.
            b) When the design load is not indicated on Drawings, include calculations to develop anchor forces based on Design Criteria listed herein.
            c) Sealed and signed by contractor’s professional structural engineer.
            d) Calculations will be submitted for information purposes only.
         5) Type of post-installed anchor system used.
            a) Provide manufacturer's ICC-ES report for the following:
               (1) Mechanical anchorage per ICC-ES AC193.
               (2) Adhesive anchorage per ICC-ES AC308.

B. Samples:
   1. Representative samples of concrete anchors may be requested by Engineer. Review will be for type and finish only. Compliance with all other requirements is exclusively the responsibility of the Contractor.
C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Certification of qualifications for each installer of post-installed anchors.
      a. Indicate successful completion or certification for each type of approved post-installed anchor as required by the Contract Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer’s or distributor’s packaging undamaged and complete with installation instructions.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

C. Protect and handle materials in accordance with manufacturer’s recommendations to prevent damage or deterioration.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cast-in-place Concrete Anchors:
   1. Building, and non-building structures:
      a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized threaded rods.
      b. ASTM A307, Grade A for galvanized headed bolts.
   2. Lift station supported equipment and all other cast-in-place concrete anchors:
      a. Stainless steel with matching nut and washer.
      b. Submerged application: ASTM F593, Type 316.
      c. Non-submerged application: ASTM F593, Type 304 or Type 316.

B. Post-Installed Mechanical and Adhesive Concrete Anchors:
   1. Stainless steel with matching nut and washer.
   2. Submerged application: ASTM F593, Type 316.
   3. Non-submerged application: ASTM F593, Type 304 or Type 316.

C. Reinforcement: See Section 03 21 00.

D. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

E. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

F. Washers:
   1. ASTM F436 unless noted otherwise.
   2. If stainless steel anchorage is being used for cast-in-place anchorage, furnish washers of the same material and alloy as in the accompanying anchorage.
   3. Plate washers: Minimum 1/2 IN thick fabricated ASTM A36 square plates as required.
   4. Follow manufacturer’s requirements for all post-installed anchorage.
G. Nuts:
1. ASTM A563 for all cast-in-place anchorage.
2. If stainless steel anchorage is being used for cast-in-place anchorage, nuts shall meet ASTM F594 and be the matching material and alloy as in the accompanying anchorage.
3. Follow manufacturer’s requirements if using post-installed anchorage.

H. Galvanizing Repair Paint:
1. High zinc dust content paint for regalvanizing welds and abrasions.
2. ASTM A780.
3. Zinc content: Minimum 92 percent in dry film.
4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

I. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.2 CONTRACTOR DESIGNED ANCHORAGE

A. Acceptable Manufacturers:
1. Post-installed anchor systems for the listed manufacturers will be considered only if a current ICC-ES evaluation report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section and if the anchor system is approved by the Engineer.
   a. Hilti.
   b. Powers Fasteners.
   c. Simpson Strong-Tie.
2. Submit request for substitution in accordance with Specification Section 01 25 00.

B. Contractor shall design the anchorage when any of the following occur:
1. Design load for concrete anchorage is shown on the Drawings.
2. When specifically required by the Contract Documents.
3. When an anchorage is required but not specified in the Drawings.
4. When anchorage is shown on Drawings other than Structural Drawings.

C. Anchorage Design Loads:
1. Determine all of the design loads, including wind and seismic loads, per the Building Code.
   a. Anchorage of piping, equipment and non-structural components: Use the actual dead and operating loads provided by the manufacturer.

D. When Contract Drawings, other than the Structural Drawings, indicate an anchor diameter or length, the Contractor design shall incorporate these as “minimums.”

E. Cast-in-Place Concrete Anchors:
1. Provide the material, nominal diameter, embedment length, spacing, edge distance and design capacity to resist the calculated load based on the requirements given in the Building Code including ACI 318.
2. Design assuming cracked concrete.

F. Post-installed Concrete Anchors:
1. Provide the manufacturer’s system name/type, nominal diameter, embedment depth, spacing, minimum edge distance, cover, and design capacity to resist the specified or calculated load based on requirements given in the Building Code, ACI 318 and current ICC-ES report, for the anchor to be used.
2. Design assuming cracked concrete.

2.3 ENGINEER DESIGNED ANCHORAGE

A. When the size, length and details of anchorages are shown on Contract Structural Drawings, Contractor design of anchorage is not required.

B. Acceptable Manufacturers:
1. Additional newer post-installed anchor systems for the listed manufacturers will be considered only if a current evaluation agency report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section, the anchor system is certified by ICC-ES for cracked concrete conditions, and if approved by the Engineer.
2. Mechanical Anchors:
   a. Hilti:
      1) Kwik Bolt 3 (ICC-ES ESR-2302).
3. Adhesive Concrete Anchors:
   a. Hilti:
      1) HIT RE 500 V3 (ICC ESR-3814).
4. Screw Concrete Anchors:
5. Submit request for substitution in accordance with Specification Section 01 25 00.
   a. Substitution request to indicate the proposed anchor has the at least the same tension and shear strength as the specified anchor installed as indicated in the Contract Drawings.
   b. Calculations to be stamped by a Professional Structural Engineer registered in the state that the Project is located in.

PART 3 EXECUTION

3.1 GENERAL

A. Cast-in-Place Anchorage:
   1. Use where anchor rods or bolts are indicated on the Drawings, unless another anchor type is approved by the Engineer.
   2. Provide concrete anchorage as shown on the Drawings or as required to secure components to concrete.

B. Adhesive Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. May be used where subjected to vibration or where buried or submerged.
   3. Do not use in overhead applications or sustained tension loading conditions such as utility hangers.
   4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.
C. Mechanical Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. Do not use where subjected to vibration.
   3. May be used in overhead applications.
   4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.

D. Do not use powder actuated fasteners and other types of bolts and fasteners not specified herein for structural applications unless approved by the Engineer or specified in Contract Documents.

3.2 PREPARATION

A. Provide adequate time to allow for proper installation and inspection prior to placing concrete for cast-in-place concrete anchorage.

B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed.
   1. Notify Engineer of conditions detrimental to proper and timely completion of work.
   2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

C. Special Inspection is required in accordance with the Building Code for all concrete anchorage.
   1. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
   2. See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section for additional requirements.

D. Post-installed anchor manufacturer’s representative shall demonstrate and observe the proper installation procedures for the post-installed anchors at no additional expense to the Owner.
   1. Follow such procedures to assure acceptable installation.

3.3 INSTALLATION

A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
   1. Tack welding of anchorage is prohibited.
   2. Coat the projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
   3. Anchorage location tolerance shall be in accordance with AISC 303.
   4. Provide steel or durable wood templates for all column and equipment anchorage.
      a. Templates to be placed above top of concrete and not impede proper concrete placement and consolidation.

B. Unless noted or specified otherwise:
   1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
      a. Provide dissimilar materials protection per Specification Section 09 96 00.
   2. Provide washers for all anchorage.
3. Where exposed, extend threaded anchorage a maximum of 3/4 IN and a minimum of 1/2 IN above the top of the fully engaged nut.
   a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.

C. Do the following after nuts are snug-tightened down:
   1. If using post-installed anchorage, follow MPII.
   2. Upset threads of anchorage to prevent nuts from backing off.
      a. Provide double nut or lock nut in lieu of upset threads for items that may require removal in the future.
   3. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn to prevent nuts from backing off.
   4. If two (2) nuts are used per concrete anchor above the base plate, tighten the top nut an additional 1/8 turn to "lock" the two (2) nuts together.
   5. If using post-installed anchorage, follow manufacturer’s installation procedures.

D. Assure that embedded items are protected from damage and are not filled in with concrete.

E. Secure architectural components such that it will not be aesthetically distorted nor fasteners overstressed from expansion, contraction or installation.

F. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

G. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions and ASTM A780.

H. For post-installed anchors, comply with the MPII on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar.
   1. Use hammer drills to create holes.
   2. Properly clean out the hole per the ICC-ES reports utilizing a non-metallic fiber bristle brush and compressed air or as otherwise required to remove all loose material from the hole prior to installing the anchor in the presence of the Special Inspector.

3.4 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Section 01 40 00.
   2. See Section 03 05 05.

3.5 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings when specified in Specification Section 09 96 00.

END OF SECTION
SECTION 03 21 00 - REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bar requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. SP 66, ACI Detailing Manual.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      d. 318, Building Code Requirements for Structural Concrete.
   2. ASTM International (ASTM):
      c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      e. A970, Standard Specification for Headed Steel Bars for Concrete Reinforcement.
   3. Concrete Reinforcing Steel Institute (CRSI):

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Mill certificates for all reinforcing.
      d. ICC report, manufacturer and type of proprietary reinforcing mechanical splices.
   3. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing supports.
   4. Sufficient reinforcing details to permit installation of reinforcing.
   5. Reinforcing details in accordance with ACI SP 66 and ACI 315.
6. Locations where proprietary reinforcing mechanical splices are required or proposed for use.
7. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
   a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Adhesive for reinforcing adhesive anchors:
      a. See Specification Section 03 15 19.
   2. Reinforcing mechanical splices:
      a. Lenton Rebar Splicing by Erico, Inc.
      b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
      c. Bar-Grip Systems by Barsplice Products, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

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


C. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125 percent of the yield strength of the reinforcing bars being spliced.

D. Adhesive for Reinforcing Adhesive Anchors:

2.3 ACCESSORIES

A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:
   1. Metal fabrications with plastic-coated tips in contact with forms.
   2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
      a. 100 percent non-metallic, non-corrosive.
      b. Required for all walls and elevated construction exposed to liquid or above liquid in all liquid containing structures.
B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

A. Tolerances:
   1. Conforms to ACI 117, expect as modified herein.
   2. Sheared lengths: +1 IN.
   3. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
   4. All other bends: +0 IN, -1/2 IN.

B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated for standard hooks in ACI 318.

C. Ship reinforcing to jobsite with attached plastic or metal tags.
   1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
   2. Mark numbers on tags to be so placed that the numbers cannot be removed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Tolerances:
   1. Conform to ACI 117, except as modified herein.
   2. Reinforcing placement:
      a. Clear distance to formed surfaces: +1/4 IN.
      b. Minimum spacing between bars: -1/4 IN.
      c. Top bars in slabs and beams:
         1) Members 8 IN deep or less: +1/4 IN.
         2) Members between 8 IN and 2 FT deep: -1/4 IN, +1/2 IN.
         3) Members more than 2 FT deep: -1/4 IN, +1 IN.
      d. Crosswise of members: Spaced evenly within +1 IN.
      e. Lengthwise of members: +2 IN.
   3. Minimum clear distances between reinforcing bars:
      a. Beams, walls and slabs: Distance equal to bar diameter or 1 IN, whichever is greater.
      b. Columns: Distance equal to 1-1/2 times the bar diameter or 1-1/2 IN, whichever is greater.
      c. Beam and slab reinforcing shall be threaded through the column vertical rebars without displacing the column vertical bars and still maintaining the clear distances required for the beam and slab reinforcing bars.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
   1. For reinforcing: Class B splice meeting the requirements of ACI 318.
   2. For welded wire reinforcement:
      a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one (1) spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN.
      b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 318.
3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.
   a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

D. Welding: Welding reinforcing is not permitted.

E. Placing Reinforcing:
   1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
   2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
   3. Reinforcing support:
      a. Uncoated reinforcing:
         1) Support reinforcing and fasten together to prevent displacement by construction operations.
            a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
            b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
            c) Reinforcement shown on the Contract Documents may not be repositioned for use a support for reinforcement. Additional drop bars may be provided for support of reinforcing.
         2) Reinforcing supported on ground:
            a) Slab on grade and other members with only one mat of reinforcing:
               (1) Provide metal bar supports with bottom plate.
               (2) Do not use concrete blocks to support slab-on-grade reinforcing.
            b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
         3) Reinforcing supported on formwork:
            a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
            b) All other formed surfaces:
               (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
               (2) Only tips in contact with the forms need to be plastic coated.
   4. Support reinforcing over cardboard void forms by means of concrete supports which will not puncture or damage the void forms during construction nor impair the strength of the concrete members in any way.
   5. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 IN.
      a. Place spacer bars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
   6. Extend reinforcement to within 2 IN of concrete perimeter edges.
      a. If perimeter edge is formed by earth, extend reinforcement to within 3 IN of the edge.
   7. To assure proper placement, furnish templates for all column vertical bars and dowels.
   8. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.

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a. Do not bend reinforcing by means of heat.
9. Do not tack weld reinforcing.
10. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
   a. See Specification Section 03 15 19.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:
   1. Notify Engineer whenever the specified clearances between bars cannot be met.
   2. Do not place any concrete until the Engineer submits a solution to reinforcing congestion problem.
   3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
   4. If bars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of reinforcing.
   5. No cutting of reinforcing shall be done without written approval of Engineer.

B. Special Inspection:
   1. See Section 01 40 00.
   2. See Section 03 05 05.

END OF SECTION
SECTION 03 31 30 - CONCRETE, MATERIALS AND PROPORTIONING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete materials, strengths and proportioning for concrete work.
   2. Grouting:
      a. Base plates for columns and equipment.
      b. As specified and indicated in the Contract Document.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 03 15 19 - Anchorage to Concrete.
   5. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   6. Section 03 41 33 - Precast and Prestressed Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
      c. 212.3R, Chemical Admixtures for Concrete.
      d. 232.2R, Use of Fly Ash in Concrete.
      e. 318, Building Code Requirements for Structural Concrete.
   2. ASTM International (ASTM):
      f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
      k. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
      m. C1116, Standard Specification for Fiber-Reinforced Concrete.
q. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).

3. Steel Deck Institute (SDI):
a. 31, Design Manual for Composite Decks, Form Decks and Roof Decks.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

B. Water-Bearing Concrete: Any concrete surface to be in contact with process fluids during normal operation of the facility, including, but not limited to, tank, channels, wet wells and distribution chambers.

C. Supplementary Cementitious Materials (SCM): Fly ash, silica fume and ground granulated blast furnace slag.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's instructions.
      c. Concrete mix designs as required by Specification Section 03 05 05.
      d. Manufacturer and type of proposed admixtures.
      e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
   3. Certifications:
      a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
      b. Certification that the SCM meet the quality requirements stated in this Specification Section, and SCM supplier's certified test reports for each shipment of SCM delivered to concrete supplier.
      c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
      d. Certification of aggregate gradation.
      e. Certification of coarse aggregate impurities as relates to alkali-silica reactivity per ASTM C33, Appendix X.
      f. Certification of shrinkage test results.
   4. Test reports:
      a. Cement and SCM mill reports for all cement to be supplied.
      b. Provide test results for alkali-silica reactive impurities on coarse aggregates per referenced ASTM standards.
1.5 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
   1. Store cement and SCM in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
   2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
   3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
   4. Do not use frozen or partially frozen aggregates.
   5. Do not use bottom 6 IN layer of stockpiled material in contact with ground.
   6. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
      a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
      b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers are acceptable:
   1. Non-shrink grout:
      a. BASF Corporation.
      b. Euclid Chemical Company.
      c. Five Star Products, Inc.
   2. Epoxy grout:
      a. BASF Corporation.
      b. Five Star Products, Inc.
      c. Euclid Chemical Company.
      d. Sika Corporation.
   3. Synthetic fibers:
      a. GCP Applied Technologies, Inc.
      b. BASF Corporation.
      c. Euclid Chemical Company.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

A. Cement:
   1. Cast-in-place concrete: ASTM C150, Type II.
   2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. SCM:
   1. Fly Ash:
      a. ASTM C618, Class F.
      b. Non-staining.
      c. Suited to provide hardened concrete of uniform light gray color.
d. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.

e. Produced by source approved by the State Highway Department in the state where the Project is located for use in concrete for bridges.

f. Evaluate and use in accordance with ACI 232.2R.

2. Cement and SCM type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
4. All concrete mixes require the use of water reducers to maintain the specified water-to-cement ratios without additional cement.
5. SCM: Per above.
6. Admixtures to be chloride free.
   a. Do not use calcium chloride.
7. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.
8. Provide admixtures certified by manufacturer to be compatible with other admixtures.
9. Shrinkage reducing admixtures:
   a. Admixture used to reduce the shrinkage of Portland Cement concrete.
   b. Utilize at dosage necessary to help achieve required shrinkage value stated herein.
   c. Similar to:
      1) Eclipse 4500 by GCP Applied Technologies, Inc.
      2) Conex by Euclid Chemical Co.
      3) MasterLife SRA 20 or MasterLife CRA 007 by BASF Corporation.

D. Water:
1. Potable.
2. Clean and free from deleterious substances.

E. Aggregates for Normal Weight Concrete:
1. ASTM C33.
2. Fine and coarse aggregates to be regarded as separate ingredients.
3. Provide aggregates approved for bridge construction by the State Highway Department of the State the project is located.
4. Coarse aggregate:
   a. Use only washed aggregates.
   b. Coarse aggregate sieve analysis:
      1) Per Table 1 in the PART 2 MIXES Article.
5. Fine aggregates to be natural, not manufactured.
6. Do not use aggregates that may be deleteriously reactive when combined with alkalis in cement.
   a. Evaluate proposed aggregates for potential deleterious expansion due to alkali silica reactivity per ASTM C33 (Appendix X), ASTM C289, ASTM C227, ASTM C1260 or ASTM C1567.
F. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement in accordance with ASTM C1218:
   1. Prestressed concrete: 0.06.
   2. All other concrete: 0.10.

G. Sand Cement Grout (referred to as "Grout" on the Drawings):
   1. Approximately three (3) parts sand, one (1) part Portland cement, 6 ±1 percent entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
      a. Provide sand in accordance with requirements for fine aggregate for concrete.
   2. Minimum 28-day compressive strength:
      a. 3000 psi.
      b. Shall be at least strength of parent concrete when used at construction joints.

H. Non-shrink Grout:
   1. Non-shrink, nonmetallic, noncorrosive, and non-staining.
      a. Conform to ASTM C1107.
   2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
   3. Grout to produce a positive but controlled expansion.
      a. Mass expansion shall not be created by gas liberation or by other means.
   4. Minimum 28 day compressive strength: 7,000 psi.
   5. Acceptable manufacturers:
      a. BASF Admixtures, Inc. "Masterflow, 713".
      b. Euclid Chemical "NS Grout".
      c. Sika Corporation "Sika Grout 212".
      d. Sauereisen, Inc. "F-100 Level Fill Grout".

I. Epoxy Grout:
   1. Three-component epoxy resin system:
      a. Two (2) liquid epoxy components.
      b. One (1) inert aggregate filler component.
   2. Adhesive acceptable manufacturers:
      a. BASF “Masterflow 648”.
      c. Euclid Chemical "E3-G."
      d. Sika "Sikadur Hi-Mod."
   3. Aggregate acceptable manufacturers:
      a. BASF “Masterflow 648”.
      c. Euclid Chemical "Euclid aggregate."
      d. Sika aggregate.
   4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
   5. The aggregate shall be compatible with the adhesive.

J. See Specification Section 03 31 31 for Grout Schedule of use.

2.3 MIXES

A. General:
1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
2. Ready-mixed concrete shall conform to ASTM C94/C94M.
3. All concrete to be normal weight concrete, weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Concrete Mixes: Refer to Table 1 below.

C. Air Entrainment:
1. Provide air entrainment in concrete resulting in a total air content percent by volume per Table 1 below.
   a. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures.

D. Slump:
1. Measure slump at point of discharge into concrete members.
2. Walls and columns:
   a. 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
   b. Slump shall be obtained by use of mid-range or high-range water reducer conforming to ASTM C494.
3. All other members:
   a. Concrete using a water reducer per ASTM C494: 8 IN maximum, 4 IN minimum measured at point of discharge into the concrete member.
   b. Concrete without a water reducer per ASTM C494: 5 IN maximum, 1 IN minimum measured at point of discharge into the concrete member.
4. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
5. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
   a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ratio is not exceeded.
6. Slump may be adjusted in the field through the use of water reducers.
   a. Coordinate dosage and mixing requirements with concrete supplier.
7. Slump tolerances shall comply with the requirements of ACI 117.

E. Proportioning:
1. General:
   a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
   b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
2. Normal weight concrete target cementitious materials contents and maximum water cementitious ratios per Table 1 below.
   a. Target cementitious materials contents are intended to provide a crack free, durable finished product, not one with excessive strength.
3. SCM:
   a. Fly ash:
1) For cast-in-place concrete only, a maximum of 25 percent by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
2) If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.
3) Concrete containing fly ash shall not be used in the construction of the precast concrete units specified in Specification Section 03 41 33.

4. Water reducing, retarding, and accelerating admixtures:
   a. Use in accordance with manufacturer's instructions.
   b. Add to mix at batching plant.
   c. Use water-reducing or high-range water reducing admixture in concrete, as required, for placement and workability.
      1) Water reducers are required to maintain specified maximum water to cement ratios.

5. High range water reducers (superplasticizers):
   a. Use required for:
      1) All concrete to be pumped except slabs on grade.
      2) All concrete for water containing structures.
      3) Other concrete members at Contractor’s option.
   b. Use required for all non-pumped concrete except slabs on grade and foundations.
   c. Maximum concrete slump before addition of admixture to be 3 IN maximum slump after addition to be 8 IN.
   d. Reference Specification Section 03 31 31 for additional requirements.

6. Concrete mix proportioning methods for normal weight concrete:
   a. Method 1:
      1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
      2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three (3) different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
      3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 percent specified.
      4) For each water cement ratio or cement content, make at least three (3) trial strength tests for specified test age, and cure in accordance with ASTM C192.
         b) Test for strength at 28 days in accordance with ASTM C39.
            (1) Quantity of cylinders per trial strength test:
               (a) 6 IN DIA cylinders: Two (2).
               (b) 4 IN DIA cylinders: Three (3).
      5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
      6) From this curve select water cement ratio or cement content to be used to produce required average strength.
      7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
      8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
      9) See paragraph hereafter for definition of required average strength.
   b. Method 2:
1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.

2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.

3) Field test records to represent materials, proportions and conditions similar to those specified.
   a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
   b) Field test records shall meet the requirements of ACI 318.

4) Required concrete proportions may be established by interpolation between the strengths and proportions of two (2) or more test records each of which meets the requirements of this Specification Section.

7. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with ACI 318 using the standard deviation of the proposed concrete production facility as described in ACI 318.

F. Flowable Fill:
   1. A mixture of cement, fly ash, fine sand, water and air having a consistency which will flow under a very low head.

2. Approximate quantities of each component per cubic yard of mixed material:
   a. Cement (Type I or II): 50 LBS.
   b. Fly ash: 200 LBS.
   c. Fine sand: 2,700 LBS.
   d. Water (approximate): 420 LBS.
   e. Air content (approximate): 10 percent.

3. Actual quantities shall be adjusted to provide a yield of 1 CY with the materials used.

4. Approximate compressive strength should be 85 to 175 psi.

5. Fine sand shall be an evenly graded material having not less than 95 percent passing the No. 4 sieve and not more than 5 percent passing the No. 200 sieve.

G. Allowable Shrinkage:
   1. Per Table 1 when tested in accordance with ASTM C157 at 28 Days.

   2. Continue testing to 64 weeks for informational purposes.
<table>
<thead>
<tr>
<th>TYPE OF CONCRETE</th>
<th>28 DAY COMPRESSIVE STRENGTH</th>
<th>W/C RATIO</th>
<th>TARGET TOTAL CEMENT</th>
<th>SCM</th>
<th>ASTM C33 Size No.</th>
<th>AIR CONTENT</th>
<th>ALLOWABLE SHRINKAGE LIMIT</th>
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</thead>
<tbody>
<tr>
<td>Normal weight concrete fill</td>
<td>3000 psi</td>
<td>0.45</td>
<td>517</td>
<td>Note 1</td>
<td>57</td>
<td>4-1/2 to 7-1/2</td>
<td>None</td>
</tr>
<tr>
<td>Normal weight concrete topping</td>
<td>4000 psi</td>
<td>0.45</td>
<td>564</td>
<td>Note 1</td>
<td>7</td>
<td>5-1/2 to 8</td>
<td>None</td>
</tr>
<tr>
<td>Normal weight precast concrete</td>
<td>5000 psi</td>
<td>0.42</td>
<td>611</td>
<td>57</td>
<td>4-1/2 to 7-1/2</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Normal weight concrete w/ power trowel finish</td>
<td>4000 psi</td>
<td>0.45</td>
<td>564</td>
<td>Note 1</td>
<td>57 or 67</td>
<td>0 to 2</td>
<td>0.048</td>
</tr>
<tr>
<td>Normal weight water-bearing concrete</td>
<td>4500 psi</td>
<td>0.42</td>
<td>564</td>
<td>Note 1</td>
<td>57 or 67</td>
<td>4-1/2 to 7-1/2</td>
<td>0.042</td>
</tr>
<tr>
<td>Normal weight all other concrete</td>
<td>4500 psi</td>
<td>0.42</td>
<td>564</td>
<td>Note 1</td>
<td>57 or 67</td>
<td>4-1/2 to 7-1/2</td>
<td>0.048</td>
</tr>
</tbody>
</table>

**Table 1 Notes:**
1. If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to meet total target cement requirement.

2.4 SOURCE QUALITY CONTROL

A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanliness and grading on samples secured from aggregates at point of batching.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Specification Section 01 40 00.
   2. See Specification Section 03 05 05.

B. Perform concrete tests per Specification Section 03 05 05.
   1. Perform a strength test on all concrete to which water or superplasticizer, above the amount stated in the approved concrete mix design, has been added.
      a. Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

**END OF SECTION**
SECTION 03 31 31 - CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mixing, placing, jointing, and curing of concrete and grout construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 03 11 13 - Formwork.
   5. Section 03 21 00 - Reinforcement.
   6. Section 03 31 30 - Concrete, Materials and Proportioning.
   7. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   8. Section 07 92 00 - Joint Sealants.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
      c. 304.2R, Placing Concrete by Pumping Methods.
      d. 305.1, Specification for Hot Weather Concreting.
      f. 308.1, Specification for Curing Concrete.
      g. 309R, Guide for Consolidation of Concrete.
      h. 360R, Guide to Design of Slabs-on-Ground.
   2. ASTM International (ASTM):
      d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
   3. Corps of Engineers (COE):
      a. CRD-C572, Specifications for Polyvinylchloride Waterstop.
   4. National Ready Mixed Concrete Association (NRMCA):
      a. Checklist for Certification of Ready Mixed Concrete Production Facilities.
   5. NSF International (NSF).

B. Qualifications:
   1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.
2. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction, and at no additional cost.

1.3 DEFINITIONS

A. Words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
         1) Procedure for adding high-range water reducer at the jobsite.
      c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.
      d. Manufacturers and types:
         1) Joint fillers.
         2) Curing agents.
         3) Construction joint bonding adhesive.
   3. Certifications:

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Copies of concrete delivery tickets.
   3. Description of proposed curing methods.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Concrete Delivery:
   1. Prepare a delivery ticket for each load of ready mixed concrete.
   2. Truck operator shall hand ticket to Contractor at the time of delivery.
   3. Ticket to show:
      a. Mix identification.
      b. Quantity delivered.
      c. Amount of material in each batch.
      d. Outdoor temperature in the shade.
      e. Time at which cement was added.
      f. Time of delivery.
      g. Time of discharge.
      h. Amount of water that may be added at the site without exceeding the specified water-cement ratio.
      i. Amount of water added at the site.
1.6 PROJECT CONDITIONS

A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
   1. Do not use revised concrete mixes until submitted to and approved by Engineer.

1.7 SEQUENCING AND SCHEDULING

A. Do not begin concrete production until proposed concrete mix design has been approved by Engineer.
   1. Approval of concrete mix design does not relieve Contractor of his responsibility to provide concrete that meets the requirements of the Contract Documents.

PART 2 PRODUCTS

2.1 PRODUCTS

A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.

B. Neoprene Expansion Joint Fillers:
   1. Acceptable manufacturers:
      a. Permaglaze.
      b. Rubatex.
      c. Williams Products.
   2. Materials:
      a. Closed cell neoprene.
      b. ASTM D1056, Type 2, Class A or C.
      c. Grade: Compression deflection as required to limit deflection to 25 percent of joint thickness under pressure from concrete pour height.

C. Asphalt Expansion Joint Fillers:
   1. Acceptable manufacturers:
      a. W.R Meadows.

D. Fiber Expansion Joint Fillers:

E. Waterstops, Preformed Strip Type:
   1. Acceptable manufacturers:
      a. Greenstreak Plastics, Inc. (Hydrotite).
      b. Adeka Ultra Seal USA (MC-2010MN).
      c. DeNeef (Swellseal Plus).
   3. Manufactured solely for the purpose of preventing water from traveling through construction joints.
   4. Volumetric expansion limited to 3 times maximum.
   5. See Drawings for application and other requirements.
F. Water Swelling Sealant:
1. Compatible with strip-type waterstop.
2. Single component, gun applied.
3. Moisture cured.
4. Minimum 70 percent volumetric expansion swelling capability.

G. Curing Products to conform to one or more of the following:
1. Absorbent Covers.
3. Dissipating curing compound:
   a. Pigmented, waterborne, membrane-forming.
   b. ASTM C309, Type 2, Class B, Dissipating shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately 4 to 6 weeks after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions so as to not impair the later addition of applied finishes.
   c. Acceptable Products:
      1) Dayton Superior Corporation; Day Chem Rez Cure (J-11-WD).
      2) Euclid Chemical Company (The); Kurez DR VOX.
      3) L&M Construction Chemicals, Inc.; L&M Cure R2.
4. Clear, water or solvent-borne, membrane-forming curing and sealing compound:
   a. ASTM C1315, Type 1, Class A.
   b. Moisture loss shall be not more than 0.40 Kg/m² when applied at 300 SQ FT/GAL.
   c. Manufacturer's certification is required.
   d. Subject to project requirements, provide one of the following products:
      1) Euclid Chemical Company (The); Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
      2) L&M Construction Chemicals, Inc.; Lumiseal Plus.
      4) Euclid Chemical Company (The); Super Diamond Clear VOX.
      5) L&M Construction Chemicals, Inc.; Lumiseal WB Plus.

H. Epoxy Bonding Agent:
1. Three component, water based, epoxy modified Portland cement bonding agent and anti-corrosion protection coating providing up to 24 HRS open time in which to apply repair mortar.
2. Product shall be capable of achieving bond strength of 2,700 psi per ASTM C882.
3. Products:
   a. Euclid Chemical Company (The), Duralprep AC.
   b. Sika Chemical Corporation; Armatec 110.


2.2 SOURCE QUALITY CONTROL

A. The concrete plant shall conform to the Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
PART 3 EXECUTION

3.1 PREPARATION

A. General:
   1. Complete formwork.
   2. Remove earth, snow, ice, water, and other foreign materials from areas that will receive concrete.
   3. Secure reinforcement in place.
      a. See Specification Section 03 21 00.
   4. Position expansion joint material, anchors and other embedded items.
   5. Obtain approval of reinforcement erection and placement prior to placing concrete.
   6. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and approval is obtained.
      a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
      b. Do not allow rainwater to increase mixing water nor to damage surface finish.
   7. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
   8. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
      a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs on Ground:
   1. Obtain approval of subgrade compaction density prior to placing slabs on ground.

C. Edge Forms and Screeds:
   1. Set accurately to produce designated elevations and contours of finished surface.
   2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
   3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

A. General:
   1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
   2. Batch, mix, and transport in accordance with ASTM C94/C94M.

B. Control of Admixtures:
   1. Control at the batch plant:
      a. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.
      b. Charge admixtures into mixer as solutions.
         1) Measure by means of an approved mechanical dispensing device.
         2) Liquid considered a part of mixing water.
         3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.

d. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

2. Control of Admixtures in the field:

a. Additional quantities of admixtures (with the exception of retarders) may be added in the field provided:
   1) Addition of admixtures shall be under the supervision of the ready mix quality control representative.
   2) Addition of each admixture to be documented on the delivery ticket.
   3) Provide additional mixing per ASTM C94.

C. Tempering and Control of Mixing Water:

1. Mix concrete only in quantities for immediate use.
2. Discard concrete which has set.
3. Discharge concrete from ready mix trucks within time limit and drum revolutions stated in ASTM C94/C94M.
4. Addition of water at the jobsite:
   a. See Specification Section 03 31 30 for specified water cement ratio and slump.
   b. Do not exceed maximum specified water cement ratio or slump.
   c. Incorporate water by additional mixing equal to at least half of total mixing required.

3.3 PLACING OF CONCRETE

A. General:
1. Place concrete as such a rate that concrete, which is being integrated with fresh concrete, is still workable.
   a. Select placement equipment and manpower in order to assure timely delivery of concrete into forms to avoid cold joints and placement issues.
2. Comply with ACI 304R and ACI 304.2R.
3. Do not begin placing concrete during rain, sleet, or snow.
   a. Protect fresh concrete from ensuing inclement weather.
4. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
5. Begin work only when work of other trades affecting concrete is complete.
6. Deposit concrete:
   a. Continuously to avoid cold joints.
7. Locate construction joints at locations approved by Engineer.
   a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
8. Spreaders:
   a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
   b. Embedded:
      1) Obtain approval of Engineer.
      2) Materials: Concrete or metal.
      3) Ends of metal spreaders coated with plastic coating 2 IN from each end.
9. Deposit concrete as nearly as practicable in its final position to avoid segregation.
   a. Maximum free fall: 4 FT.
b. Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface placed upon.

10. Perform the following operations before bleeding water has an opportunity to collect on surface:
   a. Spread.
   b. Consolidate.
   c. Straightedge.
   d. Darby or bull float.

11. No water shall be added to the concrete surface to ease finishing operation.

B. Cold Weather Concrete Placement:
   2. Do not place concrete on subgrade that are below 32 DegF or contain frozen material.
   3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
   4. Temperature of concrete when discharged at site: Per ACI 306.1.
   5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 DegF, when temperature of surrounding air is 40 DegF or below at time concrete is placed.
      a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
   6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DegF.
   7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DegF.
   8. Follow ACI 360R-10 for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.

C. Hot Weather Concrete Placement:
   1. Comply with ACI 305.1.
   2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
   3. Temperature of concrete at point of delivery (i.e. truck discharge) when placed:
      a. Not to exceed 90 DegF.
      b. Not so high as to cause:
         1) Shrinkage cracks.
         2) Difficulty in placement due to loss of slump.
         3) Flash set.
   4. Temperature of forms and reinforcing when placing concrete:
      a. Not to exceed 90 DegF.
      b. May be reduced by spraying with water to cool below 90 DegF.
         1) Leave no standing water to contact concrete being placed.
   5. Prevent plastic shrinkage cracking and/or slab curling due to evaporation.

D. Consolidating:
   1. Consolidate in accordance with ACI 309R except as modified herein.
   2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
      a. Eliminate:
         1) Air or stone pockets.
         2) Honeycombing or pitting.
3) Planes of weakness.

3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
   a. Size and coordinate external vibrators to specifically match forming system used.

4. Internal vibrators:
   a. Minimum frequency of 8000 vibrations per minute.
   b. Insert and withdraw at points approximately 18 IN apart.
      1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
   c. Use in:
      1) Beams and girders of framed slabs.
      2) Columns and walls.
      3) Vibrating concrete around all waterstops.
   d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.

5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.

6. Do not use vibrators to transport concrete within forms.

7. Provide spare vibrators on jobsite during all concrete placing operations.

8. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.

9. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.

1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94/C94M.

2. Horizontal belt conveyors:
   a. Mount at a slope which will not cause segregation or loss of ingredients.
   b. Protect concrete against undue drying or rise in temperature.
   c. Use an arrangement at discharge end to prevent segregation.
   d. Do not allow mortar to adhere to return length of belt.
   e. Discharge conveyor runs into equipment specially designed for spreading concrete.

3. Metal or metal lined chutes:
   a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
   b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
   c. Provide end of each chute with a device to prevent segregation.

4. Pumping or pneumatic conveying equipment:
   a. Designed for concrete application and having adequate pumping capacity.
   b. Control pneumatic placement so segregation is avoided in discharged concrete.
   c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
   d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
   e. Provide pumping equipment without Y sections.

3.4 JOINTS AND EMBEDDED ITEMS
A. Construction Joints – Not Applicable.

B. Waterstops - General:
   1. Waterstop to be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
   2. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer unless shown on Drawings.
   3. Preformed strip type:
      a. Locate waterstop at center of wall, unless noted otherwise on Drawings.
         1) Maintain at least 3 IN from edge of concrete.
      b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
      c. Roughened joints shall be especially prepared during concrete placement to provide smooth surface for proper water stop installation.
      d. Use in joints against existing concrete where indicated on Drawings.

C. Other Embedded Items:
   1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
      a. Give Contractor whose work is related or integral to concrete, or supported by it, ample notice and opportunity to furnish and install items before placing concrete.
   2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.

D. Placing Embedded Items:
   1. Support against displacement.
   2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
   3. Provide adequate means for anchoring waterstop in concrete.
      a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

3.5 FINISHING

A. See Specification Section 03 35 00.

B. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT

A. Grout Schedule of Use:
   1. Non-shrinking non-metallic grout:
      a. Filling form tie holes.
      b. Under column and beam base plates.
      c. Other uses indicated on the Drawings.
   2. Epoxy grout:
      a. Patching cavities in concrete.
      b. Grouting of dowels and anchor bolts into existing concrete.
      c. Grouting of equipment base plates where driving motor is 500 HP and above.
      d. Other uses indicated on the Drawings.
B. Grout Installation:
   1. Non-shrink non-metallic grout:
      a. Clean concrete surface to receive grout.
      b. Saturate concrete with water for 24 HRS prior to grouting.
      c. Mix in a mechanical mixer.
      d. Use no more water than necessary to produce flowable grout.
      e. Place in accordance with manufacturer's instructions.
      f. Provide under equipment base plates and in other locations indicated on the Drawings.
      g. Completely fill all spaces and cavities below the top of base plates.
      h. Provide forms where base plates and bed plates do not confine grout.
      i. Where exposed to view, finish grout edges smooth.
      j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
      k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
   2. Epoxy grout:
      a. Mix and place in accordance with manufacturer's instructions.
      b. Apply only to clean, dry, sound surface.
      c. Completely fill all cavities and spaces around dowels and anchors without voids.
      d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
      e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
   1. Follow recommendations of ACI 308.1 except as modified herein.
   2. All traffic shall be kept from the surface as necessary to protect the concrete but not less than the first 48 HRS of curing.

B. Apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).
   1. Ponding or continuous sprinkling. Take care to avoid eroding the surface of freshly placed concrete.
   2. Application of wet Absorbent Covers:
      a. Minimum lap: 12 IN.
      b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as required to keep concrete surface continuously wet.
      c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
   3. Application of sand kept continuously wet.
   4. Continuous application of steam (not exceeding 150 DegF) or mist spray.
   5. Application of Moisture Retaining Cover sheet materials.
      a. Place as soon as possible after final finishing and without marring the surface.
      b. Minimum lap: 12 IN.
      c. Seal all edges to make water-tight.
d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
e. Hold cover and edges in place as required to prevent wind from displacing the cover.
f. Moisture Retaining Fabric:
   1) Install in accordance with manufacturer’s written recommendations.
   2) Saturate concrete surface and fabric side of cover immediately prior to placing.
g. Monitor continuously during the curing period:
   1) Repair any holes, tears or displaced cover.
   2) Rewet as required to keep concrete moist under cover.

6. Application of other moisture retaining covering as approved by Engineer.
7. Water used for curing shall be within 20 DegF of the concrete temperature.
8. Application of a curing compound.
   a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
   b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
   c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two (2) coats of the curing compound.
      1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
      2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
      3) Allow the preceding coat to completely dry prior to applying the next coat.
      4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.

9. Surfaces In Contact with Forms:
   a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
      1) See Section 03 11 13.
   b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
   c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
   d. After form removal, cure concrete until end of time prescribed.
   e. Use one of the methods listed above.
   f. Forms left in place shall not be used as a method of curing in hot weather.
   g. The term "hot weather", where used in these specifications, is defined in ACI 305.1.
   h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.

C. Curing Period:
1. Continue curing for at least seven (7) days for all concrete except Type III, high early strength concrete for which period shall be at least three (3) days.
   a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is (7) days old, provided concrete is not permitted to become surface dry during transition.

D. Cold Weather:
1. Follow recommendations of ACI 306.1.
2. Maintain temperature of concrete per ACI 306.1 for a minimum of 72 HRs after concrete is placed, when outdoor temperature is 40 DegF, or less.
3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

E. Hot Weather:
   1. Follow recommendations of ACI 305.1 and ACI 308.1.
   2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
   3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
   4. Maximum temperature rate of decrease: Per ACI 305.1.

F. Rate of Temperature Change:
   1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.

G. Protection from Mechanical Injury:
   1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
   2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
   3. Do not load self supporting structures in such a way as to overstress concrete.

3.8 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Section 01 40 00.
   2. See Section 03 05 05.

END OF SECTION
SECTION 03 35 00 - CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Concrete finishing and repair of surface defects.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 11 13 - Formwork.
   4. Section 03 31 30 - Concrete, Materials and Proportioning.
   5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
   2. ASTM International (ASTM):
      d. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      e. D4259, Standard Practice for Abrading Concrete.
   3. The Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 13/NACE No. 6, Surface Preparation of Concrete.

1.3 DEFINITIONS

A. Vertical Surface Defects:
   1. Any void in the face of the concrete deeper than 1/8 IN, such as:
      a. Tie holes.
      b. Air pockets (bug holes).
      c. Honeycombs.
      d. Rock holes.
   2. Scabbing:
      a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
   3. Foreign material embedded in face of concrete.
   4. Fins 1/16 IN or more in height.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

C. Other words and terms used in this Specification Section are defined in ACI CT-13.
1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Certifications:
      a. Certification of aggregate gradation.
      b. Certification that products being used will not interfere with bonding of future floor or wall finishes.

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

1.6 WARRANTY

A. Provide warranty equal to specified manufacturer's standard warranty for all products used.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Bonding agents:
      a. Euclid Chemical Co.
      b. BASF Admixtures, Inc.
      c. L&M Construction Chemicals, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

A. Bonding Agent:
   1. For use only on concrete surfaces not receiving liquid water repellent coating:
      a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
      b. Euclid Chemical Co. "Flex-Con."
      c. BASF Admixtures, Inc. "Acryl-Set."
      d. L&M Construction Chemicals, Inc. "Everbond."
      e. Thoro System Products "Acryl 60."
   2. For use only on concrete surface receiving liquid water repellent:
a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.

B. Cement:
   1. ASTM C150, Type II Portland for areas exposed to sewage.
   2. ASTM C150, Type I Portland elsewhere.

C. Aggregate:
   1. Sand: Maximum size #30 mesh sieve.
   2. For exposed aggregate finish surfaces: Same as surrounding wall.

D. Water: Potable.

E. Non-shrink Grout: See Specification Section 03 31 30 and Specification Section 03 31 31.

2.3 MIXES

A. Bonding Grout:
   1. Dry ingredients: One (1) part cement to one (1) part aggregate.
   2. Wet ingredients: Bonding agent and water in accordance with manufacturer's recommendations.

B. Patching Mortar:
   1. Dry ingredients: One (1) part cement to two and one-half (2-1/2) parts aggregate by damp loose volume.
      a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.
   2. Wet ingredients: Bonding agent and water in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 PREPARATION

A. For methods of curing, see Specification Section 03 31 31.

B. Preparation of Bonding Grout Mixture:
   1. Mix cement and aggregate.
   2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
   3. Add bonding agent/water mixture to cement/aggregate mixture.
   4. Mix to consistency of thick cream.
   5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.

C. Preparation of Patching Mortar Mixture:
   1. Mix cement and aggregate.
   2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
   3. Add only enough bonding agent/water mixture to cement/aggregate mixture to allow handling and placing.
4. Let stand with frequent manipulation with a trowel, until mix has reached stiffest consistency to allow placement.

D. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
1. Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
   a. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
   b. No featheredges will be permitted.
2. Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.

E. Repairing Surface Defects:
1. This method of repairing surface defects is to be used only on vertical concrete surfaces, in tanks containing water, surfaces to receive liquid water repellent and exterior surfaces.
2. Fill and repair using patching mortar mix specified in the MIXES Article in PART 2 of this Specification Section.
   a. Use non-shrink grout to fill tieholes as outlined in this Specification Section.
3. If required by bonding agent manufacturer, etch surfaces with a muriatic acid solution followed by a thorough rinse with clean water.
   a. Test concrete to determine pH level and continue flushing with clean water until surface pH is within acceptable limits.
4. Dampen area to be patched and an area at least 6 IN wide surrounding it prior to application of bonding grout.
5. Brush bonding grout into the surface after the surface water has evaporated.
6. Allow bonding grout to set for period of time required by bonding agent manufacturer before applying premixed patching mortar.
7. Fill tie holes with non-shrink, nonmetallic grout.
   a. Where exposed to view and scheduled to receive concrete Finish #2 or #5, hold grout below surface of concrete and fill with patching mortar to match surrounding concrete.
8. Fill all other defects with patching mortar.
   a. Match color of surrounding wall.
   b. Do not use acrylic bonding agent in patching mortar for filling defects in surfaces to be treated with liquid water repellent.
9. Consolidate grout or mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
10. Leave undisturbed for at least 60 minutes before finishing level with surrounding surface.
    a. Do not use metal tools in finishing a patch in a formed wall which will be exposed or coated with other materials.
11. Keep areas damp in accordance with grout manufacturer or bonding agent manufacturer's directions.

3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DegF.
1. If necessary, enclose and heat area to between 50 and 70 DegF during repair of surface defects and curing of patching material.
   a. Use only clean fuel, indirect fired heating apparatus.
B. Concrete Finishes for Horizontal Slab Surfaces:

1. General:
   a. Tamp concrete to force coarse aggregate down from surface.
   b. Screed with straightedge, eliminate high and low places, bring surface to required
      finish elevations; slope uniformly to drains.
   c. Dusting of surface with dry cement or sand during finishing processes not permitted.

2. Unspecified slab finish:
   a. When type of finish is not indicated, use following finishes as applicable:
      1) Surfaces intended to receive bonded applied cementitious applications: Scratched
         finish.
      2) Surfaces intended to receive roofing, or waterproofing membranes: Floated
         finish.
      3) Floors: Troweled finish.
      4) Garage floors and ramps: Broom or belt finish.
      5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered
         by other finish materials: Broom or belt finish.
      6) All slabs to receive a floated finish before final finishing.

3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and
   leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.

4. Floated finish:
   a. After concrete has been placed, consolidated, struck off, and leveled, do no further
      work until ready for floating.
   b. Begin floating when water sheen has disappeared and surface has stiffened
      sufficiently to permit operations.
      1) Use wood or cork float.
   c. During or after first floating, check planeness of entire surface with a 10 FT
      straightedge applied at not less than two (2) different angles.
   d. Cut down all high spots and fill all low spots to produce a surface with Class B
      tolerance throughout.
   e. Refloat slab immediately to a uniform texture.

5. Troweled finish:
   a. Float finish surface to true, even plane.
   b. Power trowel, and finally hand trowel.
   c. First troweling after power troweling shall produce a smooth surface which is
      relatively free of defects, but which may still show some trowel marks.
   d. Perform additional trowelings by hand after surface has hardened sufficiently.
   e. Final trowel when a ringing sound is produced as trowel is moved over surface.
   f. Thoroughly consolidate surface by hand troweling.
   g. Leave finished surface essentially free of trowel marks, uniform in texture and
      appearance and plane to a Class A tolerance.
   h. On surfaces intended to support floor coverings, remove any defects that would show
      through floor covering by grinding.

6. Broom or belt finish: Immediately after concrete has received a float finish as specified,
   give it a transverse scored texture by drawing a broom or burlap belt across surface.

7. Underside of concrete slab finish:
   a. Match finish as specified for adjacent vertical surfaces.
   b. If more than one (1) finish occurs immediately adjacent to underside of slab surface,
      provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL
A. Horizontal slab finishes will be accepted provided:
   1. Applicable specification requirements are satisfied.
   2. Water does not pond in areas sloped to drain.
   3. Gap between a 10 FT straightedge placed anywhere and the finished surface does not exceed:
      a. Class A tolerance: 1/8 IN.
      b. Class B tolerance: 1/4 IN.
      c. Class C tolerance: 1/2 IN.
   4. Accumulated deviation from intended true plane of finished surface does not exceed 1/2 IN.
   5. Accuracy of floor finish does not adversely affect installation and operation of movable equipment, floor supported items, or items fitted to floor (doors, tracks, etc.).

B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.
   1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

END OF SECTION
DIVISION 07

THERMAL AND MOISTURE PROTECTION
SECTION 07 92 00 - JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sealing all joints that will permit penetration of dust, air or moisture.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 302.1R, Guide for Concrete Floor and Slab Construction.
   2. ASTM International (ASTM):
   3. Underwriters Laboratories, Inc. (UL).

B. Qualifications: Sealant applicator shall have minimum five (5) years experience using products specified on projects with similar scope.

C. Mock-Ups:
   1. Before sealant work is started, a mock-up of each type of joint shall be sealed where directed by the Engineer.
      a. The approved mock-ups shall show the workmanship, bond, and color of sealant materials as specified or selected for the work and shall be the minimum standard of quality on the entire project.
      b. Each sample shall cure for a minimum of seven (7) days at which time the sealant manufacturer's authorized factory representative shall perform adhesion tests on each sample joint.
         1) Perform adhesion tests per ASTM C1521.
         2) If mock-up is not acceptable or if adhesion test fails, provide additional mock-up and adhesion testing as required until acceptable to Engineer.

1.3 DEFINITIONS

A. Corrosive Areas Include:
   1. For purposes of this Specification Section, corrosive environments include:
      a. The entire project site is a corrosive environment, except:
         1) Environments defined as Highly Corrosive.
         2) Rooms scheduled to receive Architectural Paint (AP).

B. Defect(ive): Failure of watertightness or airtightness.
C. Finish sealant: Sealant material per this specification applied over face of compressible sealant or expanding foam sealant specified, to provide a finished, colored sealant joint.

D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

E. "Interior wet areas":
   1. Toilets, showers and locker rooms.
   2. Laboratory and Receiving.
   4. Process areas.
   5. Equipment rooms, pump rooms and similar areas.
   6. Chemical storage and feed rooms.
   7. Truck loading.
   8. Wet wells and similar areas.

F. "Seal," "sealing" and "sealant": Joint sealant work.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling and bond breaker.
   3. Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied.
   4. Certification of applicator qualification.

B. Test Results:
   1. Provide adhesion test results for each sealant sample including adhesion results compared to adhesion requirements.
   2. Manufacturer's authorized factory representative recommended remedial measures for all failing tests.

C. Samples:
   1. Cured sample of each color for Engineer's color selection.
   2. Color chart not acceptable.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver material in manufacturer's original unopened containers with labels intact. Labels shall indicate contents and expiration date on material.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Compressible sealant:
      b. Emseal.
      c. Norton.
      d. Sandell.
   2. Expanding foam sealant:
      a. Macklanburg Duncan.
      b. Convenience Products.
      c. FAI International, Inc.
   3. Polyether sealants:
      a. BASF.
      b. ChemLink, Inc.
      c. Tremco.
   4. Polysulfide rubber sealant:
      a. Pecora.
      b. BASF.
      c. PolySpec.
   5. Polyurea joint filler:
      a. Dayton Superior Specialty Chemical Corporation.
      b. Euclid Chemical Co.
      c. L&M Construction Chemicals, Inc.
      d. BASF.
   6. Polyurethane sealants:
      a. Pecora.
      b. Sika Chemical Corp.
      c. BASF.
      d. Tremco.
   7. Silicone sealants:
      a. ChemLink.
      b. GE Construction Sealants.
      c. Dow Corning.
      d. Tremco.
   8. Backer rod, compressible filler, primer, joint cleaners, bond breaker: As recommended by sealant manufacturer.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

A. Sealants - General:
   1. Provide colors matching materials being sealed.
2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
3. Non-sagging sealant for vertical and overhead horizontal joints.
4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
6. Sealant backer rod and/or compressible filler:
   a. Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
      1) Control joint depth.
      2) Break bond of sealant at bottom of joint.
      3) Provide proper shape of sealant bead.
      4) Serve as expansion joint filler.

B. Compressible Sealant:
   1. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing coated on front face with nonreactive release agent that will act as bond breaker for applied sealant.
      a. Polytite Manufacturing Corp. "Polytite-B."
   2. Fire rated where required.
   3. Adhesive: As recommended by sealant manufacturer.

C. Expanding Foam Sealant:
   1. One (1) or two (2) component fire rated moisture cured expanding urethane.
   2. Shall not contain formaldehyde.
   3. Density: Minimum 1.5 pcf.
   4. Closed cell content: Minimum 70 percent.
   5. R-value: Minimum 5.0/IN.
   7. Smoke developed: Less than 25.

D. Polyether Sealant:
   1. Silyl-terminated polyether polymer.
   2. ASTM C920, Type S, Grade NS, Class 50, Use NT, M, A, and O.
      a. BASF MasterSeal 150.
      b. ChemLink DuraLink.
      c. Tremco Dymonic FC

E. Polysulfide Rubber Sealant:
   1. One (1) or two (2) component.
      a. Pecora Synthacalk GC2+.
      b. PolySpec THIOKOL 2235.

F. Polyurea Joint Filler:
   1. Two (2) component, semi-rigid material for filling formed or saw-cut control joints in interior concrete slabs.
      a. Dayton Superior Specialty Chemical Corp. "Joint Fill, Joint Seal, Joint Saver II" as required for condition and recommended by manufacturer.
      b. Euclid Chemical Co. "EUCO QWIK" joint.
      c. L&M Construction Chemicals, Inc. "Joint Tite 750".
      d. BASF MasterSeal “CR100” control joint filler.
2. Comply with ACI 302.1R performance recommendations regarding control and construction joints.

G. Polyurethane Sealant:
   1. One (1) or two (2) components.
   2. Paintable.
   3. Meet ASTM C920 Type S or Type M, Grade NS or P, Class 25, Use NT, T, M, A and O.
      b. Sika Chemical Corporation Sikaflex-1a, Sikaflex-2C NS/SL.
      c. BASF MasterSeal NP-1, NP-II, SL-1 SL-2.
      d. Tremco Dymonic or Dymeric, Vulkem 116,227,45,245.

H. Silicone Sealant:
   1. One (1) component.
   2. Meet ASTM C920, Type S, Grade NS, Class 25, Use NT, G, A, O.
      a. ChemLink: DuraSil.
      b. General Electric: Silpruf, Silglaze II.
      c. General Electric: Sanitary 1700 sealant for sealing around plumbing fixtures.
      d. Dow Corning: 786 for sealing around plumbing fixtures.
      f. Tremco: Spectrem 1, Spectrem 3, Tremsil 600.
   3. Mildew resistant for sealing around plumbing fixtures.

PART 3 EXECUTION

3.1 PREPARATION

   A. Before use of any sealant, investigate its compatibility with joint surfaces, fillers and other materials in joint system.

   B. Use only compatible materials.

   C. Where required by manufacturer, prime joint surfaces.
      1. Limit application to surfaces to receive sealant.
      2. Mask off adjacent surfaces.

   D. Provide joint depth for joints receiving polyurea joint filler in accordance with manufacturer's recommendations.

3.2 INSTALLATION

   A. Install products in accordance with manufacturer's instructions and UL requirements.

   B. Clean all joints.

   C. Make all joints water and airtight.

   D. At changes in direction of joints, joint intersections and where sealant joints interface with other construction, install continuous sealant as necessary to ensure a weather-tight seal.
E. Make depth of sealing compounds, except expanding foam and polyurea sealant, not more than one-half width of joint, but in no case less than 1/4 IN nor more than 1/2 IN unless recommended otherwise by the manufacturer.

F. Provide correctly sized backer rod, compressible filler or compressible sealant in all joints to depth recommended by manufacturer:
   1. Take care to not puncture backer rod and compressible filler.
   2. Provide joint backer rod as recommended by the manufacturer for polyurea joint filler.

G. Apply bond breaker where required.

H. Tool sealants using sufficient pressure to fill all voids.

I. Upon completion, leave sealant with smooth, even, neat finish.

J. Where piping, conduit, ductwork, etc., penetrate wall, seal each side of wall opening.

K. Install compressible sealant to position at indicated depth.
   1. Size so that width of material is twice joint width.
   2. Take care to avoid contamination of sides of joint.
   3. Protect side walls of joint (to depth of finish sealant).
   4. Install with adhesive faces in contact with joint sides.
   5. Install finish sealant where indicated.

L. Install expanding foam sealant to minimum 4 IN depth or thickness of wall being penetrated if less than 4 IN or as indicated on Drawings.
   1. Provide adequate fire rated backing material as required.
   2. Hold material back from exposed face of wall as necessary to allow for installation of backer rod and finish sealant.
      a. Allow expanding foam sealant to completely cure prior to installing backer rod and finish sealant.
   3. Trim off excess material flush with surface of the wall if not providing finished sealant.
   4. Prior to using expanding foam sealant in openings occurring in the veneer wythe of cavity wall construction, install backer rod to a depth that will provide sufficient foam sealant depth, per the manufacturer, and will also prevent the foam from expanding into and filling the cavity.

3.3 SEALANT WORK

A. General:
   1. Work includes but is not limited to: Sealing all joints which will permit penetration of dust, air, or moisture.
   2. Refer to SCHEDULE for materials to be used.

B. Concrete joints:
   1. Flooring joints.
   2. Isolation joints.
   3. Joints between paving or sidewalks and building.
   4. Construction, control and expansion joints.
   5. Joints between precast roof units and between precast roof units and walls.
C. Plumbing fixtures.
D. Penetrations of walls, floors and decks.
E. Other joints where sealant, expanding foam sealant or compressible sealant is indicated.

3.4 FIELD QUALITY CONTROL

A. Adhesion Testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: One (1) test per every 1000 LF of joint sealed.
      b. Building expansion joints: One (1) test per every 500 LF of joint sealed.
      c. All other type of joints except butt glazing joints: One (1) test per every 3000 LF of joint sealed.
      d. Manufacturer's authorized factory representative shall recommend, in writing, remedial measures for all failing tests.

3.5 SCHEDULE

A. Furnish sealant as indicated for the following areas:
   1. Exterior areas:
      a. Above grade: Polyether.
      b. Below grade: Polyurethane.
   2. Interior areas:
      a. Noncorrosive areas:
         1) Wet exposure: Polyether.
            a) Toilet rooms, locker rooms, janitor closets or similar areas: Mildew resistant silicone.
         2) Dry exposure: Polyether, unless noted otherwise.
      b. Corrosive areas:
         1) Wet exposure: Polysulfide.
         2) Dry exposure: Polyurethane.
      c. Fire-rated construction: Not Applicable.
   3. Immersion:
      a. Prolonged contact with or immersion in:
         1) Nonpotable water, wastewater or sewage: Polysulfide.
   5. Exterior wall penetrations: Expanding urethane foam, with finish sealant.
      a. Finish sealant:
         1) Exterior side:
            a) Above grade: Polyether.
            b) Below grade: Polyurethane.
         2) Interior side:
            a) Noncorrosive area:
               (1) Wet exposure: Polyether.
               (2) Dry exposure: Polyether, unless noted otherwise.
b) Corrosive area:
   (1) Wet exposure: Polysulfide.
   (2) Dry exposure: Polyurethane.

END OF SECTION
SECTION 08 31 00 - ACCESS DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Floor access doors.
   2. Odor resistant vault access doors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 10 14 00 - Signage.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      e. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      f. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   2. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

1.3 DEFINITIONS

A. Airtight: Air leakage rate of less than 0.01 cfm/LF of door perimeter while under a pressure differential, across the cover, of 9 IN wc.

B. Heavy Duty: Will support live load of 300 psf.

C. Odor Resistant: Air infiltration rate of less than 1.0 cfm/LF of cover perimeter while under a pressure differential, across the cover, of 1 IN wc.

1.4 SUBMITTALS
A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Floor access doors:
      a. Bilco Company.
      b. Babcock Davis Associates.
      c. Dur-Red Products.
      d. Halliday Products.
      e. USF Fabrication Inc.
   2. Odor resistant vault access doors:
      a. Bilco Company.
      b. Nystrom.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

A. Aluminum:
   2. Extruded shapes:  ASTM B221.

B. Steel:

C. Stainless Steel:  ASTM A240 or A666.
   1. Type 316 unless indicated otherwise.

D. Fiberglass Reinforced Plastic (FRP):
   1. Resin:  Vinyl ester.

2.3 MANUFACTURED UNITS

A. General:
1. All access doors shall be provided by the same manufacturer when possible.
2. Coat all aluminum components in contact with concrete or masonry with manufacturer's standard bituminous coating.

B. Heavy Duty Floor Access Doors:
   1. Frame: 1/4 IN mill finish aluminum channel with anchor tabs.
      a. 1-1/2 IN DIA drain coupling.
   2. Cover:
      a. 1/4 IN mill finished diamond plate aluminum.
      b. Reinforce cover with aluminum stiffeners.
         1) Live load: Wheel loading of 16,000 lbs.
         2) Deflection: Maximum 1/150 of span.
   3. Hardware:
      a. All hardware to be stainless steel.
      b. Positive hold open arm that engages automatically when door reaches full 90-degree open position.
      c. Slam lock and removable key handle.
   4. Bilco Company, Type "J-AL H20" or "JD-AL H20."
      a. Size(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.

C. Odor Resistant Vault Access Doors:
   1. Frame: 1/4 IN mill finish aluminum channel with continuous anchor flange.
   2. Cover: 1/4 IN mill finish diamond plate aluminum.
      a. Reinforce cover as required for loading specified.
         1) Live load: 300 psf.
         2) Deflection: Maximum 1/150 of span.
   3. EPDM gasket.
   4. Hardware:
      a. All hardware to be type 316 stainless steel.
      b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
      c. Slam lock and removable key handle.
   5. Bilco Company, Type "J-AL-R" or "JD-AL-R"
      a. Sizes(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.
      b. Provide secondary fall protection system.

2.4 ACCESSORIES

A. Secondary Fall Protection System:
   1. Design and install system such that when in the open position, no part of the system obstructs the clear opening size listed in the SCHEDULES Article in PART 3 of this Specification Section.
   3. Finish:
      a. Powder coated.
      b. Color: Safety Orange or Safety Yellow.
   4. Hardware:
      a. Stainless steel Type 316.
      b. Tamper proof Type 316 stainless steel bolts.
   5. Provide positive latch to hold grating in upright position.
6. Size: Size grating platform to allow 6 IN clear space on each unhinged side for visual observation.
7. Provide padlock hasp for Owner provided padlock.
8. Double leaf openings:
   a. Provide two (2) individual grating platforms hinged on the same side of the hatch frame but independent from one another.
      1) Provide each platform with a padlock hasp and positive latch to hold grating in upright position.
9. Install secondary fall protection system at the factory.

B. Load Rating Plates:
   1. Minimum 18 GA Type 316 stainless steel, ASTM A666.
   2. Engraved with maximum design live load allowed for unit on which it will be mounted.
   3. Display load in English units as well as metric units.
   4. Size as required for text as needed.
   5. Text:
      a. Font: Helvetica Narrow, all caps.
      b. Size: 1/4 IN height.
      c. Depth of engraving: 3 mils.
   6. Finish:
      a. Text:
         1) Black epoxy baked on paint.
         2) Plate to have finish conducive to paint application.
      b. Coat entire plate with baked on clear coat on front and back side.
7. Attach to top of all floor or vault access doors using stainless steel screws in location determined by manufacturer.
   a. Provide a neoprene gasket under the plate to separate the stainless steel from the aluminum cover or frame.

C. Signage:
   1. OSHA compliant signage per Specification Section 10 14 00, Type B2.
   2. Chemical, abrasion, and graffiti resistant FRP.
   3. Size: Minimum 14 IN wide by 10 IN high.
   4. Header and verbiage as indicated in SCHEDULES Article in PART 3 of this Specification Section.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
3.2 SCHEDULES

A. Vault Access Door Schedule:

<table>
<thead>
<tr>
<th>DOOR NO.</th>
<th>DRAWING NO.</th>
<th>LOCATION</th>
<th>CLEAR OPENING SIZE (a)</th>
<th>TYPE</th>
<th>REMARKS</th>
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<td>VAD-101</td>
<td>P.1, P.2, P.3</td>
<td>WET WELL</td>
<td>3'-0&quot; x 6'-0&quot;</td>
<td>JD-AL-R</td>
<td>b, c, e</td>
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<td>VAD-102</td>
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<td>J-AL H20</td>
<td>b, d, e</td>
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<td>VAD-103</td>
<td>P.1, P.2, P.3</td>
<td>METER VAULT</td>
<td>2'-6&quot; x 2'-6&quot;</td>
<td>J-AL H20</td>
<td>b, d, e</td>
</tr>
</tbody>
</table>

1. Notes:
   a. Clear Opening Size is the minimum clear dimensions, and shall not be encroached upon by hinges, springs, lift arms, fall protection, or any other obstruction.
   b. Provide secondary fall protection system.
   c. Connect piping to channel drain and route to wet well below.
   d. Connect piping to channel drain and route to sump in vault below.
   e. Provide OSHA signage per ACCESSORIES Article of this Specification Section.
      1) Header: “DANGER”
      2) Verbiage: "PERMIT-REQUIRED CONFINED SPACE DO NOT ENTER"
      3) Seton Style No. 60811 or equal.

END OF SECTION
DIVISION 09
FINISHES
SECTION 09 96 00 - HIGH PERFORMANCE INDUSTRIAL COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High performance industrial coatings (HPIC).
   2. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
   3. Minimum surface preparation requirements.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   4. Section 04 22 00 - Concrete Masonry.
   5. Section 05 50 00 - Metal Fabrications.
   6. Section 10 14 00 - Identification Devices.
   7. Division 22 - Plumbing.
   8. Division 26 - Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      b. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      c. D4259, Standard Practice for Abrading Concrete.
      d. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
      e. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      g. D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      k. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

   2. International Concrete Repair Institute (ICRI):
      a. 310.2, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

   3. National Association of Pipe Fabricators (NAPF):
a. 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings:
   1) 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
   2) 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings.
5. The Society for Protective Coatings (SSPC):
a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
   b. SP 1, Solvent Cleaning.
   c. SP 16, Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
6. The Society for Protective Coatings/NACE International (SSPC/NACE):
a. SP 5/NACE No. 1, White Metal Blast Cleaning.
   b. SP 6/NACE No. 3, Commercial Blast Cleaning.
   c. SP 7/NACE No. 4, Brush-off Blast Cleaning.
   d. SP 10/NACE No. 2, Near-White Blast Cleaning.
   e. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
1. Coating manufacturer's authorized representative shall provide written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
2. Applicators shall have minimum of 10 years experience in application of similar products on similar project.
   a. Provide references for minimum of three (3) different projects completed in last five (5) years with similar scope of work.
   b. Include name and address of project, size of project in value (painting) and contact person.

C. Miscellaneous:
1. Furnish coating through one (1) manufacturer unless noted otherwise.

D. Deviation from specified mil thickness or product type is not allowed without written authorization of Engineer.

E. Material shall not be thinned unless approved, in writing, by coating manufacturer's authorized representative.

1.3 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified or in a Basic Requirements or Common Requirements Specification Section.

C. Corrosive Environment:
1. Immersion in or subject to:
a. Condensation, spillage or splash of a corrosive material such as water, wastewater or chemical solution.
b. Exposure to corrosive caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions.
c. For purposes of this Specification Section, the entire facility is considered a corrosive environment, unless identified as highly corrosive below.

D. Highly Corrosive Environment:
   1. Immersion in or subject to:
      a. Condensation, spillage or splash of a highly corrosive material such as wastewater, or chemical solution.
      b. Exposure to highly corrosive caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions.
      c. For purposes of this Specification Section, highly corrosive environments include:
         1) Wet well.

E. Holiday:
   1. A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating.
   2. May also be identified as a discontinuity or pinhole.

F. Exposed Exterior Surface:
   1. Exterior surface which is exposed to view.
   2. Exterior surface which is exposed to weather but not necessarily exposed to view.

G. Finished Area: An area that is listed in or has finish called for on Room Finish Schedule or is indicated on Drawings to be coated.

H. Immersion Service:
   1. Any surface immersed in water or some other liquid.
   2. Surface of any pipe, valve, or any other component of the piping system subject to frequent wetting.
   3. Surfaces within 2 FT above high-water level in water bearing structures.

I. Surface Hidden from View:
   1. Within pipe chases.
   2. Between top side of ceilings and underside of floor or roof structures above.

J. HPIC: High performance industrial coatings.
   1. Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

K. Water level for purposes of coating: See Drawings.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Applicator experience qualifications.
a. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.

3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's application instructions.
   c. Manufacturer's surface preparation instructions.
   d. If products being used are manufactured by Company other than listed in the MATERIALS Article of this Specification Section, provide complete individual data sheet comparison of proposed products with specified products including application procedure, coverage rates and verification that product is designed for intended use.
   e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
   f. Coating manufacturer's recommendation on abrasive blasting.
   g. Manufacturer's recommendation for universal barrier coat.
   h. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.

4. Manufacturer's statement regarding applicator instruction on product use.

5. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by Senior Corrosion Specification Specialist employed by the coating manufacturer.

B. Samples:
   1. Manufacturer's full line of colors for Engineer's preliminary color selection.
   2. After preliminary color selection by Engineer provide two (2) 3 x 5 IN samples of each final color selected.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Approval of application equipment.
   3. Applicator's daily records:
      a. Submit daily records at end of each week in which coating work is performed unless requested otherwise by Engineer's on-site representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:
   1. Name or type number of material.
   2. Manufacturer's name and item stock number.
   3. Contents, by volume, of major constituents.
   4. Warning labels.
   5. VOC content.

B. Store materials in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 DegF.

1.6 PROJECT CONDITIONS

A. Verify that atmosphere in area where coating is to take place is within coating manufacturer's acceptable temperature, humidity and sun exposure limits.
1. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
   a. Provide temporary dehumidification equipment properly sized to maintain humidity levels required by coating manufacturer.
   b. Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 HR basis.
      1) Vent exhaust gases to exterior environment.
      2) No exhaust gases shall be allowed to vent into the space being coated or any adjacent space.

2. Do not apply coatings in snow, rain, fog or mist.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. High Performance Industrial Coatings:
      a. Carboline Protective Coatings.
      b. PPG Industries.
      c. Sherwin Williams.
      d. Tnemec.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

A. Coatings used for interior finishes shall meet the requirements of the Building Code and NFPA101.

B. General:
   1. High Performance Industrial Coatings: Products listed are manufactured by Tnemec.
   2. High Temperature Coatings: Products listed are manufactured by Dampney.
   3. Products of other manufacturers will be considered for use provided that the product:
      a. Is of the same generic resin.
      b. Requires comparable surface preparation.
      c. Has comparable application requirements.
      d. Meets the same VOC levels or better.
      e. Provides the same finish and color options.
      f. Will withstand the atmospheric or immersion conditions of the location where it is to be applied.
   4. Where manufacturer’s product data sheet indicates a minimum mil thickness per coat that is greater than specified herein, mil thickness for entire coating system shall be increased proportionately.

C. Coatings shall comply with the VOC limits of EPA.

D. For unspecified materials such as thinner, provide manufacturer's recommended products.

E. High Performance Industrial Coatings:
## GENERIC DESCRIPTION

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<th>PRODUCT</th>
<th>SERIES</th>
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<td>Modified Aromatic Polyurethane Primer</td>
<td>1 Omnithane</td>
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<tr>
<td>Polyamide Epoxy</td>
<td>66HS Hi-Build Epoxoline</td>
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<td>Zinc-Rich Urethane</td>
<td>94-H2O Hydro-Zinc</td>
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<td>Modified Polyamidoamine Epoxy</td>
<td>135 Chembuild</td>
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<td>Acrylic Emulsion</td>
<td>180 WB Tneme-crete</td>
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<td>Modified Flexible Polyamine Epoxy</td>
<td>206SC Chembloc</td>
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<td>Modified Polyamine Epoxy Surfacer/Filler</td>
<td>215 Surfacing Epoxy</td>
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<td>Epoxy Modified Cementitious Mortar</td>
<td>218 MortarClad</td>
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<tr>
<td>Modified Polyamine Epoxy (Secondary Containment)</td>
<td>237SC Chembloc</td>
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<tr>
<td>Novolac Vinyl Ester (Primer)</td>
<td>251SC Chembloc</td>
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<tr>
<td>Novolac Vinyl Ester (Secondary Containment)</td>
<td>252SC Chembloc</td>
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<td>Aliphatic Polyester Polyurethane</td>
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<tr>
<td>Modified Polyamine Epoxy</td>
<td>435 Perma-Glaze</td>
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<td>Hydrophobic Aromatic Polyurethane</td>
<td>446 Perma-Shield MCU</td>
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<tr>
<td>Polyfunctional Hybrid Urethane (Gloss)</td>
<td>740 UVX</td>
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### 2.3 COATING SYSTEMS

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<td>3.0 to 4.0 mil Series 66HS</td>
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PART 3 EXECUTION

3.1 ITEMS TO BE COATED

A. Exterior Surfaces, including but not limited to:
   1. Piping, valves, fittings, hydrants and supports:
      a. As scheduled in Division 22 and Division 40.
   2. Pumps and motors.
   3. Ferrous metal process equipment.
   4. Miscellaneous ferrous metal surfaces:
      a. Items specifically noted on Drawings to be painted.
   5. Miscellaneous galvanized steel surfaces:
      a. Pipe Bollards.
      b. Items specifically noted on Drawings to be painted.
   6. Appurtenant surfaces attached to or adjacent to a surface indicated to be painted:
      a. Conduit, boxes, covers and supports.

3.2 ITEMS NOT TO BE PAINTED

A. General: Do not paint items listed in this Article, unless noted otherwise.
B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.

C. Electrical Equipment.

D. Moving parts of mechanical and electrical units where painting would interfere with the operation of the unit.

E. Code labels, equipment identification or rating plates and similar labels, tagging and identification.

F. Contact surfaces of friction-type structural connections.

G. Stainless Steel Surfaces, except:
   1. Piping where specifically noted to be painted.
   2. Banding as required to identify piping.

H. Aluminum Surfaces, except:
   1. Where specifically shown in the Contract Documents.
   2. Where in contact with concrete.
   3. Where in contact with dissimilar metals.
   4. Appurtenant surfaces as described in the ITEMS TO BE PAINTED article.

I. Fiberglass Surfaces, except:
   1. Fiberglass piping where specifically noted to be painted.
   2. Piping supports where specifically noted to be painted.
   3. Appurtenant surfaces as described in the ITEMS TO BE PAINTED article.

J. Interior of Pipe and Conduits.
   1. See Division 40 for pipe linings.

K. Galvanized Steel Items, unless specifically noted to be painted.

3.3 EXAMINATION

A. Concrete:
   1. Test pH of surface to be painted in accordance with ASTM D4262.
      a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable range.
      b. Retest pH until acceptable results are obtained.
   2. Verify that moisture content of surface to be painted is within coating manufacturer's recommended acceptable limits.
      a. Test surface to be coated in accordance with ASTM D4263 to determine the presence of moisture.
         1) If moisture is detected, test moisture content of surface to be coated in accordance with ASTM F1869 or ASTM F2170.
         2) Provide remedial measures as necessary to bring moisture content within coating manufacturer’s recommended acceptable limits.
         3) Retest surface until acceptable results are obtained.
3.4 PREPARATION

A. General:
   1. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
      a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Engineer.
   2. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.
   3. Adhere to manufacturer's recoat time surface preparation requirements.
      a. Surfaces that have exceeded coating manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional coating in accordance with manufacturer's published recommendations.
         1) Minimum SSPC SP 7/NACE No. 4 unless otherwise approved by Engineer.

B. Protection:
   1. Protect surrounding surfaces not to be coated.
   2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
   3. Protect code labels, equipment identification or rating plates and similar labels, tagging and identification.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
   1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations and NAPF.
      a. All piping, pumps, valves, fittings and any other component used in the water piping system that requires preparation for painting shall be prepared in accordance with requirements for immersion service.
      b. Prepare all areas requiring patch painting in accordance with recommendations of manufacturer and NAPF.
      c. Remove bituminous coating per piping manufacturer, paint manufacturer and NAPF recommendations.
         1) The most stringent recommendations shall apply.
   2. Complete fabrication, welding or burning before beginning surface preparation.
      a. Chip or grind off flux, spatter, slag or other laminations left from welding.
      b. Remove mill scale.
      c. Grind smooth rough welds and other sharp projections.
   3. Solvent clean in accordance with SSPC SP 1.
   4. Restore surface of field welds and adjacent areas to original surface preparation.

E. Galvanized Steel and Non-ferrous Metals:
   1. Solvent clean in accordance with SSPC SP 1 followed by brush-off blast clean in accordance with SSPC SP 16 to remove zinc oxide and other foreign contaminants.
      a. Provide uniform 1 mil profile surface.

F. Concrete:
   1. Cure for minimum of 28 days.
   2. Concrete surfaces shall be cleaned in accordance with ASTM D4258.
3. Abrasive blast concrete surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6.
   a. Provide profile per ICRI 301.2 as listed in MATERIALS article of this Specification Section.
4. Test pH and moisture content in accordance with EXAMINATION article in this Specification Section.

G. Preparation by Abrasive Blasting:
1. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before painting.
2. Provide compressed air for blasting that is free of water and oil.
   a. Provide accessible separators and traps.
3. Protect nameplates, valve stems, rotating equipment, motors and other items that may be damaged from blasting.
4. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of paint coatings.
   a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.
5. Perform additional blasting and cleaning as required to achieve surface preparation required.
   a. Re-blast surfaces not meeting requirements of these Specifications.
   b. Prior to painting, re-blast surfaces allowed to set overnight and surfaces that show rust bloom.
   c. Surfaces allowed to set overnight or surfaces which show rust bloom prior to painting shall be re-inspected prior to paint application.
6. Profile depth of blasted surface: Not less than 1 mil or greater than 2 mils unless required otherwise by coating manufacturer.
7. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.
8. Confine blast abrasives to area being blasted.
   a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
   b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.
9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.
10. Properly dispose of blasting material contaminated with debris from blasting operation.

H. All Plastic Surfaces:
1. Sand using 80-100 grit sandpaper to scarify surfaces.

3.5 APPLICATION

A. General:
1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
   a. Application equipment must be inspected and approved in writing by coating manufacturer.
   b. Hollow metal shall be spray applied only.
2. Temperature and weather conditions:
   a. Do not paint surfaces when surface temperature is below 50 DegF unless product has
      been formulated specifically for low temperature application and application is
      approved in writing by Engineer and paint manufacturer's authorized representative.
   b. Avoid painting surfaces exposed to hot sun.
   c. Do not paint on damp surfaces.
3. Apply materials under adequate illumination.
4. Provide complete coverage to mil thickness specified.
   a. Thickness specified is dry mil thickness.
5. Evenly spread to provide full, smooth coverage.
   a. All paint systems are "to cover."
      1) In situations of discrepancy between manufacturer's square footage coverage
         rates and mil thickness, mil thickness requirements govern.
   b. When color or undercoats show through, apply additional coats until paint film is of
      uniform finish and color.
   c. Finished paint system shall be uniform and without voids, bugholes, holidays, laps,
      brush marks, roller marks, runs, sags or other imperfections.
6. If so directed by Engineer, do not apply consecutive coats until Engineer has had an
   opportunity to observe and approve previous coats.
7. Work each application of material into corners, crevices, joints, and other difficult to
   work areas.
8. Avoid degradation and contamination of blasted surfaces and avoid inter-coat
   contamination.
   a. Clean contaminated surfaces before applying next coat.
9. Smooth out runs or sags immediately or remove and recoat entire surface.
10. Allow preceding coats to dry before recoating.
    a. Recoat within time limits specified by coating manufacturer.
    b. If recoat time limits have expired re-prepare surface in accordance with coating
       manufacturer's printed recommendations.
11. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
12. Coat all aluminum in contact with dissimilar materials.
13. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating
    to work into all recesses.
14. Backroll surfaces if paint coatings are spray applied.

B. Employ services of coating manufacturer's qualified technical representative to ensure that
   field-applied coatings are compatible with factory-applied or existing coatings.
1. Certify through material data sheets.
2. Perform test patch.
   a. Prepare existing coating surface to receive specified coating system.
   b. Apply coating to a minimum 1 SF area and allow to cure in accordance with
      manufacturer's recommendations.
   c. Evaluate adhesion to existing coating:
      1) Concrete or Masonry substrates: ASTM D4541.
      2) All other substrates: ASTM D6677 and ASTM D3359 (X-cut method).
3. If field-applied coating is found to be not compatible, require the coating manufacturer's
   technical representative to recommend, in writing, product to be used as barrier coat,
   thickness to be applied, surface preparation and method of application.
   a. Perform test patch as described above.
4. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system listed in the MATERIALS Article, Paint Systems paragraph of this Specification Section.
   a. All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Owner.

C. Prime Coat Application:
   1. Apply structural steel and miscellaneous steel prime coat in the factory.
      a. Finish coats shall be applied in the field.
      b. Prime coat referred to here is prime coat as indicated in this Specification.
         1) Prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.
   2. Prime all surfaces indicated to be painted.
      a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.
   3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.
   4. Apply zinc-rich primers while under continuous agitation.
   5. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
   6. Touch up damaged primer coats prior to applying finish coats.
      a. Restore primed surface equal to surface before damage.

D. Finish Coat Application:
   1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
   2. Touch up damaged finish coats using same application method and same material specified for finish coat.
      a. Prepare damaged area in accordance with the PREPARATION Article of this Specification Section.

3.6 COLOR CODING

   A. Color code piping in accordance with the SCHEDULE Article of this Specification Section.

3.7 FIELD QUALITY CONTROL

   A. Application Deficiencies:
      1. Surfaces showing runs, laps, brush marks, telegraphing of surface imperfections or other defects will not be accepted.
      2. Surfaces showing evidence of fading, chalking, blistering, delamination or other defects due to improper surface preparation, environmental controls or application will not be accepted.
         a. Epoxy surfaces showing evidence of chalking or amine blush shall be prepared and recoated as follows:
            1) Solvent clean surfaces in accordance with SSPC SP1 and abrasive blast in accordance with SSPC SP7/NACE No. 4.
            2) Recoat with intermediate and finish coats in accordance with coating system specified herein.
B. Provide Protection for Painted Surfaces:
   1. Surfaces showing soiling, staining, streaking, chipping, scratches, or other defects will not be accepted.

C. Contractor Performed Testing:
   1. The Contractor shall provide ongoing testing and inspection, including but not limited to the following:
      a. Measurement and recording of environmental conditions as specified herein.
      b. Measurement and recording of substrate conditions as specified herein.
      c. Thickness Testing:
         1) Wet film thickness during application in accordance with ASTM D4414.
         2) Dry Film Thickness (DFT) in accordance with SSPC PA 2 and ASTM D7091.

D. Instrumentation:
   1. Provide instrumentation as necessary to measure and record atmospheric and substrate conditions, including but not limited to:
      a. Dry Film Thickness Gauge.
      b. Wet Film Thickness Gauge.
      c. Sling Psychrometer.
      d. Surface Temperature Gauge.
      e. Anemometer.
      f. Moisture Meter.

E. Maintain Daily Records:
   1. Record the following information during application:
      a. Date, starting time, end time, and all breaks taken by painters.
      b. Air temperature.
      c. Relative humidity.
      d. Dew point.
      e. Moisture content and pH level of concrete or masonry substrates prior to coating.
      f. Surface temperature of substrate.
      g. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.
      h. For exterior painting:
         1) Sky condition.
         2) Wind speed and direction.
      i. Record environmental conditions, substrate moisture content and surface temperature information not less than once every 4 HRS during application.
         1) Record hourly when temperatures are below 50 DegF or above 100 DegF.
   2. Record the following information daily for the paint manufacturer's recommended curing period:
      a. Date and start time of cure period for each item or area.
      b. For exterior painting:
         1) Sky conditions.
         2) Wind speed and direction.
         3) Air temperature.
            a) Dry Bulb.
            b) Wet Bulb.
         4) Relative humidity.
5) Dew point.
6) Surface temperatures.
c. Record environmental conditions not less than once every 4 HRS.
   1) Record hourly when temperatures are below 50 DegF or above 100 DegF.
d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.
3. Format for daily record to be computer generated.

F. Measure wet coating with wet film thickness gages in accordance with ASTM D4414.

G. Measure coating dry film thickness in accordance with SSPC PA 2.
   1. Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.

H. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

I. Measure substrate humidity with humidity gage specifically designed for such.

J. Provide Wet Paint Signs.

3.8 CLEANING

A. Clean Paint Spattered Surfaces:
   1. Use care not to damage finished surfaces.

B. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.

C. Remove surplus materials, scaffolding, and debris.

3.9 COLOR SCHEDULE

A. Pipe Bollards: Tnemec 02SF Safety Yellow.

B. Piping and Pipe Banding Color Schedule:
   1. Match existing piping and banding colors.
   2. Refer to Specification Section 10 14 00 for the piping system and banding material.
DIVISION 10

SPECIALTIES
SECTION 10 14 00 - IDENTIFICATION DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items, and hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
   2. The International Society of Automation (ISA).
      a. 70, National Electrical Code (NEC).
   5. Occupational Safety and Health Administration (OSHA):

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Catalog information for all identification systems.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. W.H. Brady Co.
2. Panduit.
5. Carlton Industries, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:
   1. Materials:
      a. Aluminum or stainless steel.
      b. Stainless steel shall be used in corrosive environments.
   2. Size:
      a. Diameter: 1-1/2 IN minimum.
      b. Thickness: 0.035 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.

B. Type A2 - Rectangle Metal Tags:
   2. Size:
      a. 3-1/2 IN x 1-1/2 IN minimum.
      b. Thickness: 0.036 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.

C. Type A3 - Metal Tape Tags:
   1. Materials: Aluminum or stainless steel.
   2. Size:
      a. Width 1/2 IN minimum.
      b. Length as required by text.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Embossed.

D. Type B1- Square Nonmetallic Tags:
   2. Size:
      a. Surface: 2 x 2 IN minimum.
      b. Thickness: 100 mils.
   3. Fabrication:
      a. 3/16 IN mounting hole with metal eyelet.
      b. Legend: Preprinted and permanently embedded and fade resistant.
   4. Color:
      a. Background: Manufacturer standard or as specified.
b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:
1. Materials: Fiberglass reinforced or durable plastic.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 60 mils minimum.
3. Fabrication:
   a. Rounded corners.
   b. Drilled holes in corners with grommets.
   c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.
4. Color:
   a. Background: Manufacturer standard or as specified.
   b. Lettering: Black.

F. Type C - Laminated Name Plates:
1. Materials: Phenolic or DR (high impact) acrylic.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 1/16 IN.
3. Fabrication:
   a. Outdoor rated and UV resistant when installed outdoors.
   b. Two (2) layers laminated.
   c. Legend: Engraved through top lamination into bottom lamination.
   d. Two (2) drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:
1. Materials: Vinyl tape or vinyl cloth.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 5 mils minimum.
3. Fabrication:
   a. Indoor/Outdoor grade.
   b. Weather and UV resistant inks.
   c. Permanent adhesive.
   d. Legend: Preprinted.
   e. Wire markers to be self-laminating.
4. Color: White with black lettering or as specified.

H. Type E - Heat Shrinkable Tape Tags:
2. Size: As required by text.
3. Fabrication:
I. Type F - Underground Warning Tape:
   2. Size:
      a. 6 IN wide (minimum).
      b. Thickness: 3.5 mils.
   3. Fabrication:
      a. Legend: Preprinted and permanently imbedded.
      b. Message continuous printed.
      c. Tensile strength: 1750 psi.

J. Type G - Stenciling System:
   1. Materials:
      a. Exterior type stenciling enamel.
      b. Either brushing grade or pressurized spray can form and grade.
   2. Size: As required.
   3. Fabrication:
      a. Legend: As required.
   4. Color: Black or white for best contrast.

K. Underground Tracer Wire:
   1. Materials:
      a. Wire:
         1) 12 GA AWG.
         2) Solid.
      b. Wire nuts: Waterproof type.
      c. Split bolts: Brass.

2.3 ACCESSORIES

A. Fasteners:
   1. Bead chain: #6 brass, aluminum or stainless steel.
   2. Plastic strap: Nylon, urethane or polypropylene.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.
C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
   1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
   1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:
   1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
   2. Continuous pass from each valve box and above grade at each structure.
   3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
   4. 1,000 FT maximum spacing between valve boxes.
   5. If split bolts are used for splicing, wrap with electrical tape.
   6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.
   7. Use continuous strand of wire between valve box where possible.
      a. Continuous length shall be no shorter than 100 FT.

3.2 SCHEDULES

A. Process Systems:
   1. General:
      a. Provide arrows and markers on piping.
         1) At 20 FT maximum centers along continuous lines.
         2) At changes in direction (route) or obstructions.
         3) At valves, risers, "T" joints, machinery or equipment.
         4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
      b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
         1) If flow is in both directions use double headed arrow markers.
      c. Apply tapes and stenciling in uniform manner parallel to piping.
   2. Trenches with piping:
      a. Tag type: Type F - Underground Warning Tape.
      b. Location: Halfway between top of piping and finished grade.
      d. Natural gas or digester gas:
         1) Color: Yellow with black letters.
         2) Legend:
            a) First line: “CAUTION CAUTION CAUTION”
            b) Second line: “BURIED GAS LINE BELOW”
      e. Potable water:
         1) Color: Blue with black letters.
         2) Legend:
            a) First line: “CAUTION CAUTION CAUTION”
            b) Second line: “BURIED WATER LINE BELOW”
f. Storm and sanitary sewer lines:
1) Color: Green with black letters.
2) Legend:
   a) First line: “CAUTION CAUTION CAUTION”
   b) Second line: “BURIED SEWER LINE BELOW”

g. (Nonpotable) water piping, except 3 IN and smaller irrigation pipe:
1) Color: Green with black letters.
2) Legend:
   a) First line: “CAUTION CAUTION CAUTION”
   b) Second line: “BURIED NONPOTABLE WATER LINE BELOW”

h. Chemical feed piping (e.g., chlorine solution, polymer solution, caustic solution, etc.):
1) Color: Yellow with black letters.
2) Legend:
   a) First line: “CAUTION CAUTION CAUTION”
   b) Second line: “BURIED CHEMICAL LINE BELOW”

i. Other piping (e.g., compressed air, irrigation, refrigerant, heating water, etc.):
1) Color: Yellow with black letters.
2) Legend:
   a) First line: “CAUTION CAUTION CAUTION”
   b) Second line: “BURIED PIPE LINE BELOW”

3. Yard valves, buried, with valve box and concrete pad:
   a. Tag type: Type A2 - Rectangle Metal Tags.
   b. Fastener: 3/16 IN x 7/8 IN plastic screw anchor with 1 IN #6 stainless steel pan head screw.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).

4. Valves and slide gates:
   a. Tag type:
      1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
      2) Indoor noncorrosive:
         a) Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
      3) Indoor corrosive:
         a) Stainless steel Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
   b. Fastener:
      1) Type A1: Chain of the same material.
      2) Type B1: Stainless steel chain.
   c. Color: Per ASME A13.1 corresponding to the piping system.
   d. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).

5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.):
   a. Tag type:
      1) Type B2 - Nonmetallic Signs.
      2) Type D - Self-Adhesive Tape Tags and Signs.
      3) Type G - Stenciling System.
   b. Fastener:
1) Self.
2) Screws.
3) Adhesive.
c. Legend:
   1) Letter height: 1/2 IN minimum.
   2) Equipment designation as indicated on the Drawings (e.g., “Primary Sludge Pump P-xxx”).

6. Piping systems:
   a. Tag type:
      1) Outdoor locations: Type G - Stenciling System.
      2) Indoor locations:
         a) Type D - Self-Adhesive Tape Tags and Signs.
         b) Type G - Stenciling System.
   b. Fastener: Self.
   d. Legend:
      1) Letter height: Manufacturers standard for the pipe diameter.
      2) Mark piping in accordance with ASME A13.1.
      3) Use piping designation as indicated on the Drawings.
      4) Arrow: Single arrow.

B. Instrumentation Systems:
   1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
      a. Tag type:
         1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
         2) Indoor noncorrosive:
            a) Type A1 - Round Metal Tags.
            b) Type B1 - Square Nonmetallic Tags.
         3) Indoor corrosive:
            a) Stainless steel Type A1 - Round Metal Tags.
            b) Type B1 - Square Nonmetallic Tags.
      b. Fastener:
         1) Type A1: Chain of the same material.
         2) Type B1: Stainless steel chain.
      c. Legend:
         1) Letter height: 1/4 IN minimum.
         2) Equipment ISA designation as indicated on the Drawings (e.g., “FIT-xxx”).
   2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):
      a. Tag type: Type C - Phenolic Name Plates.
      b. Fastener: Screws.
      c. Legend:
         1) Letter height: 1/2 IN minimum.
         2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").
   3. Components inside equipment enclosure, (e.g., PLC’s, control relays, contactors, and timers):
      a. Tag type: Type D - Self-Adhesive Tape Tags.
      b. Fastener: Self.
      c. Legend:
         1) Letter height: 3/16 IN minimum.
         2) Description or function of component (e.g., "PLC-xxx” or “CR-xxx”).
4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
   1) Letter height: 1/4 IN minimum.
   2) Component ISA tag number as indicated on the Drawings (e.g., “HS-xxx”).

C. Plumbing Systems:
1. General:
   a. Position markers on both sides of pipe with arrow markers pointing in flow direction.
      1) If flow is in both directions use double headed arrow markers.
   b. Apply tapes and stenciling in uniform manner parallel to piping.
2. Piping systems:
   a. Tag type:
      1) Outdoor locations: Type G - Stenciling System.
      2) Indoor locations:
         a) Type D - Self-Adhesive Tape Tags and Signs.
         b) Type G - Stenciling System.
   b. Fastener: Self.
   d. Legend:
      1) Letter height: Manufacturers standard for the pipe diameter.
      2) Mark piping in accordance with ASME A13.1.
      3) Use piping designation as indicated on the Drawings.
      4) Arrow: Single arrow.

D. Electrical Systems:
1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
   a. Tag type: Type F - Underground Warning Tape.
   c. Location:
      1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.
      2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.
   d. Electrical power (e.g., low and medium voltage):
      1) Color: Red with black letters.
      2) Legend:
         a) First line: “CAUTION CAUTION CAUTION”.
         b) Second line: “BURIED ELECTRIC LINE BELOW”.
   e. Communications (e.g., telephone, instrumentation, LAN, SCADA):
      1) Color: Orange with black letters.
      2) Legend:
         a) First line: “CAUTION CAUTION CAUTION”.
         b) Second line: “BURIED COMMUNICATION LINE BELOW”.
2. Motor control centers:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Main equipment legend:
      1) Letter height:
a) First line: 1 IN minimum.
b) Subsequent lines: 3/8 IN minimum.
2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").
3) Second line:
   a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
   b) Include the building name or number if the source is in another building.
4) Third line: System voltage and phase (e.g., “480/277 V, 3PH”).
5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).

d. Main and feeder device legend:
   1) Letter height: 3/8 IN minimum.
   2) Description of load (e.g., “MAIN DISCONNECT”, "PUMP Pxxx" or "PANELBOARD HPxxx").

3. Panelboards and transformers:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 3/8 IN minimum.
      2) Description of load (e.g., "MAIN DISCONNECT", "PUMP Pxxx" or "PANELBOARD HPxxx").
   
3. Panelboards and transformers:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 3/8 IN minimum.
      2) Description of load (e.g., "MAIN DISCONNECT", "PUMP Pxxx" or "PANELBOARD HPxxx").

4. Safety switches, separately mounted circuit breakers and motor starters, VFD’s, etc.:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").

5. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/2 IN minimum.
      2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").

6. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power
   transformers, control relays, contactors, timers, etc.):
   a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 3/16 IN minimum.
      2) Description or function of component (e.g., "M-xxx", “CR-xxx” or “TR-xxx").

7. Through enclosure door mounted equipment (e.g., selector switches, controller digital
   displays, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
1) Letter height: 1/4 IN minimum.
2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., “HS-xxx”).

8. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
   a. Tag type: Type D - Self-Adhesive Tape Tags.
   b. Fastener: Self.
   c. Tag conductor at both ends.
   d. Legend:
      1) Letter height: 1/8 IN minimum.
      2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.

9. Conductors in handholes and manholes.
   a. Tag type: Type A3 - Metal Tape Tags.
   b. Fastener: Nylon strap.
   c. Tag conductor at both ends.
   d. Legend:
      1) Letter height: 1/8 IN minimum.
      2) Circuit number or wire number as scheduled on the Drawings.

10. Grounding conductors associated with grounding electrode system in accordance with the following:
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Legend:
       1) Letter height: 1/8 IN minimum.
       2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").

11. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
    a. Tag type: Type D - Self-Adhesive Tape Signs.
    b. Fastener: Self.
    c. Legend: Per NFPA 70.

12. Equipment where more than one (1) voltage source is present:
    a. Tag type:
       1) Type B2 - Nonmetallic Signs.
       2) Type D - Self-Adhesive Tape Signs.
    b. Fastener:
       1) Screw or adhesive.
       2) Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Exterior face of enclosure or cubical.
    e. Legend:
       1) OSHA Danger Sign.
       2) Description of Danger: “MULTIPLE VOLTAGE SOURCES”.

3.3 HAZARD AND SAFETY SIGNS

A. Provide 25 Hazard and Safety Signs:
   1. Type B2.
   2. Inscription as directed by Owner.

END OF SECTION
DIVISION 13

SPECIAL CONSTRUCTION
SECTION 13 44 00 – INSTRUMENTATION FOR PROCESS CONTROL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for complete instrumentation system for process control.
   2. Integration of new starter panels, control panels and instrumentation.
   3. Integration of all control panels and instrumentation supplied by equipment manufacturers.
   4. Supply and integration of all necessary hardware, software, accessories and programming to provide a fully functional system as described in the plans and specifications.
   5. Supply and integration of all primary elements and instruments required for process control in accordance with the plans and specifications.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 and Division 1, and Division 33 requirements.
   2. Section 13 44 10 – Process Instrumentation and Control Equipment
   3. Section 13 44 20 – Primary Elements and Transmitters
   4. Section 13 44 30 – Control Loop Descriptions
   5. Division 26 requirements

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. International Society for Measurement and Control (ISA):
      a. S5.1, Instrumentation Symbols and Identification.
      c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
      e. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   2. National Institute of Standards and Technology (NIST).

B. Miscellaneous:
   1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

C. Qualifications:
   1. Integrator:
      a. Experience.
         1) Have satisfactorily provided a control system or SCADA system for a minimum of five projects of similar magnitude and function.
      b. Supplier/Integrator:
         1) Concentric Integration, 8678 Ridgefield Road, Crystal Lake, IL 60012. Contact is Mike Klein, 815-444-3240, mklein@goconcentric.com.
         2) No Substitutions.
D. Instrumentation subcontractor scope of supply/work:
1. The Instrumentation Contractor shall furnish all control panels and instrumentation including meters, transducers and floats
2. The Instrumentation Contractor shall supply all required software and programming for the control panels and SCADA integration.
3. The Instrumentation Contractor shall integrate all systems and establish communications with SCADA.
4. The Instrumentation Contractor shall make necessary programming changes to the City SCADA system PLCs.
5. The Instrumentation Contractor shall schedule and sequence his work such that the associated wastewater pumping systems are off line for as short a period as possible. Ideally the work should be scheduled during out of service periods of the construction.
6. The Electrical Contractor shall furnish and install Electrical power equipment and generator equipment, and shall establish new 240V 3P service with the Utility company, and shall be responsible for all wiring, conduits, switches, etc.

1.3 SYSTEM DESCRIPTION

A. Control System Requirements:
1. This Specification Section 13 44 00 provides the general requirements for the instrument and control system.
2. The instrument and control system consists of all primary elements, transmitters, switches, controllers, computers, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special grounding or isolation, auxiliaries, software, and other devices required to provide complete control of the facility as specified in the Contract Documents.

B. Unless otherwise required for instrument compatibility, electric control signals shall be 4 to 20 mA, 24 V DC.

C. All signals shall be directly linearly proportional to measured variable unless specifically noted otherwise.

D. Single Instrumentation Subcontractor:
1. Furnish and coordinate instrumentation system through a single instrumentation subcontractor. The instrumentation subcontractor shall be responsible for functional operations of all systems, performance of control system engineering, supervision of installation, final connections, calibrations, preparation of drawings and operation and maintenance manuals, startup, training, demonstration of substantial completion and all other aspects of the control system.
2. Ensure coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.
3. Prior to shop drawing preparation, the Instrumentation Subcontractor shall inspect the Owner's existing equipment and as-constructed electrical documentation so as to be able to fully coordinate the interface of new and existing instrumentation and controls. All costs associated with this work shall be incorporated into the original bid.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Section 01 33 00.
2. Submittals shall be original printed material or clear unblemished photocopies of original printed material. Facsimile information is not acceptable.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Equipment catalog cut sheets.
   c. Instrument data sheets:
      1) ISA S20 or approved equal.
      2) Separate data sheet for each instrument.
   d. Materials of construction.
   e. Minimum and maximum flow ranges.
   f. Pressure loss curves.
   g. Physical limits of components including temperature and pressure limits.
   h. Size and weight.
   i. Electrical power requirements and wiring diagrams.
   j. NEMA rating of housings.
   k. Submittals shall be marked with arrows to show exact features to be provided.
4. Loop diagrams per ISA S5.4.
   a. Each loop diagram on a separate sheet.
   b. Each sheet shall contain the following minimum information.
      1) All loop devices clearly identified.
      2) Identification of the loop and each loop component, including connections to such things as recorders and computers. Numbering and tagging must agree with the P&ID.
      3) All interconnections with identifying numbers for:
         a) Electrical cables.
         b) Conductor pairs.
      4) Identification of connections including:
         a) Junction boxes.
         b) Terminals.
         c) Bulkheads.
         d) Ports.
         e) Computer input/output connections.
         f) Grounding systems.
      5) Signal levels and ranges.
      6) Device location.
      7) Energy sources designating voltage, pressure, and other applicable requirements.
      8) Enough process lines and equipment to clearly show the process side of the loop and provide clarity of control action. This includes:
         a) What is being measured.
         b) What is being controlled.
         c) Other information required to complete the process loop.
      9) Reference to supplementary records and drawings to show inter-relation to other control loops.
      10) Controller action.
      11) Control valve action upon electronic, hydraulic, or pneumatic failure.
5. Process connected instrument installation details containing the following minimum information:
   a. Bill of materials providing as a minimum the following information:
1) Tube material and size.
2) Connection size.
3) Fitting size, material, and rating.
4) Valve type and material.
5) Instrument description.
6) Pipe stand size and material.

b. Required elevations and dimensions.

6. Comprehensive set of point-to-point wiring diagrams showing all interconnections between packaged systems or equipment control panels, motor control centers, instrumentation and all other electrical equipment as required to depict a complete and functional plant-wide electrical control system. Instrumentation wiring already shown on loop diagrams need not be included on point-to-point wiring diagrams.

a. Diagrams shall provide the following minimum information:
   1) Terminal block identification (includes terminals on remote equipment furnished by Others).
   2) Wire size.
   3) Wire type.
   4) Wire color.
   5) Wire shielding and insulation type.
   6) Conductor quantities and associated conduit size.
   7) Ground points.
   8) Interconnection requirements to existing systems or equipment furnished by Others.

b. Diagrams shall be provided on Drawings of sufficient size so as to minimize the number of drawings.
   1) Maximum drawing size 24 x 36 IN
   2) Minimum drawing size: 11 x 17 IN

7. Electrical schematic control diagrams. Diagrams shall include:
   a. Terminal identification.
   b. Unique identification of all control devices and contacts.
      1) Utilize Owner's device identification numbers where applicable.
   c. Wire identification.
   d. Equipment identification.
   e. Indication of remote and local devices and wiring.
   f. Overcurrent protection indication.
   g. Voltage.
   h. All control logic.
      i. Logic diagrams per ISA S5.2.

8. Panel fabrication drawings.
9. Scaled floor plan layouts of control room.
10. PLC equipment drawings.
11. Graphic layouts.
12. Graphic component construction.
14. Certifications:
    a. Documentation verifying that calibration equipment is certified with NIST traceability.
    b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA. Certification documentation is required for all equipment for which the specifications require independent agency approval.
15. Testing reports:
a. Source quality control reports.

B. Operation and Maintenance Manuals:
   1. See Section 01 70 00.
   2. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. System Operating Criteria:
   1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two cycles per minute or a magnitude of movement of 0.5 percent full travel.
   2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
   3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
   4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position final element.
   5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 percent of full scale.
   6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.2 ACCESSORIES

A. Provide instruments with manufacturer's identification nameplate showing:
   1. Manufacturer's model number.
   2. Manufacturer's serial number.
   3. Range.
      a. Utilize the same units of measurement as are utilized in the Contract Documents.
   4. Power supply requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use bottom entry for all conduit entry to instruments and junction boxes.
B. Install electrical components per Division 26.

C. Panel-Mounted Instruments:
   1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
   2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

D. See Section 26 05 00.

3.2 FIELD QUALITY CONTROL

A. See Section 01 70 00.

B. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.
   1. Documentation requirements include the utilization of the forms located at the end of this section.
      a. Loop Checkout Sheet.
      b. Instrument Certification Sheet.
      c. Final Control Element Certification Sheet.

C. Instrumentation Calibration:
   1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
   2. Calibrate all field-mounted instruments, other than local pressure and temperature gages, after the device is mounted in place to assure proper installed operation.
   3. Calibrate in accordance with the manufacturer's specifications.
   4. Bench calibrate pressure and temperature gages. Field mount gage within 1 week of calibration.
   5. Replace any instrument which cannot be properly adjusted.

D. Loop checkout requirements are as follows:
   1. Check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections. Use actual signals where available. Closely observe controllers, recorders, alarm and trip units, remote setpoints, ratio systems, and other control components. Make corrections as required. Following any corrections, retest the loop as before.
   2. Check all interlocks to the maximum extent possible.
   3. In addition to any other as-recorded documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Owner.

E. Provide verification of system assembly, power, ground, and I/O tests.

F. Verify existence and measure adequacy of all grounds required for instrumentation and controls.

END OF SECTION 13 44 00
SECTION 13 44 10 - PROCESS INSTRUMENTATION AND CONTROL EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   a. Major instruments
   b. Controls
   c. Control panels

B. Related Divisions
   1. Division 0 – Procurement and Contracting Requirements
   2. Division 1 – General Requirements
   3. Division 13 – Special Construction
   4. Division 26 – Electrical
   5. Division 33 – Utilities
   6. Division 40 – Process Interconnections

1.2 SYSTEM DESCRIPTION

A. The work performed by the integrator includes the detailed system engineering, submittal and shop drawing documentation, program documentation, equipment furnishing of field instruments and control panel assembly, installation inspection, programming, testing, calibrating, startup of system, owner training, and O&M manual and record drawing documentation.

B. The work also includes the very careful review and coordination of interfaces of the existing equipment modifications at this and other sites. All equipment, hardware and software interfacing components not specified but required to make a working system shall be provided by the System Supplier. Modifications shall be performed without interruption of other operations except as approved by the Engineer.

C. The plans and specifications are not intended to include all details of a complete equipment installation for the purpose specified. The System Supplier shall be responsible for all details, which may be necessary to properly install, adjust, and place in successful and continuous operation the complete installation.

D. The integrator shall prepare for and attend a series of pre-submittal and pre-programming meetings with the Engineer and Owner at the owner’s location to detail the control system functions.

E. An overview of the major components, subsystems and work to be furnished by the contractor include:
   1. Integration of new control panels and hardware.
   2. The control panel shall communicate alarms and status to City SCADA.
   3. The control panels communicate with the local sensors and local control equipment by hardwiring.
   4. Local control equipment consists of the following:
      a. Primary Elements and Transmitters
      b. Motor Starters
      c. SCADA communications via City Fiber Optic Network
F. SCADA System
   1. Communicate with City SCADA using new Allen-Bradley Stratix 5700 Series (p/n 1783-BMS10CGA) Ethernet switches, furnished and installed by contractor.

G. System Spare Parts
   1. Furnish spare parts as specified in this product section.
   2. Other equipment as specified or as recommended by the manufacturer.

H. Documentation
   1. Identification labeling of all new and existing instrumentation. The System Supplier shall furnish engraved nameplates and stainless steel service tags for all process transmitters as shown on the P&IDs. This includes hand control stations, local panels and measurement devices, existing and new. Legending shall include process service, ranges, and tag number as described in this specification.
   2. Documentation of the system EXACTLY as described in the specifications. Update existing CAD files and provide Microstation and Autocad files for all drawings and organize in the form and format as specified. The documentation shall be complete and comprehensive for the plant and shall incorporate all existing manuals into a single manual.
   3. Design of the system and control panels to accommodate future remote control incorporating failsafe and terminal block bus wiring standards as specified or directed by the Engineer.
   4. Complete factory system test of all components and software.
   5. Complete site system test of all components and software, including Owner/Engineer training.
   6. Markup one set of the plan’s drawings to indicate all as-built changes.

1.3 DIVISION OF WORK

A. The integrator shall have the overall system responsibility and shall provide all materials and work necessary to satisfy all requirements of this section.

B. The installation and wiring between components and the provision of required miscellaneous installation supplies, fittings, etc. to provide a complete system shall be by the Electrical Contractor. The Electrical Contractor shall also mount the field instruments and control panels and install and terminate all field wiring and between the field components and panels.

C. The Contractor shall coordinate the detailed interfaces including wire and terminal numbers between components furnished in other sections and shall coordinate the work activities between these sections and the integrator.

D. The integrator and Electrical Contractor shall document all signal interfaces on his drawings including wire & terminal numbers between components furnished in other sections.

1.4 REFERENCES

A. Reference Standards:
   1. NEMA: National Electrical Manufacturer's Association.
   2. ISA: Instrument Society of America
   3. UL: Listing of control panels
   4. ISO requirements.
1.5 SUBMITTAL AND SHOP DRAWINGS

A. Following contract award but before any components are fabricated and/or integrated into assemblies, or shipped to the site, the Instrumentation Subcontractor shall furnish to the Engineer and receive his review of full details, description of operation, shop drawings, catalog cuts, loop drawings, interconnecting wiring diagrams, and such other descriptive matter and documentation as described herein to fully describe the equipment and to demonstrate its conformity to these Specifications.

B. System Manual: A 3-ring binder shall be provided indexed as follows to organize the required submittal and shop drawing information.
   1. All equipment descriptive documentation shall be typed and the drawings shall be CAD produced.
   2. The manual shall consist of view-type 3-ring binders, locking ring K-M type L25. Numbered and alpha indexes shall be AICO type goldline, minimum 1 set each binder. Depending upon the amount of material a second binder volume may be necessary.
   3. The format and content of each section is described in detail in this section.
   4. System Manual organization:
      a. Backbone and cover project identification.
      b. Numbered indexes as follows:
         i. Introduction; general project and contractor references
         ii. Contents
         iii. Component listing (bill of material)
         iv. System description (10 pages) with PLC system block diagrams including software functions
         v. Instrument loop functional diagrams
         vi. Shop drawings - drawing list and mechanical diagrams
         vii. Shop drawings - drawing list and electrical diagrams block diagrams, loop wiring, interconnecting wiring and panel power & utility wiring.
         viii. Shop drawings - drawing list and installation details
      ix. Software program documentation
         (a) Controller program documentation
         (b) PLC program documentation – writing sequence of operation and computer generated ladder diagrams
         (c) Application software program documentation
            (1) overview, point, group displays
            (2) graphics
            (3) alarm and event reports
            (4) maintenance program
      x. Components (A thru end)
         (a) With alpha numbered tab for each component, each section to include a System Supplier produced application data sheet and manufacturer's literature annotated for this application.
         (b) One section for each component code and one each for spares, test equipment, expendables.
      xi. Identification listings
         (a) panel nameplate list, legend
         (b) annunciator legends
         (c) field device tag legends
         (d) alarm auto-dialer legends
xii. Factory simulation test
xiii. Test procedures
xiv. Calibration and test records
xv. Training materials
xvi. Maintenance and engineers' terminal configurations
xvii. O&M manual outline.

C. Documentation requirements:
   1. Bill of Material with complete description of items supplied in sufficient detail to order
      spare parts; quantity used; manufacturer's catalog, style, or part number; and tag or other
      cross reference to permit easy correlation with material appearance in specification and
      drawings. Catalog information shall be submitted for all equipment, regardless of whether
      or not it is of the same manufacture as that listed in the Specifications. The list shall be in
      spreadsheet format with file provided.
   2. Drawings: Provide the following:
      a. Loop diagrams, which shall consist of an individual wiring diagram for each analog or
         discrete loop signal showing all terminal numbers, the location of the DC power
         supply, the location of any booster relays or common dropping resistors, etc. The loop
         diagrams shall meet the minimum requirements of ISA S5.4 plus the following
         requirements: each loop diagram shall be divided into three areas for identification of
         element locations: panel face, back-of-panel, and field, respectively. On each diagram
         present a tabular summary of:
            i. the output capability of the transmitting instruments,
            ii. the input impedance of each receiving instrument,
            iii. an estimate of the loop wiring impedance based on the wire sizes and lengths
                shown,
            iv. the total loop impedance, and
            v. reserve output capacity. Loop diagrams shall be on individual 8-1/2-inch by 11-
               inch sheets.
      b. Panel elementary diagrams of pre-wired panels. Diagrams shall be similar to the loop
         diagrams except for power and utility functions. The drawings shall include all
         auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc.
      c. Interconnecting wiring diagrams, showing all component and panel terminal board
         identification numbers and external wire numbers. This diagram shall include all
         intermediate terminations between field elements and panels (e.g., terminal junction
         boxes, motor control centers, etc.). This diagram shall be coordinated with the
         Electrical Contractor and shall bear his mark showing that this has been done.
         Diagrams, device designations, and symbols shall be in accordance with NEMA ICS
         1-101. The drawings shall contain the drawing number and terminal numbers of the
         interfaced equipment provided by others.
      d. Panel mechanical drawings shall show top, front, side, back, sections. The instrument
         arrangement drawing shall be scaled. Internal and subpanel equipment layout shall be
         provided. Include material lists, legends, scales. All drawings shall be scaled. A
         separate cutout detail drawing shall be provided.
      e. Instrument installation detail drawings shall be provided for field process installed
         devices. Custom drawings shall be provided for each installation. Copies of the
         manufacturer's product literature shall not be acceptable. These shall be submitted for
         approval.
      f. Functional loop diagrams shall detail the loop diagrams on the P&ID's and shall be in
         the detail shown on the ISA standard for same.
g. Block diagrams of the communication and control diagrams shall be complete and include all modem, baud rate, line type and other similar information to fully describe the panel signaling.

h. Graphic display drawings.

i. Points I/O list with columns for tag, type, service, and readouts. Readouts shall indicate the display type and number.

3. Written descriptions and other documentation:
   a. An overview written description of the system shall be provided. It shall describe the system control functions, power conditions (loss, restart). PLC communications and operation shall be indicated. A sequence of operation shall be provided.
   b. The controller documentation shall be provided as described in the component section.
   c. Sizing/Selection Calculations: Complete sizing/selection of the panel heating and cooling shall be submitted along with the proposed device sizes to accomplish the functions.

4. Application data sheets shall be provided for every component furnished. The format shall follow the ISA standard forms and shall be customized for this project to include the actual setup, configuration, calibration and any or all other features required to exactly document the component for this application. The data sheet shall include a service category and function including the device type. The information shall be supplied in sufficient detail to order spare parts; quantity used; manufacturers catalog, style, or part number; and tag or other cross reference to permit easy correlation and drawings. Catalog information shall be submitted to all equipment, and the literature shall be annotated to indicate the equipment being provided, with all other non-applicable items crossed out.

5. The test and calibration record forms shall be submitted for approval. All the forms for the components shall be filled-out and provided in the submittal.

D. The integrator shall submit shop drawings to the Engineer in accordance with the requirements of the General Conditions.

E. All submittals shall be complete, neat, orderly and indexed. All components shall be referenced by the instrument loop tag designations shown.

F. At or before the time of shipment the Instrumentation Subcontractor shall provide four sets of "as-built" shop drawings to the Owner. Upon receipt of field-marked drawings the Instrumentation Subcontractor shall provide four sets of revised "as-installed" shop drawings to the Owner.

1.6 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Furnish four copies to the Owner of a reviewed and approved, complete system manual.

B. The O&M manual shall exactly follow the format of the submittal manual and include the shop drawings and other documentation as specified.

C. The O&M manual shall in addition contain an indexed section to house the calibration and loop testing documentation that shall be provided for the project.

D. Installation, operation, and maintenance requirements for each component of equipment in accordance with the General Conditions.
E. The manuals shall be furnished at least 15 calendar days before the scheduled delivery of equipment.

F. It is the intent of this project to assemble comprehensive manuals for all new and existing equipment.

1.7 MANUFACTURER'S SERVICES

A. The integrator has calibration and commissioning responsibility for the instrumentation and control system and shall perform the work with their staff.

B. The Engineer may direct the integrator to engage the manufacturer's services at the Contractor's cost if the Engineer determines that the component has not met its performance requirements.

1.8 TESTING

A. The integrator shall fully test all components and systems.

B. The integrator shall coordinate testing with all other associated subcontractors and suppliers.

C. As a minimum, the testing shall include the following:
   1. Factory Tests:
      a. Before shipment all field equipment, panels and panel assemblies shall be tested for proper operation at the Suppliers factory.
      b. A factory acceptance test shall be required for this project.
      c. Results of the factory tests shall be recorded and submitted for approval before shipment of any panel or panel assembly to the plant.
      d. Engineer may waive the Factory Test requirement at his discretion.
   2. Operational Acceptance Tests:
      a. The objective of these tests is to demonstrate that the system of Process Instrumentation and Control is READY for final operation.
      b. The system shall be checked for proper installation, adjusted, and calibrated on a loop-by-loop basis to verify that it is ready to function as specified.
      c. All system elements shall be checked to verify that they have been installed properly and that all terminations have been made correctly.
      d. All discrete elements and systems shall have their set points adjusted and shall be checked for proper operation (e.g., interlock functions, contact closure on rising/falling P.V., etc.)
      e. All continuous elements and systems shall have three-point calibrations performed. All controller tuning constants shall be adjusted to preliminary settings.
   3. Functional Acceptance Tests:
      a. The operational acceptance tests shall be completed before starting the Functional acceptance tests.
      b. The actual testing program shall be conducted in accordance with prior approved procedures and shall be documented as required hereinafter.
      c. A witnessed, Functional acceptance test shall be performed on the complete system of Instrumentation and Controls. Each function shall be demonstrated to the satisfaction of the Engineer on a paragraph-by-paragraph and loop-by-loop basis.
      d. East test shall be witnessed and signed off by the System Supplier and the Engineer upon satisfactory completion.
e. The integrator shall notify the Engineer at least 2 weeks before the date of the Functional acceptance test.

f. Test Procedure Development and Test Documentation: The integrator shall perform testing procedures as approved by the Engineer.

g. The Contractor shall include in the submittal, the test procedures proposed.

1.9 TRAINING FOR COMPLETE SYSTEM

A. Factory training shall be provided for the Owner/Engineer on the system for two days including all materials.

B. Provide site training during the startup.

1.10 RESPONSIBILITY FOR COMPLETE SYSTEM

A. The integrator shall provide and be ultimately responsible for the supply, installation, certification, adjustment, and startup of a complete, coordinated system that shall reliably perform the specified functions.

B. The integrator shall obtain the required information on those primary elements, valves, valve actuators, motor controls and other control equipment or devices that are required to be interfaced with, but that are not provided under this section.

C. The integrator shall coordinate his work to ensure that:
   1. All components provided under this section are properly installed.
   2. The proper type, size, and number of control wires with their conduits are provided and installed.
   3. Proper electric power circuits are provided for all components and systems.

D. All conduits are provided and installed under the Electrical work. With the exception of certain specified special control cables, all wiring is provided and installed under Electrical work.

1.11 ACCEPTABLE SYSTEM SUPPLIERS

A. Supplier/Integrator:
   1. Concentric Integration, 8678 Ridgefield Road, Crystal Lake, IL 60012. Contact is Mike Klein, 815-444-3240, mklein@goconcentric.com.

   2. For the purpose of standardization and responsibility, all instrumentation specified shall be provided by one Instrumentation Subcontractor.

   3. The Instrumentation Subcontractor shall be an approved Allen-Bradley System Integrator.

   4. The Instrumentation Subcontractor shall have extensive experience with the specified software.

1.12 SUBSTITUTIONS

A. Substitution Procedures:
   1. Bidders may, until noon, two weeks prior to the bid date, submit written request to the Engineer for substitution of products, systems or instruments in lieu of those specified in the Contract Documents.
2. All substitutions shall be clearly identified, described and in accordance with provisions of Contract Documents.
3. Consideration of products or methods of documentation or performance of the submittal requirements other than that specified requires conformance with the substitution procedure as defined herein.
4. Whenever, in the Contract Documents, a product, system or software is referred to by trade name or by the name of a patentee, manufacturer, or by reference to catalog, it shall be understood as specifying the standard for the design, efficiency, durability and performance of the product or system.
5. Whenever a substitute is submitted for acceptance, the final decision as to whether or not such substitution is closely equivalent to specified product or system and meets design concept shall be made by the Engineer. The Engineer shall base his decision upon his review of the substitution submittal requirements and his past and current experience with the substitute products or suppliers.
6. A submittal shall be provided for review of the types and quality of the work. In addition to providing company, personnel and past project experience profiles, a submittal sample shall be provided. The substitute's submittal shall exactly follow the format of the specified documentation, with sample drawings, data sheets etc. to demonstrate conformity and experience. Incomplete or items not per the specifications shall disqualify the substitute. Similar projects shall have reference provided including the type of PLC system, references for remote maintenance monitoring, references for the specified software projects.
7. The Engineer will not consider requests for substitution for items specified as no substitution permitted.
8. The substitute supplier shall prepare a submittal describing the implementation and coordination of work for this site and its integration and working arrangements with the related systems. This shall include documentation modifications and software licensing.
9. The substitute supplier shall be responsible for the total cost, which includes the Engineer’s design and documentation work, of all deviations and alterations from the specified requirements as caused by the proposed equipment. The cost shall be billed at a rate of $175.00 per hour plus additional related out-of-pocket costs.

B. After Award of Contract:
1. Substitutions required for compliance with final interpretations of code requirements or insurance regulations.
2. Unavailability of specified products, through no fault of the contractor. Unavailability shall mean that the product is no longer available in the marketplace.
3. Subsequent information discloses inability of specified product to perform properly or to fit in a designated space.
4. All requirements of pre-award substitute procedures.

1.13 REPEAT SUBMITTAL REVIEWS AND RETEST WITNESSING

A. Submittals will receive up to two reviews by the Engineer without cost to the Instrumentation Subcontractor. If a given submittal fails to reach the completed status on the second submittal, the Instrumentation Subcontractor will have the costs associated with further reviews by the Engineer deducted from the Contract amount. These costs will be computed based on $175 per hour for Engineer review time.

B. Submittals returned as incomplete or not in compliance have the specified format shall be considered having been reviewed.
C. If a test or a portion of a test requiring witnessing fails to the point where it needs to be rerun at a later date, the Instrumentation Subcontractor will have the cost associated with the additional test witnessing by the Engineer and Owner deducted from the Contract amount. These costs will be computed, based on actual costs incurred by the same number of Engineer and Owner personnel as originally witnessed the test, as follows:
1. Retest Witnessing $175.00 per hour
2. Travel Mileage charge

1.14 COORDINATION MEETINGS

A. Coordination meetings shall be held at the Engineer's office periodically during the course of the project. The Engineer will summarize resolutions reached in each coordination meeting will be scheduled within 30 days after award of Contract to the Instrumentation Subcontractor. The Instrumentation Subcontractor shall provide for his attendance and attendance of any involved subcontractors at monthly meetings for the duration of the project. Specific dates will be established in the Engineer-approved schedule.

B. See also additional requirements under Section 01 30 00.

1.15 MILESTONE ACTIVITIES

A. The integrator shall provide a schedule for the project and indicate activities supporting the following system project milestones.
1. Inspection and review of existing sites and listing of modifications including the plan for changes.
2. Pre-submittal review submittal
3. Programming and MMI review submittal
4. Delivery of Panels; provide breakdown of deliverable elements
5. Operations testing; provide breakdown of deliverable elements
6. Acceptance testing; provide breakdown of deliverable elements
7. Site training
8. Remote monitoring
9. O&M manuals

PART 2 PRODUCTS

2.1 FUNCTIONAL REQUIREMENTS

A. Control System Overview:
1. The control system architecture, hierarchy and functional operation is shown on the drawings for the process.
2. The control system shall provide manual control and status indication of the various motor drives and pumping as specified herein and as shown on the drawings.
3. The control system shall also provide continuous measurement, indication and automatic control of operations. Custom alarm point and status graphics shall be designed and submitted for approval.
4. The system logic for the motor control functions shall include customary control practices for pump control for the type of equipment specified. This includes moisture and temperature sense monitoring and alarms.
5. The control panel contains a PLC, communication equipment and an operator interface unit (OIU). The OIU shall provide complete monitoring and control capability. The panel shall
have a loop power supply, transient protection, and a UPS for sustained power. UPS shall be integrated such that if UPS power output fails, a UPS bypass circuit shall close to provide power directly to the systems, provide primary power is available.

6. The signal processing shall be such that all field signals shall be 4-20 mAdc. These current analog signals shall have loop resistors installed at the terminal blocks for individual 1-5 vdc signaling to each component in the loop.

7. The system and panel design shall allow for future expansion and the installation of future equipment. The panel construction shall take this into account and indicate the future space and electrical power and support materials in the required submittal information.

8. 3-pole control relays shall be provided for all signals such that one contact each is available for future use.

9. The PLC and controllers shall be totally isolated from external field signals.

10. All field transmitters shall have separable-unit transient surge protectors, for power line protection and signal line protection. The communication equipment shall also have the same types of protection in the panel.

11. Power supplies, surge protection and isolation shall be provided for the PLC systems. Emergency stop and reset logic for the motors shall be provided.

12. Refer to the scope and component specifications sections for additional requirements.

13. The panel shall also provide local alarm lights and an alarm auto-dialer for remote signaling. Refer to the drawings and components for additional functions.

14. The motor starters shall have local HOA's, ETM's, and run lights for unit control of the pumps. The PLC/SCADA system shall also monitor these functions in addition to accumulation of motor starts.

15. The panel and systems shall resume automatic operation upon resumption of prime power.

16. The panel shall resume automatic communication operation upon resumption of failed telephone utility line failure, if applicable.

17. The panel shall house a programmable logic controller (PLC) that shall perform the data gathering, logic, control and communication of information & signals for all the current analog and discrete and specified future requirements.

18. The PLC shall have spare analog and discrete I/O points and modules. Spare slots shall be provided.

19. The Instrumentation Subcontractor shall design the panel and submit complete details for the Engineers review and final arrangement. It shall follow the arrangement and OIU ergonomics as directed by the engineer.

20. The PLC shall determine the automatic mode starts and stops for the motors based upon internal inter-locking and safety logic using the required inputs. Prevent restart, fail to start timers and other functions shall be provided for the pump and others as applicable.

21. The PLC shall be programmed to accumulate run times and number of starts for the motors.

22. The system logic for the motor control functions shall include customary control practices for any pump. As a minimum, the logic shall include the following:
   a. A pump run-fail timer circuit.
   b. A motor starter thermal overload remote contact for use with the run-fail for pump fail alarm.
   c. A prevent restart time circuit.
   d. Auxiliary contacts for the logic and direct signaling to the panel status lights and run time indicator.
   e. Control mode logic for the manual and automatic functions interlocks.
   f. Other pump functions as determined are necessary.
   g. The above shall apply for the adjustable speed drives including speed location/type transfer.
23. The system and panel design shall allow for future expansion and the installation of future equipment as directed by the Engineer. 20% analog and discrete signals and support equipment, additional pump controls, additional analog indications.

24. The panel construction shall take this into account and indicate the future space and electrical power and support materials in the required submittal information.

25. The control system shall also provide continuous measurement, indication and automatic control of the pumping as described in this specification. The pump control points shall be fully adjustable over the entire range from the panel front.

26. Basic Control:
   a. Primary wet well level monitoring will be achieved using a submersible level transducer, with float switches to be used as backup control. A high level float switch will be installed to give a high level alarm regardless of operation mode.
   b. The pumps will operate in a lead/lag fashion. The controls will consist of two modes of operation: 1) Normal Mode and 2) Backup Mode. The mode of operation is selectable via selector switch at the lift station PCP. In general, when in Normal Mode, the pump operation is controlled by the level transducer and the logic in the PLC; when in Backup Mode, the pump operation is controlled by the backup float switches, and is independent of the PLC.

27. Normal Mode:
   a. This mode of operation will be used if the mode selector switch is in the “Normal” position and the wet well level transducer and PLC are functioning properly.
   b. The pumps will start/stop based on the wet well level as measured by the transducer and the operator adjustable pump start/stop setpoints. The pump sequence will be selectable as “1-2”, “Auto Alternate”, or “2-1”.
   c. When in auto alternate mode, the lead pump will alternate after each pump cycle.
   d. All setpoints and control will be adjustable both locally at the lift station OIT and remotely from the SCADA server.

28. Backup Mode:
   a. A backup control system based upon floats shall be included. This mode of operation will be used if any of the following conditions exist: 1) The mode selector switch is in the “Backup” position. 2) The mode selector switch is in the “Normal” position and the high level float switch is activated (typically due to failed level transducer or faulted PLC).
   b. The pumps will start/stop based on the backup float switches. Each pump will have its own “Pump On” float, and one common “Pump Off” float will be used to turn off all running pumps.
   c. Since this is strictly a backup mode of operation, there will be no means to select the lead/lag pump, or automatically alternate between lead/lag pumps.
   d. The pumps will turn on in the sequence determined by the location of the “Pump On” floats for each pump in the wet well. If in “Normal” mode and the backup control is activated, the backup control will be latched in until the “Backup Mode Reset” pushbutton is pressed.

29. All operations can also be performed in ‘Hand’ mode. A level indicating device (Red Lion, Precision Digital, or equal) will be provided so that if the PLC function fails then operation staff can still observe the level.

30. All control panel wiring will be done with stranded MTW wire sized appropriately. A UPS will be installed, and an automatic UPS bypass circuit utilized to allow automatic operation on service power if the UPS fails. All components (Fiber Optic Patch Panel, PLC, OIT, etc.) will continue to function if the UPS fails. This will generate an alarm in SCADA.

31. SCADA Data:
   a. Status:
1. The following hard-wired status signals will be wired from the PCP to the RTU and sent to the SCADA system:
   a. For each pump:
      i. Run.
      ii. H-O-A in Hand.
      iii. H-O-A in Auto.
   b. Operation Mode Switch position (Backup or Normal).
   c. Wet Well Level (analog signal).
   d. Discharge Flow Rate (analog signal).

b. The following information will be calculated in the lift station PLC and sent to the SCADA system:
   1. For each pump:
      a. Run time (current day, previous day, & cumulative).
      b. Number of Starts (current day & previous day).
   2. Total Flow (current day, previous day) – if flow meter is installed.
   3. Alarms: The following hard-wired alarm signals will be wired from the PCP to the RTU and sent to the SCADA system:
      a. For each pump:
         i. Seal Fail.
         ii. High Temperature.
         iii. Motor Fail.
      b. High Wet Well Level (Float).
      c. Power Fail
      d. Phase Monitor Fail.
      e. TVSS Fail.
      f. Intrusion Alarm.
   4. The following alarms information will be derived in the master PLC:
      a. Communication Fail.

2.2 PRODUCT QUALITY

A. The specified components have been selected for their form, fit and function for the project design.

B. For the purpose of standardization and responsibility all instrumentation specified shall be provided by one Instrumentation Subcontractor.

C. The Instrumentation Subcontractor shall be experienced with the method of documentation specified.

2.3 COMPONENT DESCRIPTIONS - PANEL FRONT DEVICES

A. Indicating Light
   1. Units shall be heavy-duty industrial indicating lights rated for 120-volt, oil-tight service.
      Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.
   2. Units shall have single lens with color as specified.
   3. Units shall have an integrally mounted transformer for each lamp to step down the 120-volt, 60-Hz input voltage to a 6-volt lamp excitation voltage, unless otherwise noted.
   4. Units shall be Allen-Bradley 800T Series, or approved substitute.
B. Selector Switch, Pushbuttons
1. Units shall be heavy-duty, oil-tight, industrial type selector switches with contacts rated for 120V ac service at 10 amperes continuous.
2. Units shall have standard size aluminum legend plates with black engraved markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements and spring return function (if any) as required.
3. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.
4. Units with up to four selection positions shall be Allen-Bradley 800T Series, or approved substitute.
5. The selector switches required are noted in the system description, drawings and as functionally required. Tag numbers per the specified method.
6. The pushbutton switches required are noted in the system description, drawings and as functionally required. Tag numbers per the specified method.

C. Control components that cannot be substituted:
1. Allen Bradley 1769-L16ER Processor
2. Allen Bradley 1734-IE4C Analog Input
3. Allen Bradley 1734-OE4C Analog Output
4. Allen Bradley 1734-IB8 Digital Input
5. Allen Bradley 1734-OB8 Digital Output
6. Allen Bradley 1769-PA4 Power Supply
7. Allen-Bradley 2711P-B7C22A9P OIT
9. Allen-Bradley 1783-BMS10CGA Ethernet Switch with fiber multi-mode SFP modules

2.4 COMPONENT DESCRIPTIONS - INTERNAL PANEL

A. PLC - Programable Logic Controller System
1. The basic system is shown on the drawings and described in the specifications. The system shall be designed utilizing the basic specified components. The Instrumentation Subcontractor shall include all other hardware and software and programming as required to meet the intent of the specifications as determined by the Engineer.
2. Description of System: The PLC shall be installed in the panel and shall perform logic and communications operations.
3. The PLC shall include an interface, both hardware and software to communicate with the controls specified, all other PLC units, new and existing, and the OIU devices.
4. The PLC shall receive all remote and panel signals for monitoring and future communications.
5. The PLC shall perform the logic and sequencing requirements of the pump control.
6. Provide rack enclosures to mount power supplies, and house the processor/memory card, and I/O cards for this and future expansion.
7. Provide application interface software and hardware.
8. The PLC system shall be remote I/O capable, including communication adapter modules.

B. Power Supplies, DC
1. Provide DC power supplies as required to power the intrinsically safe DC power for the intrinsically - safe loops and for future transmitters.
2. Power supplies shall convert 120V ac, 60-Hz power to DC power of the appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that the instruments being supplied can operate within their required tolerances. Output over-
voltage and over-current protective devices shall be provided with the power supply to protect the instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.

3. Provide NEMA 1 enclosure for all power supplies.
4. Provide minimum of one 24 VDC, 1 amp unit for panel.
5. Unit shall be Sola, or approved substitute.

C. Relay - 120V AC Logic
1. Control Circuit switching shall be accomplished with relays. These relays, for interfacing and control applications, shall be the compact general-purpose plug-in type having low coil inrush and holding and holding current characteristics.
2. Contact arrangements shall be 3 pole, and shall be rated for not less than 10 amperes at 120vac. Coil voltage shall be as noted or shown. Relays shall have plain plastic dust covers, test buttons, coil light, and mounting sockets with screw terminals.
3. Relays shall be UL recognized. Units shall be Turk type RC series. No substitutions permitted.
4. Relays shall be capable of using a Turk manufacturing time cube for on or off delay operation as required.

D. Intrinsically Safe Relay
1. Solid-state relays for intrinsically - safe relaying shall be GEMS safe-pak or approved substitute (hazardous location applications only).

E. Solid State Relay
1. Solid-state relays for equipment isolation shall be Crydom Series 1 SCR output, either AC or DC control relays as required.

F. Electrical Transient Protection
1. All instrument and control equipment mounted outside of protective structures (field mounted equipment) shall be equipped with suitable surge-arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices.
2. Protective devices used on 120vac inputs to field mounted equipment shall be secondary valve surge protectors conforming to the requirements of IEEE standard 28-1972 (ANSI C62.1-1971 or latest).
3. Incoming Line TVSS shall be LEA International LS PLUS, 100 kA

G. Signal Isolator
1. The unit shall produce an output signal linearly proportional to the input signal.
2. Isolation between input, output, and power shall be provided. The signal levels shall be 4-20 mAdc or 1-5 vdc.
3. Plug-in type units are not acceptable.
4. Units shall be AGM type PTA, model #4000 or approved substitute.

H. Miscellaneous Internal Components - Refer to the control panel requirements.

2.5 EXPENDABLES, TEST EQUIPMENT, AND SPARE PARTS

A. Provide the following spares:
1. Installed spares each panel
   a. 2 circuit breakers
b. 3 control relay

2. Loose spares
   a. 2 fuses, each size/type
   b. 12 indicating light bulbs
   c. 1 solid-state relay
   d. 1 intrinsically safe relay

3. PLC spares
   a. One of each type: analog input/output, discrete/output modules

B. PLC and computer final programs
   1. CD-ROM.
   2. E-PROM version if applicable.

2.6 CONTROL PANEL CONSTRUCTION:

A. All enclosures and panels shall comply with the requirements of this specification.

B. Traffic Box Enclosure Mechanical Requirements:
   1. Control panels, starter panels, flow meter transmitter, main breaker, TVSS etc. shall be enclosed in a NEMA 3RX traffic box style enclosure, having the following characteristics:
      a. The enclosure shall be 66” wide by 48” tall by 30” deep and shall stand on legs 18” high.
      b. The space enclosed by the traffic box legs shall be enclosed on the long sides with 14 gauge expanded 304 stainless steel mesh, 75% free area, with bonded edges. 14 ga 304 stainless steel plate shall enclose the short sides. The leg enclosures shall be removable to facilitate access to conduits.
      c. The enclosure shall have double access doors on both the north and south sides. The doors shall be fastened by lockable latching handle.
      d. The enclosure shall have installed intrusion switches and interior lighting activate by door switches.
      e. Surface finish shall be brushed 304 stainless steel

2. Traffic box interior control panel enclosures in shall be NEMA 12.
   a. Control panel enclosure shall be 30 inches wide by 36 inches tall by 12 inches deep, and shall have door fastened by latching handle. Enclosure shall be Saginaw SCE-3630012WFLP or approved equal.
   b. Power/starter panel enclosure shall be 30 inches wide by 36 inches tall by 12 inches deep, and shall have door fastened by latching handle. Enclosure shall be Saginaw SCE-3630012WFLP or approved equal.
   c. The control panel left hand opening door shall have the following equipment installed:
      1. Power on pilot light (white)
      2. Allen Bradley 2711P-B7C22A9P OIT
      3. Alarm reset push button and indicator lights
      4. Normal/Backup selector switch and backup mode reset pushbutton.
      5. For each pump: HOA switch, run light, over temp light, seal ail light, overload light, reset push button, and elapsed time meter.
   f. The power panel right hand opening door shall have the disconnect switch handle.
   g. The internal panels shall have a subpanel backplane, painted white.
   h. The power/ starter panel shall contain disconnect, breakers, starters, power monitor, 3 kVA 240:120 transformer, etc.
3. The system main breaker and TVSS unit shall be installed on the opposite side of the enclosure, along with the flow meter transmitter, panel heater and other miscellaneous equipment.

C. Control Panel General Mechanical Requirements:

1. The panel shall be completely fabricated; instruments installed, plumbed, and wired in the manufacturer's factory. All wiring and plumbing shall be completed and tested before shipment. All external connections shall be by way of numbered terminal blocks.

2. The panel shall be able to withstand, without damage, all stresses incidental to shipping, installation, and operation for which the equipment is specified.

3. The steel for the top, sides, and front shall be as required to meet the equipment requirements.

4. Steel shall be of prime stock, without tool, clamp marks, or other imperfections.

5. The panel shall be square and plumb with all dimensions to the following tolerances, as measured by straight edge over the noted straight line length across the console; 1/16" in 3 ft., 1/8" in ft. to 6 ft. and 3/16" over 6 ft. length.

6. The panel front face shall be stiffened and reinforced to prevent distortion due to the cantilever forces of installed instruments and other internal materials. The instruments weight and unit bracket and spacing shall be accounted for.

7. Unistrut (or equal) members shall be provided inside the enclosure for the support of instruments, wiring, incoming cables, or other internal materials. These supports shall leave adequate clearance available for equipment servicing or removal without the interruption of service to other devices.

8. The entire steel surface shall result in a neat and workmanlike appearance, with no welds, rivets, or bolt heads visible. All seams shall be continuous-welded, and ground smooth. The outside corners, joints, recesses, etc. shall be ground smooth and/or filled with metal putty to render them invisible after the panel has been painted. The edges of cutouts shall be ground smooth.

9. The panel shall be fitted with removable lifting rings.

10. The panel shall be wrapped in plastic for site storage.

11. Panel cutouts and openings shall be provided that are sized to the respective equipment manufacturer's specifications.

12. Removable subpanels shall be provided on both sides and of full size and as required to accommodate the mounting of internal devices such as terminals, relays, and other devices. The subpanel shall be fabricated from sheet steel with a minimum of 14 ga.

13. Access to the panel interior shall be through a front mounted double door. The doors shall have full-length continuous hinges. The door shall be fully-neoprene gasketed secured by oil-resistant adhesive. The door shall be capable of opening 180 degrees. The door will be constructed so as to permit ease in opening without sticking or binding.

14. Internal devices shall maintain a 2-inch minimum separation from the nearest door part.

15. The panel shall include a ventilating fan, heaters, grilles and filters, location and mounting as shown on the drawings and as required for environmental protection of components.

16. The panel surface shall have a smooth finish, scratch-free, and chip-proof with chemical and abrasion resistance. All surfaces to be painted shall be completely cleaned, degreased, smoothed and given a phosphatizing treatment prior to painting. One coat of primer and two (2) coats minimum, of finish paint shall be used. The second coat applied after the initial has dried. The panel interior color, including all sub-panels shall be gloss white enamel. Stainless steel shall be brush finished rather than painted.

17. One (1) pint of finish paint shall be provided from the same batch as applied, and delivered with the panel for touch-up use.
18. Internal subpanel mounted equipment shall have a minimum clearance of two (2) inches from any perpendicular exterior surface to the subpanel.

19. The panel shall have instruments mounted on the front door, as shown on the drawings. The supplier shall use the specifications of the respective instruments manufacturers for exact dimensions and position the device at the center-line of that shown on the drawing to maintain equipment lines for panel symmetry.

20. The front of panel instruments and other devices shall be properly aligned to present a workmanlike appearance. Devices on any particular center or elevation line shall not deviate from that line.

21. The panel shall include all necessary mounting screws and fastening devices, which shall be of the rustproof type.

22. All devices shall be located such that the servicing or removal can be accomplished without the interruption of operation of any other device and without the need for special tools.

D. Control Panel Electrical Requirements

1. The panel will have cable entry from bottom. The panel shall provide ample space for bringing these cables directly to the terminal blocks, through dedicated field wiring wireways.

2. There will be three (3) classes of power wiring within the panel: Low-voltage (24VDC) (For signals-analog) and 120 VAC Class I 600V (Line power and logic control) and 240V 3P power for the pumps.

3. Signal and A.C. wiring shall be separated whether in wireway, loose, or bundled. The minimum separation shall be 4" in parallel paths. Where wires must cross, they shall be at a 90 degree angle.

4. Intrinsically safe wiring shall be physically isolated from all other wiring within the panel, and shall be within its own sub space within the panel.

5. The panel shall have a main circuit breaker and branch circuit breakers for each loop. Branch breakers shall be sized for the load and wiring requirements.

6. All wiring shall be run in plastic removable covered wireway such as Panduit, or equal, maximum fill shall be 50%. Wireway shall include ducting, covers, fasteners, wire retainers, and corner strips, as required.

7. Where not practical to run in wireway, wires shall be bundled with nylon ties that are secured to the panel with adhesive backed mountings. Wire ties shall be locking such as Panduit "PLT", or equal.

8. Wire or bundled wire bends shall be neat and carefully made without damage to the wire insulation. Wiring shall be grouped in parallel runs, in either the vertical or horizontal planes and shall be installed in a uniform and workmanlike manner.

9. Wiring shall be continuous, without splices, between terminal points.

10. Individual wires or cables passing through or entering panel steel, boxes, or instrument cases shall be furnished and installed with plastic grommets to insulate and protect them.

11. The maximum length of uninsulated or unshielded stripped wire or cable to a termination shall be 1 inch.

12. Wires to the hand switches and indicating lights with compression type connections need not have lugs. The supplier must carefully check each termination to insure that the wire will not "pull-out" from the connection.

13. Wiring shall be protected with plastic bundle wrap where in contact with structural or equipment edges; for example bundles to door mounted equipment.

14. All wire ends shall be identified with shrink tube type labels, or equal, to indicate the wire or cable number. Cable shields do not need to be tagged. Identifying numbers shall include the loop number.
15. The maximum number of wires per device terminal is two.
16. Signal wires shall be instrument cable; 2 conductor twisted pair with overall shield and drain wire, #18 AWG-7 strand copper wire.
17. A.C. wiring shall primarily be No. 14 AWG, strand copper, Type MTW, 600V insulation. Other AWG sizes shall be as shown on the Drawings (such as power and ground circuits).
18. Signal Common, Power Supply Common, Annunciator (switched-D.C.), Power Supply Positive, and other low-level D.C. wiring shall be No. 16 AWG, strand copper, Type MTW, 600V insulation.
19. Individual wire color code shall be as follows:
   a. Black - A.C. line power to console disconnects.
   c. Green - Safety ground, instrument case ground, shield grounds.
   d. Red - A.C. control circuits
   e. Yellow - Externally powered wire, such as from interlock control circuits. These wires may be energized even if the panel disconnects are opened.
   f. Blue - Low-level D.C. such as Signal Common, Power Supply positive, power supply common, switched-D.C. For signal pairs; black for positive and white for common.
20. Terminal blocks shall be provided for all external panel wiring connections. The terminal blocks shall be vertical. The outside edge of each subpanel shall be dedicated to the external wire terminations.
21. There shall be separate terminal block groups for each of the classes of console wiring.
22. Each type of terminal block group shall be clearly labeled.
23. Terminal blocks shall be separated to allow for wireway and wire bends, as noted on the drawings. The arrangement shall afford maximum accessibility of terminals for ease in wiring, testing, and visibility for recognizing wire and terminal numbers.
24. Terminal blocks shall be 600 Volt Screw Terminal and shall include mounting strips, solid jumpers (as needed), marker strips, and end clamps.
25. Each terminal block point shall be identified on the marker strip with permanent, non-smear black ink. Identifying numbers shall be as shown on the shop drawings.
26. Terminal blocks shall be separated to allow for wireway and wire bends, as noted on the shop drawings.
27. Terminal block groups shall each have 10 percent spare terminals.
28. Terminal block points shall be arranged in numerical order, according to the shop drawings. The field terminal shall be mounted vertically. Spare points shall be inserted into the layout and at the end of the layout.
29. The "safety and shield" ground buses shall be provided to terminate ground wires from instrument chassis, console frame, the external ground cable and other device grounds. The safety ground bus shall be bonded to the console subpanel at each end.
30. The panel structural steel, including all subpanels and mounting brackets shall be bonded such that all elements are grounded when connected to the "safety" bus.
31. External and internal panel signal cable shields shall be terminated only at the field/panel terminal blocks, as shown on the shop drawings. The shields at the non-terminated ends, such as at the field sensor or receiving instrument, shall be insulated with tape or heat shrink tubing to insure no physical contact with any conductor. The drain wire at the cable shield termination side shall also be insulated.
32. The ends of all unused spare wires or pairs in multi-cable bundles shall be coiled, crimped, exposed ends insulated, and tagged as "spares" in the panel.
33. Each instrument or device case shall be safety grounded by an individual wire from the case to the ground bus.
34. The Electrical Contractor will provide feeder circuits of 120 VAC/60 HX/1 phase/3 wire power.
35. The wiring to hand switches, indication lights, and instruments shall have sufficient slack (6" min.) at the device to permit removal without disconnecting any wire.

E. Control Panel Identification and Labeling
1. Identification shall be provided for all equipment.
2. Nameplates shall be provided for all front of panel instruments, and other devices as shown on the Drawings.
   a. Nameplates shall be 1/8" thick, laminated plastic, such as Gravoply, with black surface and white core unless otherwise indicated on the Drawings.
   b. Nameplate front surface edges shall be beveled to frame the nameplate with a border.
   c. Nameplates shall be mounted immediately below the component it identifies, or as shown on the Drawings.
   d. Nameplates shall be fastened to the control panel with adhesive double-backed tape.
   e. The overall size of the nameplates shall be as indicated on the Drawings.
   f. The lettering shall be my machine - engraving through the facing to the core. Lettering shall be block type and square cut.
   g. The height of the nameplate lettering shall be 3/16-inch. Legends shall be as shown on the drawings.
3. Equipment labels shall also be provided for all internally mounted devices, including the front of panel mounted items.
   a. The labels shall be Kalograph mylar film photosensitive tape or equal. Dymo type are not accepted.
   b. The labels shall identify instruments by instrument tag number and other devices by device number or if none by name.
   c. Devices labeled shall include as a minimum; relay, hand switches, indicating lights, terminal blocks.
   d. The label shall not be affixed to the device itself. The label shall be easily seen and not located beneath wire bundles.
   e. Each front of panel device will have a label affixed to the interior of the front panel face.
   f. Provide inside the panel a label list for each circuit breaker assembly to identify each item tag and service.
4. Pushbuttons, selector switches, and indicating light escutcheons shall be the manufacturer's standard, with legends, as specified on the Drawings.
5. Wires and terminal block points shall be identified as described elsewhere in the specifications.

F. Preparation for Shipment
1. Following the completion of the Factory Test and Punch List work, replace all instrument and device covers to prevent damage and the entrance of debris.
2. The panel shall be thoroughly cleaned inside and out. Exterior surfaces shall be cleaned to remove all dirt and grease. The interior shall be vacuumed to remove all debris incidental to the assembly.
3. Secure the instruments and equipment to prevent damage during shipment and handling. Original equipment such as shipping stops and ties, shall be reinstalled. Glass shall be protected from breakage.
4. Box all instrument accessories, such as special tools, charts, ink, spare parts, and deliver with the panel.
5. Protection shall be provided against damage due to handling, shipment, storage, inclement weather, and field installation.
6. Label each separate shipping unit (panel section or boxes). The label shall be weather-proof and securely attached. Multiple shipping units shall indicate the unit number and
number of total units on each label. In addition to other customary information the label shall show the Contractor's Item No., and Purchase Order Number, the name of the item, and Owner.

G. Standard Light Colors and Inscriptions
1. Unless otherwise noted in the individual Loop Specifications, the following color code and inscriptions shall be followed for the lenses and legend plates of all indicated lights:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>ON</td>
<td>Red</td>
</tr>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>Green</td>
</tr>
<tr>
<td>AUTO</td>
<td>AUTO</td>
<td>Blue</td>
</tr>
<tr>
<td>MANUAL</td>
<td>MANUAL</td>
<td>White</td>
</tr>
<tr>
<td>REMOTE</td>
<td>REMOTE</td>
<td>Yellow</td>
</tr>
<tr>
<td>REQUIRED</td>
<td>REQUIRED</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

H. Standard Handswitch Colors and Inscriptions
a. Unless otherwise noted in the individual Loop Specifications, the following color code and inscriptions shall be followed for all pushbuttons/selector switches:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>00A</td>
<td>ON/OFF/AUTO</td>
<td>Black</td>
</tr>
<tr>
<td>00</td>
<td>ON</td>
<td>Black</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>Black</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET</td>
<td>Red</td>
</tr>
</tbody>
</table>

PART 3 EXECUTION

3.1 INSTALLATION

A. Standardization - All instruments shall be of the latest and most modern design and shall have the overall accuracy specified herein or equal to that of the specified components.

B. Install all equipment per the manufacturers recommendations, this includes all components indicated in the manufacturer's documentation, as directed by the Engineer.

C. The motor control center pump control starter and VFD control circuits shall be provided under a separate specification section with the required system interface components such as auxiliary contacts, thermal overloads, a 120vac control circuit transformer, and appurtenances as necessary for a complete system. The Contractor shall coordinate all interfaces.

D. The Integrator shall study the existing site conditions prior to bid.

E. The integrator shall provide a detailed programming submittal of the Operator interface units and PIC. In addition to the specified and customary submittal information all group, point displays, alarm lists, communication diagrams and other descriptive and training diagrams shall be included for Engineer review and later inclusion into the system O&M manual.

F. The integrator shall field calibrate all new and existing panel instruments at the device and loop test through to the local panel.
G. The Contractor shall coordinate, apply for and provide the telephone lines for the telemetry and communication system, if applicable.

H. The control system shall have a performance requirement meeting the referenced standard and customary practice values in the industry and per the project requirements.
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SECTION 13 44 20 - PRIMARY ELEMENTS AND TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Magnetic Flow Meters and Transmitters
   2. Submersible Level Transducers
   3. Float Switches

B. Related Sections include but are not necessarily limited to:
   1. Division 0 and Division 1 requirements.
   2. Section 13 44 00 - Instrumentation for Process Control: General Requirements.
   3. Section 13 44 30 - Control Loop Descriptions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI).
      c. MC96.1, Temperature Measurement Thermocouples.
   3. American Society of Mechanical Engineers (ASME):
      e. B88, Standard Specification for Seamless Copper Water Tube
   5. National Electrical Manufacturers Association (NEMA):
      a. ICS 6, Enclosures for Industrial Controls and Systems.

1.3 SYSTEM DESCRIPTION

A. The instruments specified in this Section are the primary element components for the control loops shown on the “I” and “E” series Drawings and specified in Section 13 44 10. These instruments are integrated with other control system components specified under the 13 44 00 specification series to produce the functional control defined in the Contract Documents.

1.4 SUBMITTEDS

A. Shop Drawings:
   1. See Sections 01 33 00.
   2. Manufacturer to review application compared to specified model and make recommendations.
B. Operation and Maintenance Manuals:
   1. See Section 01 33 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the Manufacturers listed in the articles describing the elements are acceptable.

B. Submit requests for substitutions in accordance with Specification Section 01 33 00.

2.2 PRIMARY ELEMENTS

A. Magnetic Flow Meter & Transmitter:
   1. Acceptable manufacturers:
      a. Endress & Hauser Promag 10 W
      b. ABB WaterMaster
      c. Substitution subject to approval may be proposed per the requirements of Section 01 33 00
   2. Materials:
      a. Housing: Powder Coat aluminum
   3. Design and fabrication:
      a. Size: As Specified on drawings
      b. Liner: Hard Rubber
      c. Application: raw wastewater
      d. NEMA 6P enclosure, submergence up to 10 feet
      e. Process Connection: Class 150, A105 Flanges,
      f. Electrodes: 316 SST, bullet nose
      g. Calibration: 3-point calibration, 0.5%
      h. Remote transmitter.
      j. Approvals: For location as indicated on Drawings.
      k. Cable: As required for installation. Contractor to coordinate.
      l. Cable entry: ½” NPT, potted for submersible installation.
      n. Software: ECC electrode cleaning circuit
      o. Output: Current (4-20Ma), HART, frequency and 2 relays
4. Schedule:

<table>
<thead>
<tr>
<th>TAG NUMBER</th>
<th>SERVICE</th>
<th>SIZE</th>
<th>RANGE</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE-1</td>
<td>Raw Wastewater</td>
<td>6&quot;</td>
<td>0 – 600 GPM</td>
<td>See Plans</td>
</tr>
</tbody>
</table>

B. Submersible Level Transducers
1. Acceptable Manufacturers:
   a. Ametek Model 575P
   b. No Substitutions
2. Features:
   a. 316 Stainless steel body
   b. Diaphragm: Hastelloy C
   c. Provide with nut and cable support
3. Provide with sufficient length of factory supplied cable for integration with output devices and control system. Contractor to coordinate cable length.

<table>
<thead>
<tr>
<th>TAG NUMBER</th>
<th>SERVICE</th>
<th>RANGE</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LE-1</td>
<td>Wastewater</td>
<td>0’-20’, 0-6 psi</td>
<td>See Plans</td>
</tr>
</tbody>
</table>

C. Float Switches
1. Acceptable Manufacturers:
   a. Anchor Scientific Roto-Float
   b. Substitution subject to approval may be proposed per the requirements of Section 01 33 00
2. Features:
   a. Suspension type with integral weight
   b. Polypropylene casing
   c. Mercury switch
   d. PVC cable jacket
   e. #18 conductors, 600V rating
   f. Cable length to be determined by contractor
   g. Normally open or normally closed as required
<table>
<thead>
<tr>
<th>TAG NUMBER</th>
<th>SERVICE</th>
<th>NO/NC</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS-1</td>
<td>Low Level</td>
<td>N.O.</td>
<td>Wet Well</td>
</tr>
<tr>
<td>LS-2</td>
<td>High Level</td>
<td>N.O.</td>
<td>Wet Well</td>
</tr>
<tr>
<td>LS-3</td>
<td>All Stop</td>
<td>N.O.</td>
<td>Wet Well</td>
</tr>
<tr>
<td>LS-4</td>
<td>Lead Start</td>
<td>N.O.</td>
<td>Wet Well</td>
</tr>
<tr>
<td>LS-5</td>
<td>Lag Start</td>
<td>N.O.</td>
<td>Wet Well</td>
</tr>
</tbody>
</table>

### 2.3 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
   1. Materials, unless otherwise specified, shall be as follows:
      b. Mounting brackets:
         1) 316 stainless steel.
      c. Mounting plates, angles:
         1) 316 Stainless steel.
      d. Instrument pipe stands:
         1) 316 stainless steel.

B. Tubing Support Angles and Brackets
   1. Any of the following materials are acceptable:
      a. Aluminum support with dielectric material between support and tubing
      b. Type 316 stainless steel
      c. Fiberglass

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings. Contractor shall coordinate required cable lengths for all devices.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of flow meter with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

C. Install products in accordance with manufacturer's instructions.

D. Install instrument mounting pipe stands level and plumb.

E. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

F. Keep foreign matter out of the system.

G. Remove all oil on piping and tubing with solvent before piping and tubing installation.

H. Plug all open ends and connections to keep out contaminants.

I. Tubing Installation:
   1. General:
      a. Install such that tube shows no sign of crumpling, bends of too short a radius, or flattening, etc.
      b. Make tube runs straight and parallel or perpendicular to the floor, equipment and piping runs.
      c. For liquid and steam applications, slope continuously from the process to the instrument with a minimum slope of 0.50 IN/FT.
      d. For gas and air applications, slope continuously from the instrument to the process with a minimum slope of 0.50 IN/FT.
      e. If the sensing line cannot be continuously sloped, install high point vents and low point drains.
      f. Keep instrument tubing clean during all phases of work.
      g. Blow out with clean, dry, oil-free air immediately before final assembly.
      h. Cut by sawing only and debur.
   2. Bending:
      a. Make each bend with tube bender of the correct size for the tube.
      b. Make all bends smooth and continuous.
      c. Rebending is not permitted.
      d. Make bends true to angle and radius.
      e. Maintain a true circular cross section of tubing without buckling or undue stretch of tube wall.
      f. Allowable tolerance for flattening out of tubing bends: Maximum of 8 percent of the OD for stainless steel tubing.
      g. Minimum bending radius for stainless steel tubing:
### Minimum Bending Radius

<table>
<thead>
<tr>
<th>TUBE OD INCHES</th>
<th>MINIMUM BENDING RADIUS, INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>9/16</td>
</tr>
<tr>
<td>3/8</td>
<td>15/16</td>
</tr>
<tr>
<td>1/2</td>
<td>1-1/2</td>
</tr>
</tbody>
</table>

- h. Minimum bending radius for type L, hard (drawn) copper.

<table>
<thead>
<tr>
<th>TUBE OD INCHES</th>
<th>MINIMUM BENDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>1-3/4</td>
</tr>
<tr>
<td>1/2</td>
<td>2-1/2</td>
</tr>
</tbody>
</table>

### Tubing Support

1. Intermittently support by clamping to support angle.
2. Install supports to be self-draining, supported by hangers, or cantilevered from walls or structural beams.
3. Support at 5 FT-0 IN maximum spans for horizontal or vertical runs.
4. Use tubing trays in areas where spans between supports are greater than 5 FT and for all signal tubing support.
5. Support each tubing tray at 10 FT maximum spans.
6. Align tubing in orderly rows and retain in the tray by bolted clips. The use of spring or speed clips is not acceptable.
7. Maintain order of the tubing throughout the length of the tray.
8. Locate angle, channel and tray installation to protect tubing from spills and mechanical damage.
9. Locate support members to clear all piping, conduit, equipment, hatchways, monorails, and personnel access ways and allow access for equipment operation and maintenance.
10. Support trays to prevent torsion, sway or sag.
11. Permanently attach supports to building steel or other permanent structural members.
12. Arrange supports and trays so that they do not become a trough or trap.

### Routing and Orientation

1. Route to maintain a minimum headroom clearance of 8 FT.
2. Locate and orient valves and specialties so that they are accessible for operation and maintenance from the operating floor. Do not route through or over equipment removal areas, below monorails or cranes nor above or below hatches.

### Expansion and Vibration Provisions

1. Provide horizontal expansion loops at the process connections.
2. Route tubing parallel to relative motion through sleeved supports that allow linear tube movement.
3. Cold springing of tubing to compensate for thermal expansion is prohibited.

### Threaded Connection Seals

1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

K. Instrument Mounting:
   1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
   2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
   3. Mount instruments level, plumb, and support rigidly.
   4. Mount to provide:
      a. Protection from heat, shock, and vibrations.
      b. Accessibility for maintenance.
      c. Freedom from interference with piping, conduit and equipment.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
C. Testing:
   1. Test and calibrate flow meter to demonstrate that it meets specified accuracy requirements.
   2. Comply with AWWA M6.
D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two days on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
E. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.
F. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION
SECTION 13 44 30 - CONTROL LOOP DESCRIPTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instrumentation control loops.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 and Division 1 requirements.
   2. Section 13 44 00 - Instrumentation for Process Control: General Requirements.
   4. Section 13 44 20 – Primary Elements and Transmitters.
   5. Section 40 63 43 – Programmable Logic Controllers.

1.2 QUALITY ASSURANCE

A. See Section 13 44 00.

1.3 SYSTEM DESCRIPTION

A. The control loop descriptions provide the functional requirements of the control loops represented in the Contract Documents. Descriptions are provided as follows:
   1. Control system overview and general description
   2. Major equipment to be controlled
   3. Major Field mounted instruments (does not include local gauges)
   4. Manual control functions
   5. Automatic control functions/interlocks
   6. Major indications provided at local control panels and motor starters/VFD's
   7. Remote indications and alarms

B. The control loop descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the drawings and other specification sections. The control loop descriptions shall not be considered equal to a bill of materials.

C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and shown on drawings.

1.4 SUBMITTALS

A. See Section 13 44 00.

B. See Section 01 33 00.

C. Integrator shall include control loop descriptions for each loop in system with submittals. Ensure that tag numbers cross reference with loop diagrams and tag numbers shown on instrument specification forms. Where tag numbers are not assigned, the control integrator shall assign tag numbers. Describe each element and include appropriate tag number in parenthesis. When additional elements are necessary, use and assign tag number not in conflict with others and in accordance with ISA procedures.

D. Operation and Maintenance Manuals:
1. See Section 01 70 00.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 SYSTEM RESPONSIBILITIES

A. The Integrator shall be responsible for adding control of the new systems and integrating with City SCADA.

B. Integrator shall furnish and install any required expansion boards, racks, analog or discrete input or output modules required.

C. The Integrator shall be responsible for thoroughly checking the control system to identify and correct conflicts and verify functionality.

D. The Integrator shall furnish, install and program new graphical interface terminals per Section 40 63 43.

E. The Integrator shall coordinate required interface screens with Engineer, Operations Staff, and Equipment Manufacturers to provide desired functionality.

3.2 CONTROL SCREENS

A. Basic Operator interface screens include:
   1. Master Status Screen
      a. The Master Status Screen shall indicate status of all major equipment and process control information.
         1) Equipment status shall include available/unavailable, running/stopped, and alarm condition.
         2) Process control information shall include all flow rates, levels, etc.
   2. Master Alarm Screen
      a. The Master alarm screen shall indicate current active and acknowledged alerts/alarms. Alert/Alarm information and status, including alarm name, equipment status and time/date of alert/alarm, alarm status
         1) The operator shall be able acknowledge or clear alarms from this screen.
         2) Historical (72 hour rolling record) alarm/alert information shall available on a sub-screen.
   3. Pump Screen
      a. The Pump Screen shall display the pump layout and basic status information:
         1) Indication of Running, Stopped, Available, Alarm Condition
         2) Combined Flow rate for the Pumps from associated Magnetic Flow Meter
            a) Pump control shall be available for each pump via pop-up screens.
         3) Setpoint inputs for Low Level Alarm, All Pumps Stop, Lead Pump Start, Lag Pump Start, and High Level Alarm
         4) Settings for alternation mode, lead select, or alternate
         5) Run times and accumulated starts for each pump
         6) Current Wet Well Level

3.3 CONTROL LOOPS:
A. Sequence of operation:
1. PLC-1 shall report the number of available or running booster pumps to FRWRD SCADA.
   a. PLC-1 shall monitor Flow Meter FE/FIT-1.
   b. PLC-1 shall monitor Submersible level transducer LE-1 and shall start and the pumps base upon operator setpoints input to the system.
2. New PLC-1 is a proposed CompactLogix 1769-L16ER processor based PLC and shall be located in a NEMA 12 enclosure within a NEMA 3RX Traffic Box.
3. New PLC-1 shall be equipped with a PanelView Plus touch screen HMI and shall have a graphical interface.

B. Pump Control
1. The PLC shall control (2) proposed Raw Sewage Submersible Pumps driven by starters and shall require the following signals:
   1) Start (DO)
   2) Running (DI)
   3) Fault (DO)
   4) Local/Auto (DO)
   5) High Temp (DO)
   6) Seal Failure (DO)
   b. The PLC shall monitor signals from the proposed submersible pressure transducer LE-1.
      1) Start Lead pump if wet well level exceeds El. 720.50 (operator set point).
      2) Stop Lead pump if wet well level falls below El. 719.00 (operator set point).
      3) Start Lag pump if wet well level exceeds El. 722.00 (operator set point).
      4) Stop Lag pump if wet well level falls below El. 719.50 (operator set point).
   c. The PLC shall monitor signals from the proposed float switches.
      1) Monitor float switch LS-1, Low Level Alarm.
      2) Monitor float switch LS-2, High Level Alarm.
      4) Monitor float switch LS-4, Lag Start.
      5) Monitor float switch LS-5, All Stop.
   d. The PLC shall monitor pump motor high temperature and seal failure relays.
      1) A high temperature indication shall directly lock out the associated starter, stop the pump and issue an alarm.
      2) A seal failure indication shall be logged for attention, but not alarmed.
   e. PLC/LIT Bypass Pump Control:
      a) A PLC/LIT bypass pump control system shall be provided, which, upon activation of either the high level alarm or low level alarm float for ten (10) seconds, shall become active and assume control of the station’s pumps.
      b) The PLC/LIT bypass pump control system shall operate the pumps in the event of a PLC or level transducer failure.
      c) The bypass pump control system shall start and stop the pumps by sending a start signal to each pump’s starter.
      d) The bypass control system shall be contained within the same panel as the PLC.
      e) The bypass control system shall continue to operate the pumps until the system is reset by the operator.
f) While the Bypass control system is in operation, a screen showing the words “Bypass Control System Active” shall be displayed on the PLC OIT.
g) Upon initial activation of the Bypass Control system, the station shall notify the operations staff via SCADA.

2) Power Monitoring:
   a) Allen-Bradley 1408-EM3A-ENT with digital display.
   b) Monitor two (2) proposed motor starters for Raw Sewage Pumps (P-1, P-2).
   c) Convey signal of power usage every 15 seconds to operations staff via SCADA.

2. Screens
   a. Menu Screen:
      1) The menu screen shall display a hierarchical index of all screens available to the operator from this location. The operator shall have the ability to select and display any screens.
      2) Push button selection of the following shall be included in the first level of the hierarchy:
         a) Station Layout.
         b) Master Status Screen.
         c) Master Alarm.
         d) Raw Sewage Pumps.
   b. Station Layout Screen:
      1) The Station Layout Screen shall consist of a plan view of the station showing the physical relation of the equipment.
      2) Sub screens shall be selectable from this screen.
   c. Master Status Screen:
      1) The Master Status Screen shall indicate status of all major equipment and process control information.
         a) Equipment status shall include available/unavailable, running/stopped, and alarm condition.
         b) Process control information shall include all pump speeds, levels, analysis device values, valve positions, etc.
   d. Master Alarm Screen:
      1) The Master alarm screen shall indicate current active and acknowledged alerts/alarms. Alert/Alarm information and status, including alarm name, equipment status and time/date of alert/alarm, alarm status
         a) The operator shall be able acknowledge or clear alarms from this screen.
         b) Historical (72 hour rolling record) alarm/alert information shall available on a sub-screen.
   e. Raw Sewage Pump Screen:
      1) Provide overview of station pumps, including run status (running, stopped, available, Local/Auto) and alarm status (high temperature, seal failure).
      2) Individual pump control screens shall be available via pop-up screens
         a) Information available via pop-up screen shall include Wet Well Level Setpoints (low level alarm, high level alarm, lead pump start, lead pump stop, lag pump start, lag pump stop), flow rate (MGD and gpm), total for flow meter (gallons, total shall be resettable), current wet well level (feet), LOR status, run time for each pump (hours, adjustable), and number of starts for each pump.
3) Screens shall include all status and alarms indicated on the P&IDs and/or available on manufacturer equipment. The status and alarms shall be by system, and shown graphically.

4) Pump alternator screen
   a) Auto alternation select
   b) Lead pump select
   c) Forced alternation set up screen
      (1) Time of day select (24 hour clock entry)
      (2) Forced Alternation enable/disable

3. SCADA Integration
   a. The following functions, as minimum, shall be transmitted through SCADA:
      1) HOA position.
      2) Bypass Float System Activation indication.
      3) Bypass Float System Remote Reset (Via SCADA, return to PLC control).
      4) Wet Well Level.
      5) Pump run times, events, totalization, and daily summary information (available via SCADA).
      6) Flow rates.
      7) Flow totals.
      8) Generator status and faults.

END OF SECTION 13 44 30
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DIVISION 22
PLUMBING
SECTION 22 05 03 - PIPE AND PIPE FITTINGS: PLUMBING SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Plumbing Piping.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 22 05 29 – Hangers and Supports for HVAC and Plumbing Piping and Equipment.
   4. Section 22 05 23 - Valves: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      b. B31.1, Power Piping.
      d. B31.9, Building Services Piping.
      e. B40.100, Pressure Gauges and Gauge Attachments.
   2. ASTM International (ASTM):
      b. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
      d. B16.23, Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
      e. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   4. American Water Works Association (AWWA):
      d. C151, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
      e. C203, Coal-Tar Protective Linings for Steel.
      f. C206, Field Welding of Steel Water Pipe.
      g. C207, Steel Pipe Flanges for Waterworks Service.
      h. C606, Grooved and Shouldered Joints.
      i. C651, Disinfecting Water Mains.
5. American Welding Society (AWS):
   a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.

6. Building Code:
   a. International Code Council (ICC):
         amendments, referred to herein as Building Code.

B. Qualifications:
   1. Use only certified welders meeting procedures and performance outlined in ASME
      Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local
      building and utility requirements.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration
      of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards
         referenced.
      b. Copies of manufacturer's written directions regarding material handling, delivery,
         storage and installation.
      c. Separate schedule sheet for each piping system scheduled in this Specification
         Section showing compliance of all system components.
         1) Attach technical product data on gaskets, pipe, fittings, and other components.
   3. Welders’ certificates.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 00 for requirements for the mechanics,
         administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. Qualifications of lab performing disinfection analysis on water systems.
   2. Test reports:
      a. Copies of pressure test results on all piping systems.
      b. Reports defining results of dielectric testing and corrective action taken.
      c. Disinfection test report.
      d. Notification of time and date of piping pressure tests.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are
   acceptable:
   1. Couplings:
      a. Dresser.
b. Rockwell.

2. Mechanical Couplings:
   a. Victaulic.
   b. Tyler.

3. Expansion Fittings:
   a. Flexicraft.
   b. Mason.
   c. Metraflex.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MATERIALS

A. Piping Systems:
   1. Piping systems are scheduled by service in PART 3 of this specification.

B. Pipe and Tube:
   1. Copper:
      a. Type K, L, or M tube per ASTM B88.
      b. Utilize only annealed (soft) type tubing where flared joints are used and drawn temper (hard) type tubing where soldered or brazed joints are used.
      c. Fittings, per System Type:
         1) Cast copper or bronze (pressure): Per ASTM B16.18.
         2) Wrought copper or bronze (pressure, solder): ASTM B16.22.
         3) Cast copper or bronze (DWV): Per ASTM B16.23.
      d. Joints:
         1) Flared.
         2) Soldered or Brazed:
            a) Above ground below 180 DegF: ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux.
            b) Above ground 180 DegF and above: use brazing alloy with melting temperature above 1000 DegF and suitable flux.
            c) Buried: Silver solder per AWS A5.8M/A5.8.
            d) Provide unions and valves and equipment.
      e. Unions: Class 150, bronze.

   2. Steel:
      a. Schedule 10, 40 or 80 per ASTM A53.
      b. Finish: Black or hot-dip galvanized per ASTM A53.
      c. Fittings: Per System Type:
         1) Malleable iron: Per ASTM B16.3.
         2) Forged Steel: Per ASTM A234.
      d. Joints: Per System Type:
         1) Threaded.
            a) With unions and valves and equipment.
         2) Flanged with rubber gaskets.
         3) Socket or butt welded.
      e. Unions: Class 150, malleable iron, threaded.

   3. PVC: See Section 40 05 31 – Thermoplastic Process Pipe.
2.3 MANUFACTURED UNITS

A. Unions:
   1. Copper pipe:
      a. Copper ground joint unions for pipe sizes 2 IN and smaller.
      b. Brass flanged unions for pipe sizes larger than 2 IN.

2.4 ACCESSORIES

A. Natural Gas Equipment Isolator: 316L stainless steel, T-321 stainless steel braid with connections compatible with joints in piping system.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends.
B. Remove burrs.
C. Remove scale and dirt on inside and outside before assembly.
D. Prepare piping connections to equipment with flanges and unions.
E. Deep open ends of pipe free from scale and dirt.
F. Protect open ends with temporary plugs or caps.

3.2 EXTERIOR BURIED PIPING INSTALLATION

A. Unless otherwise shown on the Drawings, provide a minimum of 4 FT of earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.

B. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01 73 20 and as shown on Drawings.

C. When entering or leaving structures with buried mechanical joint piping, install joint within 2 FT of point where pipe enters or leaves structure.
   1. Install second joint not more than 6 FT or less than 4 FT from first joint.

D. Install expansion devices as necessary to allow expansion and contraction movement.

E. Laying Pipe in Trench:
   1. Excavate and backfill trench in accordance with Division 31.
   2. Clean each pipe length thoroughly and inspect for compliance to specifications.
   3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
   4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
5. Except for first two (2) joints, before making final connections of joints, install two (2) full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
6. Lay pipe in only suitable weather with good trench conditions.
   a. Never lay pipe in water except where approved by Engineer.
7. Seal open end of line with watertight plug if pipe laying stopped.

F. Anchorage and Blocking:
   1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.
   2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
      a. Concrete blocks shall not cover pipe joints.
   3. Provide bearing area of concrete in accordance with Drawing detail.

G. Install underground hazard warning tape per Specification Section 10 14 00.

H. Install insulating components where dissimilar metals are joined together.

3.3 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:
   1. Expansion and contraction.
   2. Operation and access to equipment, doors, windows, hoists, moving equipment.
   3. Headroom and walking space for working areas and aisles.
   4. System drainage and air removal.

C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01 73 20 and as shown on the Drawings.

D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

E. Pipe Support:
   1. Use methods of piping support as shown on Drawings and as required in Specification Section 22 05 29.
   2. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
      a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
   3. Size pipe supports with consideration to specific gravity of liquid being piped.

F. Locate and size sleeves and castings required for piping system.
   1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

G. Use reducing fittings throughout piping systems.
   1. Bushings will not be allowed unless specifically approved.
H. Equipment Drainage:
   1. Provide drip pans and piping at equipment where condensation may occur.
   2. Avoid piping over electrical components such as motor control centers, panelboards, etc.
      a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping
         and over full length of electrical equipment.
      b. Hard pipe drainage to nearest floor drain.

I. Miscellaneous Piping:
   1. If system is not otherwise specified, provide stainless steel tubing.
   2. Size to handle application with 3/4 IN being minimum size provided.

J. Unions:
   1. Install in position which will permit valve or equipment to be removed without
      dismantling adjacent piping.
   2. Mechanical type couplings may serve as unions.
   3. Additional flange unions are not required at flanged connections.

K. Install expansion devices as necessary to allow expansion/contraction movement.

L. Provide full face gaskets on all systems.

M. Anchorage and Blocking:
   1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed
      to prevent separation of joints and transmission of stress into equipment or structural
      components not designed to resist those stresses.

N. Equipment Pipe Connections:
   1. Make piping connections to plumbing and HVAC equipment, including but not limited to
      installation of fittings, strainers, pressure reducing valves, flow control valves and relief
      valves provided with or as integral part of equipment.
   2. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves,
      pressure relief valves, and shock absorbers which are not specified to be provided with or
      as integral part of equipment.
   3. For each water supply piping connection to equipment, furnish and install union and gate
      or angle valve.
      a. Provide wheel handle stop valve at each laboratory sink water supply.
      b. Minimum size: 1/2 IN.
   4. Furnish and install "P" trap for each waste piping connection to equipment if waste is
      connected directly to building sewer system.
      a. Size trap as required by IPC.
   5. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P"
      traps, miscellaneous traps and miscellaneous brass through wall or floor and cap and
      protect until such time when later installation is performed.

O. Provide insulating components where dissimilar metals are joined together.

3.4 ACCESS PROVISIONS

   A. Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping
      and piping appurtenances requiring service.
B. Size of access panels to allow inspection and removal of items served, minimum 10 x 14 IN size.

C. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type.

D. Provide with key locks, keyed alike, in public use areas.

E. Furnish panels with prime coat of paint.

F. Style and type as required for material in which door installed.

G. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

3.5 CATHODIC PROTECTION

A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.

B. Make all connections from wire or cable by Thermit Cad welding accomplished by operators experienced in this process.

C. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50 percent of the straight line length.

D. After cad welding, coat all exposed metallic surfaces with hot applied tape.

3.6 CLEANING

A. Cleaning:
   1. Clean interior of piping systems thoroughly before installing.
   2. Maintain pipe in clean condition during installation.
   3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
   4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
   5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
      a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
      b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
   6. Clean chlorine piping in accordance with CI Pamphlet 6.

3.7 SCHEDULES

A. System 4 - Condensate and Sump Pump Drains:
   1. Above Ground (gravity drainage):
      a. Pipe: DWV grade PVC.
b. Fittings: DWV PVC.
c. Joints: Solvent Weld.

2. Above ground (pumped):
   a. Pipe: Schedule 80 PVC.
   b. Fittings: Schedule 80 PVC to match pipe.
   c. Joints: Solvent weld.

3. Buried (pumped):
   a. Pipe: Schedule 80 PVC.
   b. Fittings: Schedule 80 PVC to match pipe.
   c. Joints: Solvent weld.

END OF SECTION
SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1  GENERAL

1.1  SUMMARY

A. Section Includes:
   1. Gate valves.
   2. Ball valves.
   4. Check valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 22 05 03 - Pipe and Pipe Fittings: Plumbing Systems.

1.2  REFERENCES

A. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 67 - Butterfly Valves.
   2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
   3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
   4. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
   5. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3  SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.
   3. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4  QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

PART 2  PRODUCTS

2.1  ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Apollo.
   2. Crane.
   3. DeZurik.
   4. Milwaukee Valve Co.
   5. Nibco, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 GATE VALVES

   A. 2 IN and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, bonnet, non-rising stem, hand-wheel, inside screw, wedge disc, solder or threaded ends.

   B. 2-1/2 IN and Larger: MSS SP 70, Class 125, cast iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 IN and larger mounted over 8 FT above floor.

2.3 BALL VALVES

   A. 3 IN and Smaller: MSS SP 110, 400 psi WOG, bronze body, chrome plated brass ball, full port, teflon seats, blow-out proof stem, solder or threaded ends, lever handle.

2.4 CHECK VALVES

   A. Horizontal Swing Check Valves:
      1. 2 IN and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Teflon disc, solder or threaded ends.
      2. 2-1/2 IN and Larger: MSS SP 71, Class 125, cast iron body, bronze swing disc, flanged ends.

PART 3 EXECUTION

3.1 INSTALLATION

   A. Install valves with stems upright or horizontal, not inverted.

   B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

   C. Install 3/4 IN ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

   D. Install valves with clearance for installation of insulation and allowing access.

   E. Provide access where valves and fittings are not accessible.

   F. Refer to Section 22 05 29 for pipe hangers.
G. Refer to Section 40 42 00 for insulation requirements for valves.

H. Refer to Section 22 05 03 for piping materials applying to various system types.

3.2 VALVE APPLICATIONS

A. Install ball or gate valves for drain service at locations indicated on Drawings in accordance with this Section.

B. Install ball or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install ball valves for throttling, bypass, or manual flow control services.

D. Install spring loaded check valves on discharge of water pumps.

E. Install lever and weight check valves on discharge of pumps in pumped sanitary piping.

F. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment.

G. Install ball and gate valves in domestic water systems for shut-off service.

H. Install ball valves in domestic water systems for throttling service.

END OF SECTION
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SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe hangers and supports.
   2. Hanger rods.
   3. Inserts.
   4. Flashing.
   5. Formed steel channel.
   6. Firestopping relating to plumbing work.
   7. Firestopping accessories.

B. Related Sections:
   1. Division 03 - Concrete.
   2. Section 07 92 00 - Joint Sealants.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 22 05 03 - Pipes and Tubes for Plumbing Piping and Equipment.
   5. Division 40 - Process Interconnections.

1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME B31.1 - Power Piping.
   2. ASME B31.3 - Process Piping.
   3. ASME B31.5 - Refrigeration Piping.
   4. ASME B31.9 - Building Services Piping.

B. ANVIL International (ANVIL).

C. ASTM International (ASTM):
D. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

E. FM Global:

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:

H. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Manufacturer’s installation instructions.
   4. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
   5. Scaled Drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
   6. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
   7. Support systems for piping systems over 12 IN DIA, systems operating over 100 psig or systems operating over 200 DegF designed by the Contractor: Submit detail design calculations and scaled Drawings prepared and signed by a registered Professional Engineer in the state of Illinois.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE
A. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

B. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.

C. Maintain one copy of each document on site.

D. Responsibility:
   1. Contractor shall design support systems for 12 IN DIA piping and smaller, and for larger diameter piping where supports are not shown on the Drawings.
   2. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.
   3. General piping support details may be indicated on the Drawings in certain locations for pipe smaller than 12 IN DIA.
   4. Contractor shall incorporate those details with requirements of this Specification Section to provide the piping support system.

E. Each type of pipe hanger or support shall be the product of one manufacturer.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

B. Provide ventilation in areas to receive solvent cured materials.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 WARRANTY
A. Furnish five-year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Anvil International.
   2. PHD Manufacturing.
   3. Cooper B-Line.
   4. Erico International.
   5. Tolco Inc.

B. Piping Supports:
   1. Material:
      a. 304 Stainless Steel for all areas.
   2. Conform to MSS SP58.
   3. Hangers for Pipe Sizes 1/2 to 1-1/2 IN: Adjustable swivel, split ring.
   4. Hangers for Pipe Sizes 2 IN and Larger: Adjustable, clevis.
   5. Multiple or Trapeze Hangers: Channels with welded spacers and hanger rods.
   7. Wall Support for Pipe Sizes 4 IN and Larger: Welded bracket and clamps.
   9. Floor Support: Adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or metal support.
   10. Copper Pipe Support direct on copper pipe: Copper-plated, adjustable, ring.

2.2 ACCESSORIES

A. Hanger Rods: 304 stainless steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Manufacturers:
   1. Hilti.
   2. Simpson.
   3. Tolco.
   5. Grinnell.

B. Inserts: Material matching hanger rod material shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 26 gage thick aluminum.

B. Metal Counterflash: 22 gage thick aluminum.
C. Lead Flashing:
   1. Waterproofing: 5 LBS/SF sheet lead.
   2. Soundproofing: 1 LBS/SF sheet lead.

D. Flexible Flashing: 47 mil thick sheet compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. GPT Industries
   2. Proco Products, Inc.
   3. Flexicraft Industries.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 FORMED CHANNEL

A. Manufacturers:
   1. Unistrut Corporation.
   2. Cooper B-Line.
   3. Erico.

B. Product Description: 12 gage thick. With holes 1-1/2 IN OC.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Architect/Engineer before using powder-actuated anchors.

D. Obtain permission from Architect/Engineer before drilling or cutting structural members.

E. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.

F. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.
3.2 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 IN and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with MSS SP 58 and MSS SP 69.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 IN space between finished covering and adjacent work.

D. Place hangers within 12 IN of each horizontal elbow.

E. Use hangers with 1-1/2 IN minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 FT maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Refer to Section 09 96 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation.

N. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

3.4 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counter flashing where piping penetrates weather or waterproofed walls, floors, and roofs.
B. Flash vent and soil pipes projecting 3 IN minimum above finished roof surface with lead worked 1 IN minimum into hub, 8 IN minimum clear on sides with 24 x 24 IN sheet size. For pipes through outside walls, turn flanges back into wall and seal, metal counter-flash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 IN clear on sides with minimum 36 x 36 IN sheet size. Fasten flashing to drain clamp device.

D. Seal floor, shower, and mop sink drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; seal around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.5 SCHEDULES

<table>
<thead>
<tr>
<th>PIPE MATERIAL</th>
<th>MAXIMUM HANGER SPACING FEET</th>
<th>HANGER ROD DIAMETER INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum (All sizes)</td>
<td>10</td>
<td>1/2</td>
</tr>
<tr>
<td>Cast Iron (All Sizes)</td>
<td>5</td>
<td>5/8</td>
</tr>
<tr>
<td>Cast Iron (All Sizes) with 10 FT length of pipe</td>
<td>10</td>
<td>5/8</td>
</tr>
<tr>
<td>Copper Tube, 1-1/4 IN and smaller</td>
<td>6</td>
<td>1/2</td>
</tr>
<tr>
<td>Copper Tube, 1-1/2 IN and larger</td>
<td>10</td>
<td>1/2</td>
</tr>
<tr>
<td>PVC (All Sizes)</td>
<td>4</td>
<td>3/8</td>
</tr>
<tr>
<td>Steel, 3 IN and smaller</td>
<td>12</td>
<td>1/2</td>
</tr>
<tr>
<td>Steel, 4 IN and larger</td>
<td>12</td>
<td>5/8</td>
</tr>
</tbody>
</table>

END OF SECTION
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SECTION 22 20 00 - PLUMBING FIXTURES AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Plumbing fixtures, trim, and equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 60 00 - Product Requirements.
   4. Section 22 05 03 - Pipe and Pipe Fittings: Plumbing Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
   4. American Society of Mechanical Engineers (ASME):
   5. American Society of Sanitation Engineers (ASSE):
      a. 1011, Performance Requirements for Hose Connection Vacuum Breaker.
   6. Canadian Standards Association (CSA).
   7. NSF International (NSF).
   8. Underwriters Laboratories, Inc. (UL).
   9. Building Code:
      a. International Code Council (ICC):

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 01 60 00 and Specification Section 22 05 03.
   4. Fabrication and/or layout Drawings:
      a. Layout plan(s) showing dimensions, elevations, etc.
      b. Details showing connections, installation, rough-in locations, etc.
   5. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's installation instructions.
c. Chemical-resistance data.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Sump Pumps:
      a. Zoeller.
      b. Liberty.
      c. Aurora.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

A. Sump Pumps (SP-1 and SP-2):
   1. Type: Submersible.
   2. Pump casing: Cast iron, ASTM A48, Class 30B.
   3. Impeller:
      a. Cast iron, ASTM A48, Class 35A.
      b. Non-clogging vortex.
   4. Shaft: Stainless steel, AISI Type 304.
   6. Mechanical seals: Carbon and ceramic with stainless steel parts.
   9. Seal fail module:
      a. Remote panel installed in electrical room.
      b. NEMA 4X enclosure.
      c. Red indicator beacon.
      d. Moisture sensor relay.
      e. Contact Terminal.
   12. Hermetically sealed, watertight, dust-tight.

PART 3 EXECUTION

3.1 INSTALLATION
A. Cross Connection: Do not install any plumbing components that will provide a cross connection between potable and non-potable or drainage systems.

B. Fixtures:
1. Install fixtures at locations indicated on Drawings and in compliance with local Codes.
2. Connect plumbing supply, drain and vent line sizes as shown on Drawings.
3. Set proper grounds to form secure base for each fixture and rigid setting.
4. Install fixtures except water closets with water supply above rim and with Code approved backflow preventers.
5. Seal fixture joints abutting walls and floors with silicone sealant.
6. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified.
7. Install emergency fixtures in accordance with ANSI Z358.1.

C. Drains:
1. Install drains at locations indicated on Drawings and in compliance with local Codes.
2. In uncovered concrete slabs:
   a. Install at the low points of surface areas to be drained or as indicated.
   b. Set tops of drains flush with the finished floor.
   c. Install drain flashing collar or a flange so that no leakage occurs between the drain and the adjoining surfaces.
   d. Maintain the integrity of waterproof membranes, where penetrated.

3.2 FIELD QUALITY CONTROL

A. Test piping and fixtures for leaks per Specification Section 22 05 03.

END OF SECTION
DIVISION 26

ELECTRICAL
SECTION 26 05 00 - ELECTRICAL: BASIC REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   5. Section 26 05 33 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   3. ASTM International (ASTM):
   4. ETL Testing Laboratories (ETL).
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   6. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc. (UL).

B. Where UL test procedures have been established for the product type, use UL or ETL approved electrical equipment and provide with the UL or ETL label.

1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
   2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
   3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of submittal process.
   2. See individual Specification Sections for submittal requirements for products defined as equipment.
   3. General requirements:
      a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
      b. Include data sheets that include manufacturer's name and product model number.
         1) Clearly identify all optional accessories.
      c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
      d. Manufacturer's delivery, storage, handling and installation instructions.
      e. Product installation details.
      f. See individual Specification Sections for any additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 70 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content process of Operation and Maintenance Manuals.

C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01 33 00 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
   1. Outdoor areas:
      a. Wet.
      b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
   2. Indoor areas:
      a. Dry.
b. Also, wet, corrosive, highly corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

C. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
   1. Approved manufacturers:
      a. Modular strut:
         1) Unistrut Building Systems.
         2) Eaton B-Line.
         3) Globe Strut.
         4) Thomas & Betts Superstrut.
   2. Material requirements:
      a. Modular strut:
         1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
         2) Aluminum: AA Type 6063-T6.
         3) Non-Metallic.
      b. Mounting hardware:
         1) Galvanized steel.
         2) Stainless steel.
      c. Anchorage per Specification Section 05 50 00.

B. Field touch-up of galvanized surfaces.
   1. Zinc-rich primer.
      a. One (1) coat, 3.0 mils, ZRC by ZRC Products.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
   1. NFPA 70.
   2. IEEE C2.
   3. The manufacturer's instructions.
C. In general, conduit routing is not shown on the Drawings.
   1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
   2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:
   1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
   2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
   3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
   4. See Specification Section 26 05 19 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.

I. Device Mounting Schedule:
   1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
      a. Light switch (to center): 48 IN.
      b. Receptacle on exterior wall of building (to center): 18 IN.
      c. Receptacle in non-architecturally finished areas (to center): 48 IN.
      d. Telephone outlet for wall-mounted phone (to center): 54 IN.
      e. Safety switch (to center of operating handle): 54 IN.
      f. Separately mounted motor starter (to center of operating handle): 54 IN.
      g. Pushbutton or selector switch control station (to center): 48 IN.
      h. Panelboard (to top): 72 IN.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
   1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments in equipment locations in accordance with the following without obtaining the Engineer's approval:
      a. 1 FT at grade, floor and roof level in any direction in the horizontal plane.
      b. 6 IN for equipment other than lighting at ceiling level in any direction in the horizontal plane.
      c. 6 IN for lighting fixtures at ceiling level in any direction in the horizontal plane.
      d. 6 IN on walls in a horizontal direction within the vertical plane.
e. Changes in equipment location exceeding those defined above require the Engineer's approval.

K. Provide electrical equipment support system per the following area designations:
   1. Dry areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   2. Wet areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   3. Corrosive areas:
      a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.
   4. Highly corrosive areas:
      a. Fiberglass systems consisting of fiberglass channels and fittings, nuts, and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. Do not cut, or weld to, building structural members.
   2. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Wet Wells, Basins, Clarifiers, Digesters, Reservoirs, etc.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

Q. Identify electrical equipment and components in accordance with Specification Section 10 14 00.

3.2 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
   1. See Specification Section 01 73 20 for openings and penetrations in structures.

B. Replace equipment and systems found inoperative or defective and re-test.
C. The protective coating integrity of support structures and equipment enclosures shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair surfaces which will be inaccessible after installation prior to installation.
   4. See Specification Section 26 05 33 for requirements for conduits and associated accessories.

D. Replace nameplates damaged during installation.

END OF SECTION
SECTION 26 05 19 - WIRE AND CABLE: 600 VOLT AND BELOW

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Shielded VFD cable.
      e. Instrumentation cable.
      f. Fiber optic cable.
      g. Wire connectors.
      h. Insulating tape.
      i. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Insulated Cable Engineers Association (ICEA):
   2. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      a. 70, National Electrical Code (NEC).
      b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   5. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 568, Commercial Building Telecommunications Cabling Standard.
   6. Underwriters Laboratories, Inc. (UL):
      c. 467, Standard for Safety Grounding and Bonding Equipment.
      d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
      e. 486C, Standard for Safety Splicing Wire Connections.
f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.


i. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. The following are specific types of instrumentation cables:
      a. Analog signal cable:
         1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 16 AWG and smaller conductors.
         2) Commonly used types are defined in the following:
            a) TSP: Twisted shielded pair.
            b) TST: Twisted shielded triad.
      b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.

E. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

F. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Wire connectors.
         2) Insulating tape.
         3) Cable lubricant.
      b. See Specification Section 26 05 00 for additional requirements.
PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Building wire, power and control cable:
      a. Aetna Insulated Wire.
      b. Alphawire.
      c. Cerrowire.
      d. Encore Wire Corporation.
      e. General Cable.
      f. Okonite Company.
      g. Southwire Company.
   2. Shielded VFD cable:
      a. Belden Inc.
      b. General Cable.
      c. Okonite Company.
      d. Olfex Wire and Cable, Inc.
      e. Priority Wire and Cable (Prysmian).
      f. Rockbestos-Surprenant Cable Corp.
      g. Southwire Company.
   3. Instrumentation cable:
      a. Analog cable:
         1) Alphawire.
         2) Belden Inc.
         3) General Cable.
   4. Wire connectors:
      a. Burndy Corporation.
      b. Buchanan.
      c. Ideal.
      d. Ilsco.
      e. 3M Co.
      f. Teledyne Penn Union.
      g. Thomas and Betts.
      h. Phoenix Contact.
   5. Insulating and color coding tape:
      a. 3M Co.
      b. Plymouth Bishop Tapes.
      c. Red Seal Electric Co.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

A. Building Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, including a bare ground conductor.
5. Individual conductor color coding:
   b. See PART 3 of this Specification Section for additional requirements.
6. Conform to NFPA 70 Type TC.

C. Control Cable:
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
   a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
5. Individual conductor color coding:
   a. ICEA S-58-679, Method 1, Table E-2.
   b. See PART 3 of this Specification Section for additional requirements.
6. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:
1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to UL 44 for Type SIS insulation.
5. Conform to UL 83 for Type MTW insulation.

E. Shielded VFD Cable:
1. Conductor shall be copper, stranded with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Cables No. 12 through 750 kcmil:
   a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 type XHHW-2 insulation.
   b. Shielding: 5 mil copper tape, longitudinally applied with a minimum overlap of 15 percent.
   c. Number of conductors: 3 PH and 3 equally spaced ground conductors.
4. Individual conductor color coding:
   b. See PART 3 of this Specification Section for additional requirements.
5. When installed exposed outdoors, UL listed and marked as sunlight resistant.
6. For continuously corrugated cable, use manufacturer approved fittings.
7. Conform to NFPA 70, Type TC.

F. Instrumentation Cable:
   1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   2. Analog cable:
      a. Tinned copper conductors.
      b. 300 V or 600 V PVC insulation with PVC jacket.
      c. Twisted with 100 percent foil shield coverage with drain wire.
      d. Six (6) twists per foot minimum.
      f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
   3. Digital cable:
      a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
      b. Horizontal voice and data cable:
         1) Category 6A per TIA/EIA/ANSI 568.
         2) Cable shall be label-verified.
         3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
         4) Conductors: No. 24 AWG solid untinned copper.
         5) Rated CMP per NFPA 70.
      c. DeviceNet cable:
         1) Flat cable:
            a) No. 16 AWG, 4 conductor, unshielded with PVC jacket.
            b) ODVA Class 2 Flat cable.
         2) Thick cable:
            a) One (1) No. 15 AWG twisted shielded pair, one (1) No. 18 AWG twisted shielded pair with overall tinned copper braid (65 percent) and drain wire and PVC jacket.
            b) ODVA Class 2 Thick cable.
      3) Thin cable:
         a) One (1) No. 22 AWG twisted shielded pair, one (1) No. 24 AWG twisted shielded pair with overall tinned copper braid (65 percent) and drain wire and PVC jacket.
         b) ODVA Class 2 Thin cable.
      d. Conform to NFPA 262 and NFPA 70 Type ITC.

G. Fiber Optic Cable:
   1. Design and fabrication - Multi-mode:
      a. Type:
         1) Indoor: Tight buffered or loose tube with a dry gel water blocking system.
         2) Outdoor: Loose tube with a wet or dry gel water blocking system.
      b. Number of fibers: As indicated on the Drawings.
      c. Fiber size: 62.5/125 micrometer (core diameter/cladding diameter).
      d. Glass fiber core.
      e. Step index.
f. Maximum attenuation:
   1) At 850 nm: 3.75 dB/km.
   2) At 1300 nm: 1.5 dB/km.

g. Minimum bandwidth:
   1) At 850 nm: 160 MHz/km.
   2) At 1300 nm: 500 MHz/km.

h. Maximum tensile load:
   1) Installation: 225 LBS.
   2) Long term: 67 LBS.

i. Cable jacket material:
   1) In rigid steel conduit: PVC, or polyethylene.
   2) In plenum or riser: Flame retardant material, PVC not allowed.
      a) Plenum applications: Cable materials shall pass NFPA 262 requirements.
      b) Riser applications: Cable materials shall pass UL 1666 requirements.

j. Cables shall be listed and marked in accordance with the requirements of NFPA 70.

k. Optical fiber cable type utilized shall be in accordance with NFPA 70.

l. Utilize LC type connectors:
   1) Tip material: Ceramic or ceramic/glass composite.
   2) Utilize connectors which do not require adhesive, epoxy, or polish.

H. Wire Connectors:
   1. Twist/screw on type:
      a. Insulated pressure or spring type solderless connector.
      b. 600 V rated.
      c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local
         codes.
      d. Phase and neutral conductors: Conform to UL 486C.
   2. Compression and mechanical screw type:
      a. 600 V rated.
      b. Ground conductors: Conform to UL 467.
      c. Phase and neutral conductors: Conform to UL 486A.
   3. Terminal block type:
      a. High density, screw-post barrier-type with white center marker strip.
      b. 600 V and ampere rating as required, for power circuits.
      c. 600 V, 20 ampere rated for control circuits.
      d. 300 V, 15 ampere rated for instrumentation circuits.
      e. Conform to NEMA ICS 4 and UL 486A.

I. Insulating and Color Coding Tape:
   1. Pressure sensitive vinyl.
   2. Premium grade.
   3. Heat, cold, moisture, and sunlight resistant.
   4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
   5. For cold weather or outdoor location, tape must also be all-weather.
   6. Color:
      a. Insulating tape: Black.
      b. Color coding tape: Fade-resistant color as specified herein.
   7. Comply with UL 510.

J. Pulling Lubricant: Cable manufacturer’s standard containing no petroleum or other products
   which will deteriorate insulation.
PART 3  EXECUTION

3.1 INSTALLATION

A. Permitted Usage of Insulation Types:
   1. Type XHHW-2:
      a. Building wire and power and control cable in architectural and non-architectural
         finished areas.
      b. Building wire and power and control cable in conduit below grade.
   2. Type THHN/THWN and THHN/THWN-2:
      a. Building wire and power and control cable No. 8 AWG and smaller in architectural
         and non-architectural finished areas.
   3. Type SIS and MTW:
      a. For the wiring of control equipment within control panels and field wiring of control
         equipment within switchgear, switchboards, motor control centers.

B. Conductor Size Limitations:
   1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless
      otherwise indicated on the Drawings.
   2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on
      the Drawings.
   3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise
      indicated on the Drawings.

C. Color Code All Wiring as Follows:
   1. Building wire:

<table>
<thead>
<tr>
<th>240 V, 208 V, 240/120</th>
<th>480 V, 480/277 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1 Black</td>
<td>Brown</td>
</tr>
<tr>
<td>Phase 2 Red *</td>
<td>Orange</td>
</tr>
<tr>
<td>Phase 3 Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral White</td>
<td>White or Gray</td>
</tr>
<tr>
<td>Ground Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors
   shall be identified by a continuous colored outer finish along its entire length.

b. Conductors larger than No. 6 AWG:
   1) Insulated phase and neutral conductors shall be identified by one (1) of the following
      methods:
      a) Continuous colored outer finish along its entire length.
      b) 3 IN of colored tape applied at the termination.
   2) Insulated grounding conductor shall be identified by one (1) of the following
      methods:
      a) Continuous green outer finish along its entire length.
      b) Stripping the insulation from the entire exposed length.
      c) Using green tape to cover the entire exposed length.
   3) The color coding shall be applied at all accessible locations, including but not
      limited to: Junction and pull boxes, wireways, manholes and handholes.
2. Power cables ICEA S-58-679, Method 4 with:
   a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
   b. Ground conductor: Bare.
3. Shielded VFD cable ICEA S-58-679, Method 4 with:
   a. Phase conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
   b. Ground conductor: Green color insulation or bare.
4. Control cables ICEA S-58-679, Method 1, Table E-2:
   a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
   b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

D. Install all wiring in raceway unless otherwise indicated on the Drawings.

E. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
   1. Where specifically indicated on the Drawings.
   2. Where field conditions dictate and written permission is obtained from the Engineer.
   3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
      a. The combinations shall comply with the following:
         1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
         2) 125 Vdc shall be isolated from all other AC and DC circuits.
         3) AC control circuits shall be isolated from all DC circuits.
   4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
      a. The combinations shall comply with the following:
         1) Analog signal circuits may be combined.
         2) Digital signal circuits may be combined but isolated from analog signal circuits.
   5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.
      a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
         1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
         2) The neutral conductors may not be shared.
         3) Up sizing raceway size for the size and quantity of conductors.

F. Ground the drain wire of shielded instrumentation cables at one (1) end only.
   1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

G. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
1) Twist/screw on type connectors.
   b. Junction and pull boxes and wireways:
      1) Twist/screw on type connectors for use on No. 8 and smaller wire.
      2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
   c. Motor terminal boxes:
      1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
      2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
   d. Handholes:
      1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
      2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.

2. Control circuits:
   b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
   c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.

3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
   a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
   b. Junction and pull boxes: Terminal block type connector.
   c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

H. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

I. Color Coding Tape Usage: For color coding of conductors.

J. Fiber Optic Cable:
   1. Unless indicated otherwise, install all fiber optic cable in conduit.
      a. In cable trays, the cable(s) shall be installed in an interdict that is placed in the tray for protection of the cable.
   2. Splicing:
      a. Optical fibers shall not be spliced.
   3. Utilize dust tight wall-mounted interconnect center to provide the following:
      a. Interconnect fiber optic cable to jumper cable assemblies for connection to the opto-electronic interface.
   4. Where exposed to contact with electric light or power conductors, the noncurrent carrying metallic members (if applicable) of optical fiber cables entering buildings shall be grounded as close to the point of entrance as practicable in accordance with NFPA 70.
   5. Install cables in accordance with the requirements of NFPA 70.
3.2 FIELD QUALITY CONTROL


END OF SECTION
SECTION 26 05 26 - GROUNDING AND BONDING

PART 1  GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for grounding and bonding system(s).

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   6. Section 26 05 33 - Raceways and Boxes.
   7. Section 26 08 13 - Acceptance Testing.
   8. Section 26 41 13 - Lightning Protection System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Grounding clamps, terminals and connectors.
         2) Exothermic welding system.
      b. See Specification Section 26 05 00 for additional requirements.

PART 2  PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ground rods and bars and grounding clamps, connectors and terminals:
   a. Erico Products, Inc.
   b. Harger Lightning & Grounding.
   c. Heary Brothers.
   d. Hubbell - Burndy.
   e. Robbins Lightning Protection.
   f. Thomas & Betts - Blackburn.
   g. Thompson Lightning Protection.

2. Exothermic weld connections:
   b. Harger Lightning & Grounding - Ultraweld.
   c. Hubbell - Burndy (Thermoweld).
   d. Thomas & Betts - Furseweld.

2.2 COMPONENTS

A. Wire and Cable:
   2. Insulated conductors: Color coded green, per Specification Section 26 05 19.

B. Conduit: As specified in Specification Section 26 05 33.

C. Ground Bars:
   1. Solid copper:
      a. 1/4 IN thick.
      b. 2 or 4 IN wide.
      c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
   2. Predrilled grounding lug mounting holes.
   3. Stainless steel or galvanized steel mounting brackets.
   4. Insulated standoffs.

D. Ground Rods:
   1. 3/4 IN x 10 FT.
   2. Copper-clad:
      a. 10 mil minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
      b. Corrosion resistant bond between the copper and steel.
      c. Hard drawn for a scar-resistant surface.

E. Grounding Clamps, Connectors and Terminals:
   1. Mechanical type:
      b. High copper alloy content.
   2. Compression type for interior locations:
      b. High copper alloy content.
      c. Non-reversible.
      d. Terminals for connection to bus bars shall have two bolt holes.
3. Compression type suitable for direct burial in earth or concrete:
   b. High copper alloy content.
   c. Non-reversible.
   d. Factory filled with oxide inhibiting compound.

F. Exothermic Weld Connections:
   1. Copper oxide reduction by aluminum process.
   2. Molds properly sized for each application.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions.
   2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
   3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections.
   4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install per Specification Section 01 73 20.
   5. Do not splice grounding conductors except at ground rods.
   6. Install ground rods and grounding conductors in undisturbed, firm soil.
      a. Provide excavation required for installation of ground rods and ground conductors.
      b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
      c. Unless otherwise specified, connect conductors to ground rods with compressor type connectors or exothermic weld.
      d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
      e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
   7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:
   1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
   2. Grounding conductor terminations:
      a. Ground bars mounted on wall, use compression type terminal and bolt it to the ground bar with two bolts.
      b. Ground bars in electrical equipment, use compression type terminal and bolt it to the ground bar.
      c. Piping systems use mechanical type connections.
      d. Building steel, below grade and encased in concrete, use compression type connector or exothermic weld.
      e. At all above grade terminations, the conductors shall be labeled per Specification Section 10 14 00.
   3. Triad grounding system:
a. Triad consists of three ground rods arranged in a triangle separated by 20 FT and a grounding conductor interconnecting each ground rod.
b. Place first ground rod a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
c. Grounding conductor: Bare conductor, size as indicated on the Drawings.

C. Supplemental Grounding Electrode:
1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
2. Metal light poles:
   a. Connect metal pole to a ground rod.
   b. Grounding conductor: Bare #6 AWG minimum.
3. Equipment support rack and pedestals mounted outdoors:
   a. Connect metallic structure to a ground rod.
   b. Grounding conductor: #6 AWG minimum.

D. Low Voltage Transformer Separately Derived Grounding System:
1. Ground separately mounted step-down transformers XO terminal to one of the following:
   a. Closest building steel using mechanical type terminal bolted to the steel, compression type connection or exothermic weld.
   b. Closest water pipe using a mechanical type connection.
   c. Ground bar.
2. Ground step-down transformer integrally mounted in motor control center to motor control center ground bus.

E. Raceway Bonding/Grounding:
1. All metallic conduit shall be installed so that it is electrically continuous.
2. All conduits to contain a grounding conductor with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduit, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

F. Equipment Grounding:
1. All utilization equipment shall be grounded with an equipment ground conductor.

G. Handhole Grounding:
1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
   a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

END OF SECTION
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SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1  GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Outlet boxes.
      f. Pull and junction boxes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 27 26 - Wiring Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   3. ASTM International (ASTM):
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit (IMC).
      c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
      d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
      a. C80.1, Electric Rigid Steel Conduit (ERSC).
      b. C80.3, Steel Electrical Metallic Tubing (EMT).
      c. C80.5, Electrical Aluminum Rigid Conduit.
      d. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
      a. 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Flexible Metal Conduit.
      b. 6, Standard for Electrical Rigid Metal Conduit - Steel.
1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Conduit fittings.
         2) Support systems.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout Drawings:
      a. Identify dimensional size of pull and junction boxes to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rigid metallic conduits:
      a. Allied Tube and Conduit Corporation.
      b. Triangle PWC Inc.
      c. Western Tube and Conduit Corporation.
      d. Wheatland Tube Company.
      e. LTV Steel Company.
      f. EASCO Aluminum.
      g. Indalex.
      h. VAW of American, Inc.
   2. PVC-coated rigid metallic conduits and repair kits:
      a. Occidental Coating Company.
      b. Perma-Cote.
      c. Rob-Roy Ind.
      d. Rachem “GelTek” tape.
   3. Rigid nonmetallic conduit:
      a. Prime Conduit (Carlon).
      b. Cantex.
      c. Osburn Associates.
   4. Flexible conduit:
a. AFC Cable Systems.
b. Anamet, Inc.
c. Electri-Flex.
d. Flexible Metal Hose Company.
e. International Metal Hose Company.
f. Triangle PWC Inc.
g. LTV Steel Company.

5. Wireway:
   b. Wiegmann.
   c. Square D.

6. Conduit fittings and accessories:
   a. Appleton Electric Co.
   b. Carlon.
   c. Cantex.
   d. Crouse-Hinds.
   e. Killark.
   f. Osburn Associates.
   g. OZ Gedney Company.
   h. RACO.
   i. Steel City.
   j. Thomas & Betts.

7. Support systems:
   b. Eaton B-Line.
   c. Kindorf.
   d. Minerallac Fastening Systems.
   e. Caddy.
   f. Thomas & Betts Superstrut.

8. Outlet, pull and junction boxes:
   a. Appleton Electric Co.
   b. Eaton Crouse-Hinds.
   c. Killark.
   d. O-Z/Gedney.
   e. Thomas & Betts Steel City.
   f. Raco.
   g. Bell.
   h. Hoffman Engineering Co.
   i. Wiegmann.
   j. Eaton B-Line.
   k. Adalet.
   l. Rittal.
   m. Stahlin.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 RIGID METALLIC CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):
   1. Mild steel with continuous welded seam.
   2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Threads galvanized after cutting.
4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.

B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
   a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to ANSI C80.1
   b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
2. Nominal 2 mil, minimum, urethane interior coating.
3. Urethane coating on threads.
4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends: Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.

C. Rigid Aluminum Conduit (RAC):
1. AA Type 6063 aluminum alloy, T-1 temper.
2. Maximum copper content of 0.10 percent.
3. Extruded, seamless.

2.3 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
5. Standards: NEMA TC 2, UL 651.

2.4 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):
1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.

2.5 WIREWAY

A. General:
1. Suitable for lay-in conductors.
2. Designed for continuous grounding.
3. Covers:
   a. Hinged or removable in accessible areas.
   b. Non-removable when passing through partitions.
4. Finish: Rust inhibiting primer and manufacturers standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.

B. Watertight (NEMA 4X rated) Wireway:
   1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

C. Dusttight (NEMA 12 rated) Wireway:
   1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

2.6 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS and RAC:
   1. General:
      a. In hazardous locations listed for use in Class I, Groups C and D locations.
   2. Locknuts:
      a. Threaded steel or malleable iron.
      b. Gasketed or non-gasketed.
      c. Grounding or non-grounding type.
   3. Bushings:
      a. Threaded, insulated metallic.
      b. Grounding or non-grounding type.
   4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
   5. Couplings:
      a. Threaded straight type: Same material and finish as the conduit with which they are used.
      b. Threadless type: Gland compression or self-threading type, concrete tight.
   6. Unions: Threaded galvanized steel or zinc plated malleable iron.
   7. Conduit bodies (ells and tees):
      a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
      b. Standard and mogul size.
      c. Cover:
         1) Clip-on type with stainless steel screws.
         2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
   8. Conduit bodies (round):
      a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
      b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
   9. Sealing fittings:
      a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
      b. Standard and mogul size.
c. With or without drain and breather.
d. Fiber and sealing compound: UL listed for use with the sealing fitting.

10. Hazardous location flexible coupling (HAZ-FLEX):
   a. Liquid tight and arc resistant.
   b. Electrically conductive so no bonding jumper is required.
   c. Dry and wet areas:
      1) Bronze braided covering over flexible brass core.
      2) Bronze end fittings.
      3) Zinc-plated steel or malleable iron unions and nipples.
   d. Corrosive areas:
      1) Stainless steel braided covering over flexible stainless steel core.
      2) Stainless steel end fittings.
      3) Aluminum unions and nipples.

11. Expansion couplings:
   a. 2 IN nominal straight-line conduit movement in either direction.
   b. Galvanized steel with insulated bushing.
   c. Gasketed for wet locations.
   d. Internally or externally grounded.

12. Expansion/deflection couplings:
   a. 3/4 IN nominal straight-line conduit movement in either direction.
   b. 30-degree nominal deflection from the normal in all directions.
   c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
   d. Internally or externally grounded.
   e. Watertight, raintight and concrete tight.


B. Fittings for Use with PVC-RGS:
   1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

C. Fittings for Use with FLEX:
   1. Connector:
      a. Zinc plated malleable iron.
      b. Squeeze or clamp-type.
   2. Standard: UL 514B.

D. Fittings for Use with FLEX-LT:
   1. Connector:
      a. Straight or angle type.
      b. Metal construction, insulated and gasketed.
      c. Composed of locknut, grounding ferrule and gland compression nut.
      d. Liquid tight.
   2. Standards: UL 467, UL 514B.

E. Fittings for Use with Rigid Nonmetallic PVC Conduit:
   1. Coupling, adapters and conduit bodies:
      a. Same material, thickness, and construction as the conduits with which they are used.
      b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
      c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

F. Weather and Corrosion Protection Tape:
   1. PVC based tape, 10 mils thick.
   2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
   3. Used with appropriate pipe primer.

2.7 ALL RACEWAY AND FITTINGS

A. Mark Products:
   1. Identify the nominal trade size on the product.
   2. Stamp with the name or trademark of the manufacturer.

2.8 OUTLET BOXES

A. Cast Outlet Boxes:
   1. Zinc plated cast iron or die-cast copper free aluminum with manufacturers standard finish.
   2. Threaded hubs and grounding screw.
   3. Styles:
      a. "FS" or "FD".
      b. "Bell".
      c. Single or multiple gang and tandem.
      d. "EDS" or "EFS" for hazardous locations.
   4. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

B. Nonmetallic Outlet Boxes:
   1. Polyvinyl-chloride (PVC) plastic compound.
   2. Rated for direct sunlight exposure.
   3. Fire retardant and low smoke emission.
   4. Suitable for use with 90 DegC wire.
   5. Styles:
      a. “FS” or “FD”.
      b. Single or multiple gang.

C. See Specification Section 26 27 26 for wiring devices, wallplates and coverplates.

2.9 PULL AND JUNCTION BOXES

A. NEMA 4 Rated:
   1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
   6. Cover with oil resistant gasket.
B. NEMA 4X Rated (metallic):
   1. Body and cover: 14 GA Type 304 or 316 stainless steel.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Hinged door and stainless steel screws and clamps.
   6. Door with oil-resistant gasket.

C. NEMA 4X Rated (Nonmetallic):
   2. No knockouts.
   3. External mounting flanges.
   4. Hinged door with quick release latches and padlocking hasp.
   5. Door with oil resistant gasket.

D. NEMA 7 Rated:
   1. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
   2. Drilled and tapped openings or tapered threaded hub.
   3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
   4. External mounting flanges.
   5. Grounding lug.
   6. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

E. NEMA 12 Rated:
   1. Body and cover:
      a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. Type 5052 H-32 aluminum, unpainted.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   6. Flat door with oil resistant gasket.

F. Miscellaneous Accessories:
   1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
   2. Split covers when heavier than 25 LBS.
   3. Weldnuts for mounting optional panels and terminal kits.
   4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

G. Standards: NEMA 250, UL 50.

2.10 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
   1. Material requirements.
      a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
      b. Aluminum: AA Type 6063-T6.
      c. PVC coat galvanized steel: ASTM A123 or ASTM A153 and 20 mil PVC coating.
B. Single Conduit and Outlet Box Support Fasteners:
   1. Material requirements:
      a. Zinc plated steel.
      b. Stainless steel.
      c. Malleable iron.
      d. PVC coat malleable iron or steel: 20 mil PVC coating.
      e. Steel protected with zinc phosphate and oil finish.

2.11 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

   A. Sleeves, smoke and fire stop fitting through walls and floors:
      1. See Specification Section 01 73 20.

PART 3 EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

   A. Shall be in accordance with the requirements of:
      1. NFPA 70.
      2. Manufacturer instructions.

   B. Size of Raceways:
      1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in
         accordance with NFPA 70.
      2. Unless specifically indicated otherwise, the minimum raceway size shall be:
         a. Conduit: 3/4 IN.
         b. Wireway: 2-1/2 IN x 2-1/2 IN.

   C. Field Bending and Cutting of Conduits:
      1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for
         the purpose and the conduit material to make all field bends and cuts.
      2. Do not reduce the internal diameter of the conduit when making conduit bends.
      3. Prepare tools and equipment to prevent damage to the PVC coating.
      4. Degrease threads after threading and apply a zinc rich paint.
      5. Deburr interior and exterior after cutting.

   D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize
      compound.

   E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and
      accessories shall be maintained.
      1. Repair galvanized components utilizing a zinc rich paint.
      2. Repair painted components utilizing touch up paint provided by or approved by the
         manufacturer.
      3. Repair PVC coated components utilizing a patching compound, of the same material as the
         coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable,
         cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
         a. Total nominal thickness: 40 mil.
      4. Repair surfaces which will be inaccessible after installation prior to installation.

   F. Remove moisture and debris from conduit before wire is pulled into place.
1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.
   1. See Specification Section 01 73 20.

3.2 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.
   1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
   2. Run in straight lines parallel to or at right angles to building lines.
   3. Do not route conduits:
      a. Through areas of high ambient temperature or radiant heat.
      b. In suspended concrete slabs.
   4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
   5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All rigid conduits within a structure shall be installed exposed except as follows:
   1. As indicated on the Drawings.
   2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
   3. Concealed within stud frame, poured concrete, concrete block and brick walls of an architecturally finished area.
   4. Embedded in floor slabs or buried under floor serving equipment in non-architecturally finished areas that are not located on or near a wall or column and the ceiling height is greater than 12 FT.
   5. Embedded in floor slabs or buried under floor slabs where shown on the Contract Drawings or with the Engineer's permission.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
   1. Between instrumentation and telecommunication: 1 IN.
   2. Between instrumentation and 125 V, 48 V and 24 Vdc: 2 IN.
   3. Between instrumentation and 600 V and less AC power or control: 6 IN.
   4. Between telecommunication and 125 V, 48 V and 24 Vdc: 2 IN.
   5. Between telecommunication and 600 V and less AC power or control: 6 IN.
   6. Between 125 V, 48 V and 24 Vdc and 600 V and less AC power or control: 2 IN.
   7. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
1. See Specification Section 01 73 20.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:
   1. Power wire or cables: All raceway types.
   2. Control wire or cables: All raceway types.
   3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
   4. Motor leads from a VFD: RGS, RAC or shielded VFD cables in all other raceways.
   5. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:
   1. Dry areas:
      a. RGS.
      b. RAC.
   2. Wet areas:
      a. RGS.
      b. RAC.
   3. Corrosive areas:
      a. Wet wells, valve vaults, meter vaults: PVC-RGS.

C. Permitted Raceway Types Per Routing Locations:
   1. In concrete block or brick walls:
      a. PVC-40.
   2. Embedded in poured concrete walls, CMU walls, and floors:
      a. PVC-40.
      b. RGS wrapped with factory applied weather and corrosion protection tape when emerging from concrete into areas designated as wet or corrosive.
   3. Beneath floor slab-on-grade:
      a. PVC-40.
   4. Through floor penetrations, see Specification Section 01 73 20:
      a. RGS in areas designated as dry.
      b. RGS wrapped with factory applied weather and corrosion protection tape when emerging from concrete into areas designated as wet or corrosive.
      c. PVC-RGS in areas designated as wet, corrosive or highly corrosive.
   5. Direct buried conduits and ductbanks:
      a. PVC-RGS.
      b. 90 degree elbows for transitions to above grade:
         1) RGS wrapped with factory applied weather and corrosion protection tape.
         2) PVC-RGS.
      c. Long sweeping bends greater than 15 degrees:
1) RGS wrapped with factory applied weather and corrosion protection tape.
2) PVC-RGS.

6. Concrete encased ductbanks:
   a. PVC-40.
   b. 90 degree elbows for transitions to above grade:
      1) RGS wrapped with factory applied weather and corrosion protection tape.
      2) PVC-RGS.
   c. Long sweeping bends greater than 15 degrees:
      1) RGS for sizes 2 IN and larger.

D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
   1. The maximum length shall not exceed:
      a. 6 FT to light fixtures.
      b. 3 FT to all other equipment.

E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 6 FT to light fixtures.
      b. 3 FT to motors.
      c. 2 FT to all other equipment.

F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 3 FT to motors.
      b. 2 FT to all other equipment.

G. NEMA 4X Rated Wireway:
   1. Surface mounted in areas designated as wet and or corrosive.

H. NEMA 12 Rated Wireway:
   1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

I. Underground Conduit: See Specification Section 26 05 43.

3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Seals:
   1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
   2. Filler plug and drain shall be accessible.
   3. Pour the conduit seals in a two-step process.
      a. Pour the seal and leave cover off.
      b. After seal is dry, inspect for proper sealing, install cover and mark (for example, paint or permanent marker) as complete.

B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

C. Install Expansion Fittings:
   1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
   2. Elsewhere as identified on the Drawings.

D. Install Expansion/Deflection Fittings:
   1. Where conduits enter a structure.
      a. Except electrical manholes and handholes.
      b. Except where the ductbank is tied to the structure with rebar.
   2. Where conduits span structural expansions joints.
   3. Elsewhere as identified on the Drawings.

E. Threaded connections shall be made wrench-tight.

F. Conduit joints shall be watertight:
   1. Where subjected to possible submersion.
   2. In areas classified as wet.

G. Terminate Conduits:
   1. In NEMA 12 rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
      b. Use grounding type locknut or bushing when required by NFPA 70.
   2. In NEMA 4 and NEMA 4X rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
   3. In NEMA 7 rated enclosures:
      a. Into an integral threaded hub.
   4. When stubbed up through the floor into floor mount equipment:
      a. With an insulated grounding bushing on metallic conduits.
      b. With end bells on nonmetallic conduits.

H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
   1. Dry or wet and/or hazardous areas:
      a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
      b. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.
   2. Corrosive areas:
      a. Stainless steel system consisting of: Stainless steel channels and fittings, nuts and hardware and conduit clamps.
      b. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
3. Highly corrosive area:
   a. Fiberglass system consisting of:
      1) Fiberglass channels and fittings, nuts and hardware and conduit clamps.

4. Conduit type shall be compatible with the support system material.
   a. Galvanized steel system may be used with RGS.
   b. Stainless steel system may be used with RGS and PVC-RGS.
   c. PVC-RGS system may be used with PVC-RGS, PVC-40 and PVC-80.

B. Permitted single conduit support fasteners per area designations and conduit types:
   1. Architecturally finished areas:
      a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
      b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with
         bolts and bolt on beam clamps.
      c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
   2. Dry or wet and/or hazardous areas:
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam
         clamps.
   3. Corrosive areas:
      a. Material: Stainless steel and PVC coat malleable iron or steel.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam
         clamps.
   4. Conduit type shall be compatible with the support fastener material.
      a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron
         fasteners may be used with RGS.
      b. Stainless steel system may be used with RGS and PVC-RGS.
      c. PVC coated fasteners may be used with PVC-RGS, PVC-40 and PVC-80.

C. Conduit Support General Requirements:
   1. Maximum spacing between conduit supports per NFPA 70.
   2. Support conduit from the building structure.
   3. Do not support conduit from process, gas, air or water piping; or from other conduits.
   4. Provide hangers and brackets to limit the maximum uniform load on a single support to
      25 LBS or to the maximum uniform load recommended by the manufacturer if the support is
      rated less than 25 LBS.
      a. Do not exceed maximum concentrated load recommended by the manufacturer on any
         support.
      b. Conduit hangers:
         1) Continuous threaded rods combined with struts or conduit clamps: Do not use
            perforated strap hangers and iron bailing wire.
      c. Do not use suspended ceiling support systems to support raceways.
      d. Hangers in metal roof decks:
         1) Utilize fender washers.
         2) Not extend above top of ribs.
         3) Not interfere with vapor barrier, insulation, or roofing.
   5. Conduit support system fasteners:
      a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
      b. Do not use concrete nails and powder-driven fasteners.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION
A. General:
1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 26 05 00 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:
1. Permitted uses of cast outlet boxes:
   a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive and hazardous areas.
   b. Pull and junction box surface mounted in non-architecturally finished dry, wet and corrosive areas.
2. Permitted uses of non-metallic outlet boxes:
   a. Housing of wiring devices surface mounted in non-architecturally finished highly corrosive areas.
   b. Pull and junction box surface mounted in non-architecturally finished highly corrosive areas.
3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
   a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
   b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.

C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   a. Make covers of boxes accessible.
2. Permitted uses of NEMA 4 enclosure:
   a. Pull or junction box surface mounted in areas designated as wet.
3. Permitted uses of NEMA 4X metallic enclosure:
   a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
4. Permitted uses of NEMA 4X non-metallic enclosure:
   a. Pull or junction box surfaced mounted in areas designated as wet and/or highly corrosive.
5. Permitted uses of NEMA 7 enclosure:
   a. Pull or junction box surface mounted in areas designated as Class I hazardous.
6. Permitted uses of NEMA 12 enclosure:
   a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION
SECTION 26 05 43 - ELECTRICAL: EXTERIOR UNDERGROUND

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Handhole.
      b. Underground conduits and ductbanks.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.
   4. Section 10 14 00 - Identification Devices.
   5. Section 26 05 26 - Grounding.
   6. Section 26 05 33 - Raceways and Boxes.
   7. Section 31 23 18 - Site Backfilling.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   2. ASTM International (ASTM):
      a. 70, National Electrical Code (NEC).
   4. Society of Cable Telecommunications Engineers (SCTE):
      a. 77, Specification for Underground Enclosure Integrity.

1.3 DEFINITIONS

A. Direct-buried conduit(s):
   1. Individual (single) underground conduit.
   2. Multiple underground conduits, arranged in one or more planes, in a common trench.

B. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. Fabrication and/or layout Drawings:
a. Provide dimensional Drawings of each manhole indicating all specified accessories and conduit entry locations.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Quazite Composolite.
      b. Armorcast Products Company.
      c. Synertech.
   2. Handhole and ductbank accessories:
      a. Neenah.
      b. Unistrut.
      c. Condux International, Inc.
      d. Underground Devices, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
   3. Open bottom.
   4. Stackable design as required for specified depth.
   5. Cover:
      a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
      b. Non-gasketed bolt down with stainless steel penta head bolts.
      c. Lay-in non-bolt down, when cover is over 100 LBS.
      d. One or multiple sections so the maximum weight of a section is 125 LBS.
   6. Cover lifting hook: 24 IN minimum in length.

2.3 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete: Comply with Division 03 Specifications, Specification Section 03 11 13, Specification Section 03 21 00, Specification Section 03 31 30 and Specification Section 03 35 00.

B. Conduit: See Specification Section 26 05 33.

C. Duct Spacers/Supports:
   1. High density polyethylene or high impact polystyrene.
   2. Interlocking.
   3. Provide 2 IN minimum spacing between conduits.
   4. Accessories, as required:
      a. Hold down bars.
      b. Ductbank strapping.
PART 3  EXECUTION

3.1  GENERAL

A. Drawings indicate the intended location of handholes and routing of ductbanks and direct buried conduit.
   1. Field conditions may affect actual routing.

B. Handhole Locations:
   1. Approximately where shown on the Drawings.
   2. As required for pulling distances.
   3. As required to keep pulling tensions under allowable cable tensions.
   4. As required for number of bends in ductbank routing.
   5. Shall not be installed in a swale or ditch.
   6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
   7. Locations are to be approved by the Engineer prior to excavation and placement or construction of handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 31 23 16.13 for trenching and Section 31 23 18 for backfilling and compacting.

3.2  HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. For use in areas subjected to occasional non-deliberate vehicular traffic.
   2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
   3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
   4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
   5. Size: As indicated on the Drawings or as required for the number and size of conduits.
   6. Provide cable rails and pulling eyes as needed.

3.3  UNDERGROUND CONDUITS

A. General Installation Requirements:
   1. Ductbank types per location:
      a. Concrete encased ductbank:
         1) All ductbanks.
      b. Direct-buried conduit(s):
         1) Area/Roadway lighting.
   2. Do not place concrete or soil until conduits have been observed by the Engineer.
   3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
      a. Low points shall be at handholes.
4. During construction and after conduit installation is complete, plug the ends of all conduits.

5. Provide conduit supports and spacers.
   a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
      1) 1 IN and less: 3 FT.
      2) 1-1/4 to 3 IN: 5 FT.
      3) 3-1/2 to 6 IN: 7 FT.
   b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
      1) 1 IN and less: 10 FT.
      2) 1-1/4 to 2-1/2 IN: 14 FT.
      3) 3 IN and larger: 20 FT.
   c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.

6. Stagger conduit joints at intervals of 6 IN vertically.

7. Make conduit joints watertight and in accordance with manufacturer's recommendations.

8. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.
   a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.

9. Furnish manufactured bends at end of runs.
   a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.

10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.

11. After the conduit run has been completed:
    a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
    1) Test mandrel:
       a) Length: Not less than 12 IN
       b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
    b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.

12. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.

13. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 26 05 33, prior to entering a structure or going above ground.
    a. Except rigid nonmetallic conduit may be extended directly handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.

14. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable in accordance with Specification Section 10 14 00.

15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiiuses of the cables.

B. Concrete Encased Ductbank:
1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 26 05 33 or as detailed on the Drawings.

2. Install so that top of concrete encased duct, at any point:
   a. Is not less than 36 IN below grade.
   b. Is below pavement sub-grading.

3. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.

4. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.

C. Direct-Buried Conduit(s):

1. Install so that the top of the uppermost conduit, at any point:
   a. Is not less than 36 IN below grade.
   b. Is below pavement sub-grading.

2. Provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
   a. Maintain the separation of multiple planes of conduits by one of the following methods:
      1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill per Specification Section 31 23 18.
      2) Install the multilevel conduits one level at a time.
         a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 31 23 18, to maintain the required separations.

   END OF SECTION
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SECTION 26 08 13 - ACCEPTANCE TESTING

PART 1  GENERAL

1.1  SUMMARY

A.  Section Includes:  Basic requirements for acceptance testing.

B.  Related Specification Sections include but are not necessarily limited to:
    1.  Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
    2.  Division 01 - General Requirements.

1.2  QUALITY ASSURANCE

A.  Referenced Standards:
    1.  Institute of Electrical and Electronics Engineers, Inc. (IEEE):
        a.  400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power
            Cable Systems.
        b.  400.3, Guide for Partial Discharge Testing of Power Cable Systems in a Field
            Environment.
    2.  InterNational Electrical Testing Association (NETA):
        a.  ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment
            and Systems.
    4.  Telecommunications Industry Association/Electronic Industries Alliance/American
        National Standards Institute (TIA/EIA/ANSI):
        a.  455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures
            - Attenuation.

B.  Qualifications:
    1.  Testing firm qualifications:
        a.  An independent firm performing, as the sole or principal part of its business for a
            minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
        b.  Must have an established monitoring and testing equipment calibration program with
            accuracy traceable in an unbroken chain, according to NIST.
    2.  Field personnel:
        a.  Minimum of one (1) year field experience covering all phases of electrical equipment
            inspection, testing, and calibration.
        b.  Relay test technician having previous experience with testing and calibration of
            relays of the same manufacturer and type used on project and proficient in setting and
            testing the types of protection elements used.
        c.  Supervisor certified by NETA or NICET.
        d.  As an alternative, supervising technician may be certified by the equipment
            manufacturer.
    3.  Analysis personnel:
        a.  Minimum three (3) years combined field testing and data analysis experience.
        b.  Supervisor certified by NETA or NICET.
        c.  As an alternative, supervising technician may be certified by the equipment
            manufacturer.
1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Prior to energizing equipment:
      a. Coordinated phasing diagram.
   3. Within two (2) weeks after successful completion of Demonstration Period (Commissioning Period):
      a. Single report containing information including:
         1) Summary of Project.
         2) Information from pre-energization testing.

PART 2 PRODUCTS

2.1 FACTORY QUALITY CONTROL

A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:
   1. Complete electrical testing in three (3) phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   2. Perform testing in accordance with this Specification Section and NETA ATS.
   3. Provide field setting and programming of all adjustable protective devices and meters to settings provided by the Engineer.

B. Electrical Equipment and Connections Testing Program:
   1. See individual Division 26 Specification Sections for equipment specific testing requirements.
   2. Test all electrical equipment.
      a. Perform all required NETA testing.
      b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS
A. Transformers - Small Dry Type:
   1. Perform inspections and tests per NETA ATS 7.2.1.1.
   2. Perform the following additional tests:
      a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load
         after energizing, and at operating load after startup.
   3. Adjust tap connections as required to provide secondary voltage within 2-1/2 percent of
      nominal under normal load after approval of Engineer.
   4. Record as-left tap connections.

B. Cable - Low Voltage: Perform inspections and tests per NETA ATS 7.3.2.

C. Cable - Optical Fiber:
   1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
      a. Optional time domain reflectometer test.
      b. Power attenuation test.
      c. Gain margin test.

D. Low Voltage Molded Case Circuit Breakers:
   1. Perform inspections and tests per NETA ATS 7.6.1.1.
   2. Components:
      a. Test all components per applicable paragraphs of this Specification Section and
         NETA ATS.
      b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
      c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA
         ATS.
   3. Record as-left settings.

E. Metering:
   1. Perform inspections and tests per NETA ATS 7.11.
   2. Components: Test all components per applicable paragraphs of this Specification Section
      and NETA ATS.

F. Grounding:
   1. Perform inspections and tests per NETA ATS 7.13.
   2. Components: Test all components per applicable paragraphs of this Specification Section
      and NETA ATS.

G. Ground Fault Protection:
   1. Perform inspections and tests per NETA ATS 7.14.
   2. Components: Test all components per applicable paragraphs of this Specification Section
      and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Control wiring insulation resistance.
   4. Perform the following additional tests for four-wire systems:
      a. Primary current injection into switchgear bus with test set configured to simulate
         transformer source and high current jumper used to simulate unbalanced load and
         ground fault conditions.
      b. Verify no tripping for unbalanced load on each feeder and each main breaker.
      c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
      d. Verify tripping for ground fault on load side of feeder each feeder and on each main
         bus.
e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

H. Motors: Perform inspections and tests per NETA ATS 7.15.

I. Motor Controllers:
   1. Perform inspections and tests per NETA ATS 7.16.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

END OF SECTION
SECTION 26 09 13 - ELECTRICAL METERING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Digital metering equipment.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      a. C12.20, For Electricity Meter - 0.2 and 0.5 Accuracy Classes.
   3. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 70 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
      b. Content of Operation and Maintenance Manual:
         1) Data sheet of the meters electrical parameters, configuration and characteristics including a complete model number and associated equipment connected too.
         2) Operating instructions of the meter(s) supplied.
         3) Operating instructions of the Power Management software.
         4) Maintenance instructions.
         5) As-constructed electrical wiring/connection diagrams.
         6) Acceptance testing data.
PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen-Bradley.
   2. Eaton.
   3. Electro Industries.
   5. Power Measurement.

2.2 DIGITAL METERING DEVICES

A. General:
   1. Direct reading metered or calculated values.
   2. Microprocessor based.
   3. Integral LED or LCD display.
   4. Current and potential transformers as required.
   5. Integral fusing.
   6. Operating temperature: 0 DegF to 150 DegF.
   7. Standards:
      a. NEMA/ANSI C12.20.
      b. UL 508.

B. Type 'C' High Range Meter:
   1. Display the following minimum electrical parameters (accuracy):
      a. RMS current per phase (+0.2 percent full scale).
      b. RMS voltage line-to-line and line-to-neutral (+0.2 percent full scale).
      c. Real power (W): 3 PH total (+0.4 percent full scale).
      d. Apparent power (VA): 3 PH total (+0.4 percent full scale).
      e. Reactive power (VAR): 3 PH total (+0.4 percent full scale).
      f. Power factor (+1.0 percent).
      g. Frequency (+0.04 percent).
      h. Percent current individual harmonic and total harmonic distortion (50th).
      i. Percent voltage individual harmonic and total harmonic distortion (50th).
      j. Watt-hours (0.5 percent).
      k. VAR-hours (1.0 percent).
      l. VA-hours (0.5 percent).
      m. Ampere demand (+0.2 percent full scale).
      n. Watt demand (+0.4 percent full scale).
      o. VAR demand (+0.4 percent full scale).
      p. VA demand (+0.4 percent full scale).
   2. NEMA/ANSI C12.20, Class 0.2 revenue accuracy.
   3. Communication ports and protocols: Ethernet TCP/IP.
   4. Supply voltage: 120 Vac.
PART 3 EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
   1. Provide all equipment as necessary to provide a complete and functioning system.

B. Meter Type Application:
   1. Type C meters: Integral to equipment as indicated on the Drawings.

3.2 FIELD QUALITY CONTROL


3.3 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 2 HRS of on-site training in the operation and maintenance of the metering system and its components.

END OF SECTION
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SECTION 26 09 16 - CONTROL EQUIPMENT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
   2. Control devices (timers, relays, contactors, etc.).
   3. Industrial Control Panels.
   4. Operator Control Stations.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.

1.3 SYSTEM DESCRIPTION

A. This Specification specifies components used within other equipment as referenced in other technical specifications.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
         1) When components are used within equipment specified in another Section, submittal data for components specified herein shall be included with the submittal for the equipment the components are used in.
      b. Industrial Control Panel bill of material.
      c. Control Station bill of material.
      d. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout Drawings.
      a. Industrial Control Panel:
         1) Interior and exterior layout.
         2) Wiring/connection diagrams.
         3) Short circuit rating.
4) Copy of the UL 508A label.
b. Operator Control Station:
   1) Interior (if applicable) and exterior layout.
   2) Wiring/connection diagrams.
c. Associate Industrial Control Panel and Operator Control Stations with associated equipment name and tagging.

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Functional Test Plan.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 70 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
      b. Content of Operation and Maintenance Manual:
         1) Product technical data of components used within Industrial Control Panels and Operator Control Stations.
         2) As-constructed wiring/connection diagrams for Industrial Control Panels and Operator Control Stations.
         3) Functional Test Report.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pilot devices, relays, contactors, and termination equipment:
      a. Allen-Bradley.
      b. ATC Diversified Electronics.
      c. Automatic Switch Company (ASCO).
      d. Eaton.
      e. General Electric Company.
      f. Idec.
      g. Phoenix Contact.
      h. Potter & Brumsfield.
      i. Schneider Electric.
      j. Siemens.
      k. Time Mark.
   2. Alarm devices:
      a. Edwards Signaling.
      b. Federal Signal Corp.
   3. Enclosures:
      b. Wiegmann.
      c. Eaton B-Line.
      d. Adalet.
      e. Stahlin.
2.2 PILOT DEVICES

A. General Requirements:
   2. Heavy-duty NEMA 4/13 watertight/oiltight.
   3. Heavy-duty NEMA 4/4X corrosion resistant.
   4. Heavy-duty factory sealed, explosion-proof and dust ignition-proof (Class I and II).
   5. Mounting hole: 30.5 mm.
   6. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
   7. Legend plate marked as indicated on Drawings or specified.

B. Selector Switches:
   1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
   2. Maintained contact type.
   3. Knob or lever type operators.

C. Pushbuttons:
   1. Non-illuminated type:
      a. Protective boot.
      b. Momentary contact.
      c. Standard flush and mushroom operators.
      d. Black colored buttons for START or ON and red color for STOP or OFF.
      e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.

D. Indicating Lights:
   1. Allowing replacement of bulb without removal from control panel.
   2. Lamp: LED, 120 V or 24 V as required.
   3. Full voltage type.
   5. Glass lens.
   6. Color code lights as follows:
      a. Green: OFF or stopped; valve open.
      b. Amber: Standby; auto mode; ready.
      c. Red: ON or running; valve closed.

2.3 RELAYS

A. General Requirements:

B. Control Relays:
   1. General purpose (ice cube) type:
      a. Plug-in housing.
      b. Clear polycarbonate dust cover with clip fastener.
      c. Coil voltage: 120 Vac or as required.
      d. Contacts:
         1) 10 amp continuous.
         2) Silver cadmium oxide.
         3) Minimum of 3 SPDT contacts.
e. Sockets: DIN rail mounted.
f. Internal neon or LED indicator is lit when coil is energized.
g. Manual operator switch.

2. Industrial type:
   a. Coil voltage: 120 Vac or as required.
   b. Contacts:
      1) 10 amp, NEMA A600 rated.
      2) Double break, silver alloy.
      3) Convertible from normally open to normally closed or vice versa, without removing any wiring.
      4) Expandable from 2 poles to 12 poles.
   c. Provide contacts for all required control plus two spares.

2.4 CONTACTORS

A. General Requirements:

B. Definite Purpose:
   1. Coil voltage: 120 Vac or as required.
   3. Resistive load and horsepower rated.
   4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
   5. Auxiliary contacts, as indicated on Drawings or as specified.

2.5 ALARM DEVICES

A. Alarm Lights:
   1. Panel mounted:
      a. Strobe type.
      b. Shatter resistant polycarbonate lens and base.
      c. Lens color as indicated on Drawings.
      d. NEMA 4X enclosure.
      e. PLC compatible.
      f. Voltage: 120 Vac.
   2. Wall mounted:
      a. Heavy-duty strobe type.
      b. Weatherproof shatter resistant polycarbonate lens and cast base.
      c. Optically designed fresnel lens with color as indicated on Drawings.
      d. Immune to shock and vibration, no moving parts.
      e. Xenon flash tube providing a minimum of 65 single flashes per minute.
      f. Mounting: Wall or corner wall brackets.
   3. Hazardous and corrosive locations:
      a. Heavy-duty strobe type.
      b. Weatherproof and rated for the indicated hazardous location.
      c. Body: Zinc plated cast iron or cast copper free aluminum and/or coated with 20 mils of PVC.
      d. High impact glass dome with guard.
      e. Shatter resistant polycarbonate lens with color as indicated on Drawings.
      f. Immune to shock and vibration, no moving parts.
2.6 TERMINATION EQUIPMENT

A. General Requirements:
1. Modular type with screw compression clamp.
4. Thermoplastic insulation rated for -40 to +90 DegC.
5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
6. End sections and end stops at each end of terminal strip.
7. Machine-printed terminal markers on both sides of block.
8. Spacing: 6 mm.
9. Wire size: 22-12 AWG.
10. Rated voltage: 600 V.
11. DIN rail mounting.

B. Standard-Type Block:
1. Rated current: 30 A.
2. Color: Gray body.

C. Bladed-Type Disconnect Block:
1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
2. Rated current: 10 A.
3. Color:
   a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
   b. Foreign voltage entering enclosure: Orange body, orange switch.

D. Grounded-Type Block:
1. Electrically grounded to mounting rail.
2. Terminal ground wires and analog cable shields.
3. Color: Green and yellow body.

E. Fuse Holders:
1. Blocks can be ganged for multi-pole operation.
2. Spacing: 9.1 mm.
3. Wire size: 30-12 AWG.
4. Rated voltage: 300 V.
5. Rated current: 12 A.
8. DIN rail mounting.

2.7 ENCLOSURES

A. Industrial Control Panels:
1. NEMA 4 rated:
   a. Seams continuously welded and ground smooth.
   b. No knockouts.
c. External mounting flanges.
d. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
e. Cover with oil resistant gasket.

2. NEMA 4X rated:
   a. Body and cover: 14 GA Type 304 or 316 stainless steel.
   b. Seams continuously welded and ground smooth.
   c. No knockouts.
   d. External mounting flanges.
   e. Hinged door and stainless steel screws and clamps.
   f. Door with oil-resistant gasket.

3. NEMA 12 enclosure:
   a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers
      standard paint inside and out.
   b. No knockouts.
   c. External mounting flanges.
   d. Non-hinged stainless steel cover held closed with captivated cover screws threaded
      into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   e. Flat door with oil resistant gasket.

4. Control panel miscellaneous accessories:
   a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless
      steel.
   b. Interiors shall be white or light gray in color.
   c. Wire management duct:
      1) Bodies: PVC with side holes.
      2) Cover: PVC snap-on.
      3) Size as required.
   d. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
   e. Split covers when heavier than 25 LBS.
   f. Floor stand kits made of same material as the enclosure.
   g. Weldnuts for mounting optional panels and terminal kits.
   h. Ground bonding jumper from door, across hinge, to enclosure body.


B. Operator Control Stations:
   1. NEMA 4/13 rated:
      a. Die cast aluminum body with manufacturers standard finish.
      b. Gasketed die cast aluminum cover with manufacturers standard finish.
      c. Number of device mounting holes as required.
   2. NEMA 4X rated:
      a. Type 304 or 316 stainless steel body.
      b. Gasketed Type 304 or 316 stainless steel cover.
      c. Number of device mounting holes as required.

2.8 FABRICATION

A. Supplier of Industrial Control Panels shall build control panel under the provisions of UL
   508A.
   1. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial
      Control Panel" prior to shipment to the jobsite.
PART 3 EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Control Panels:
   1. Size as required to mount the equipment.
   2. Permitted uses of NEMA 4 enclosure:
      a. Surface mounted in areas designated as wet.
   3. Permitted uses of NEMA 4X enclosure:
      a. Surface mounted in areas designated as wet and/or corrosive.
   4. Permitted uses of NEMA 12 enclosure:
      a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas.

C. Operator Control Stations:
   1. Permitted uses of NEMA 4/13 enclosure:
      a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas and wet.
   2. Permitted uses of NEMA 4X enclosure:
      a. Surface mounted in areas designated as wet and/or corrosive or highly corrosive.

3.2 FIELD QUALITY CONTROL

A. See Section 26 05 00.

3.3 TRAINING

A. A qualified supplier representative shall provide the Owner with on-site training in the operation and maintenance of the Industrial Control Panel(s) and its components.

END OF SECTION
SECTION 26 22 13 - DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Dry-type transformers, 1000 kVA and less.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   4. Section 26 05 26 - Grounding.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Department of Energy (DOE):
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ST 20, Dry-Type Transformers for General Applications.
   4. Underwriters Laboratories, Inc. (UL):
      b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout Drawings:
      a. Nameplate Drawing.
   4. Certifications:
      a. Sound level certifications.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 70 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Siemens.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Ventilated or non-ventilated, air cooled, two (2) winding type.

B. Cores:
   1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
   2. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous wound with electrical grade aluminum.

D. Ventilated Units:
   1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
   2. Dripproof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.

E. Furnish Taps for Transformers as follows:
   1. 1 PH, 2 kVA and below: None.
   2. 1 PH, 3 to 25 kVA: Two (2) 5 percent FCBN.
   3. 1 PH, 25 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.
   4. 3 PH, 3 to 15 kVA: Two (2) 5 percent FCBN.
   5. 3 PH, 15 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.

F. Sound Levels:
   1. Manufacturer shall guarantee not to exceed the following:
      a. Up to 9 kVA: 40 dB.
      b. 10 to 50 kVA: 45 dB.
      c. 51 to 150 kVA: 50 dB.
      d. 151 to 300 kVA: 55 dB.

G. Efficiency (minimum):
   1. Ventilated:
      a. 1 PH, 15 - 333 kVA: DOE 2016 Efficiency.
      b. 3 PH, 15 - 1000 kVA: DOE 2016 Efficiency.

H. Insulating Material (600 V and below):
1. 3 to 15 kVA units: 185 DegC insulation system with a 115 DegC rise.
2. 15 kVA and above units: 220 DegC insulation system with a 150 DegC rise.

I. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.

J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.


PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Indoor Locations:
   1. Provide ventilated type for 15 kVA units and above.
   2. Mount 15 kVA units and above on chamfered 4 IN high concrete housekeeping pad or from wall and/or ceiling, at 7 FT above finished floor, using equipment support brackets per Section 26 05 00.
   3. Provide rubber vibrations isolation pads.

C. Enclosures: Painted steel in all areas except stainless steel in highly corrosive areas.

D. Ground in accordance with Section 26 05 26.

END OF SECTION
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SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lighting and appliance panelboards.
   2. Power distribution panelboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      b. 67, Standard for Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout Drawings:
      a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 70 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Panelboard schedules with as-built conditions.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Siemens.

B. No like, equivalent or "or-equal" item or substitution is permitted.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating or as indicated in the schedule.
   3. Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating or as indicated in the schedule.
   4. Service Entrance Equipment rated when indicated on the Drawings.

C. Construction:
   1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
   2. Multi-section panelboards: Feed-through or sub-feed lugs.
   3. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
   1. Main bus bars:
      a. Plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC.
      b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
   2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
   3. Neutral bus bars: Insulated 100 percent rated or 200 percent rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Enclosure:
   1. Boxes: Code gage galvanized steel, furnish without knockouts.
   2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
   3. Lighting and appliance panelboard:
      a. Trims supplied with hinged door over all circuit breaker handles.
      b. Trims for surface mounted panelboards, same size as box.
      c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
      d. Doors lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.
      e. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
      f. Clear plastic cover for directory card mounted on the inside of each door.
      g. NEMA 12 rated: Door gasketed.
4. Power distribution panelboard:
   a. Trims cover all live parts with switching device handles accessible.
   b. Less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
   c. Clear plastic cover for directory card mounted front of enclosure.
   d. NEMA 12 rated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.

F. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Molded case circuit breaker.
   2. Branch overcurrent protective devices:
      a. Mounted molded case circuit breaker.
   3. See Section 26 28 00 for overcurrent and short circuit protective device requirements.
   4. Factory installed.

PART 3 EXECUTION

3.1 INSTALLATION

   A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

   B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 26 05 00.

   C. Provide NEMA 12 rated enclosure as indicated on the Drawings.

   D. Provide each panelboard with a typed directory:
      1. Identify all circuit locations in each panelboard with the load type and location served.
      2. Mechanical equipment shall be identified by Owner-furnished designation if different than designation indicated on the Drawings.
      3. Room names and numbers shall be final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings.

END OF SECTION
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PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Separately mounted motor starters (including those supplied with equipment).

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
   7. Section 26 09 13 - Electrical Metering Devices.
   8. Section 26 09 16 - Control Equipment Accessories.
   9. Section 26 22 13 - Dry-Type Transformers.
   10. Section 26 24 16 - Panelboards.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
      b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
      c. ICS 3, Medium-Voltage Controllers Rated 2001 to 7200 V AC.
   3. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
      b. 845, Motor Control Centers.

B. Miscellaneous:
   1. Verify motor horsepower loads, other equipment loads, and controls from approved Shop Drawings and notify Engineer of any discrepancies.
   2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout Drawings:
      a. Motor control center:
1) Elevation Drawing with overall dimensions.
2) Starter and component schedule.
3) Identification of units and their location in the MCC.
4) Location of incoming line terminals.
5) Mounting dimensions.
6) Available conduit entrance areas.
7) Nameplate schedule.
8) Assembly ratings (amps, volts, short circuit, etc.).
9) Unit ladder logic wiring for each unit depicting electrical interlocking and wiring between units (NEMA ICS 3 Class II) and identification of terminals where field devices or remote control signals are to be terminated (NEMA ICS 3 Class II-S) as indicated on the Drawings and/or loop descriptions.

b. Separately mounted combination starters:
   1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated as indicated on the Drawings and/or loop descriptions.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 70 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
      b. Fabrication and/or layout Drawings updated with as-built conditions.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen-Bradley.
   2. Eaton.
   4. Siemens.

B. No like, equivalent or "or-equal" item or substitution is permitted.

2.2 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Enclosure:
   1. NEMA 4X rated:
      a. Body and cover: Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   2. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
C. Operating Handle:
1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
2. Circuit breaker and MCP operators includes a separate TRIPPED position.
3. Mechanical interlock to prevent to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
5. Padlockable in the OFF position.

D. External mounted overload relay pushbutton.

E. Control Devices:
1. Provide control devices as indicated on the Drawings per Specification Section 26 09 16.
2. Devices will be accessible with the door closed.

F. Control Power Transformer:
1. 120V secondary.
2. Fused on primary and secondary side.
3. Sized for 140 percent of required load.

G. Fault Current Withstand Rating: Equal to rating of the electrical gear from which it is fed.

H. Motor Starters: See requirements within this Specification Section.

I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:
1. Motor circuit protector.
2. See Section 26 28 00 for overcurrent and short circuit protective device requirements.
3. Factory installed.

2.3 MOTOR STARTERS

A. Standards:
1. NEMA ICS 2.
2. UL 508.

B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:
1. NEMA full size rated contactor.
a. NEMA half sizes and IEC contactors are not permitted.
2. Double-break silver alloy contacts.
3. Overload relays:
c. GE: Multilin MM200.
d. Siemens: Pro V (Simocode).
e. Communication link: As noted on Drawings.

C. Full Voltage Reversing (FVR) Magnetic Starters:
1. Two (2) FVNR starters with one (1) overload relay assembled together.
2. Mechanically and electrically interlocked to prevent line shorts and the energizing of both contactors simultaneously.
2.4 MANUAL MOTOR STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:
   1. Horsepower rated, for ON/OFF control.
   2. Horsepower rated, for ON/OFF control and thermal overload protection.
      a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:
   1. NEMA 4 rated:
      a. Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out or cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
      b. No knockouts, external mounting flanges.
   2. NEMA 4X rated:
      a. Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges.
   3. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.

B. Mounting height for surface mounted equipment: See Specification Section 26 05 00.

C. Combination and Manual Starter Enclosures:
   1. Permitted uses of NEMA 4X enclosure:
      a. Surface mounted in areas designated as wet and/or corrosive.
   2. Permitted uses of NEMA 12 enclosure:
      a. Surface mounted in areas designated as dry.

3.2 FIELD QUALITY CONTROL

SECTION 26 27 26 - WIRING DEVICES

PART 1  GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Wall switches.
      b. Receptacles.
      c. Device wallplates and coverplates.
      d. Occupancy sensors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   4. Section 26 05 33 - Raceways and Boxes.
   5. Section 26 24 19 - Motor Control Equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. WD 1, General Color Requirements for Wiring Devices.
      c. WD 6, Wiring Devices - Dimensional Requirements.
   2. Underwriters Laboratories, Inc. (UL):
      a. 20, General-Use Snap Switches.
      b. 498, Standard for Attachment Plugs and Receptacles.
      c. 514A, Metallic Outlet Boxes.
      d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
      e. 943, Ground-Fault Circuit-Interrupters.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.

PART 2  PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Wall switches and receptacles:
   a. Bryant Electric.
   b. Cooper Wiring Devices by Eaton.
   c. Hubbell Incorporated Wiring Device-Kellems.
   d. Leviton Manufacturing Company.
   e. Legrand/Pass & Seymour.
   f. Eaton Crouse-Hinds.
   g. Appleton Electric Co.
   h. Hubbell Killark.

2.2 WALL SWITCHES

A. Basic requirements unless modified in specific requirements paragraph of switches per
   designated areas or types:
   1. Industrial Specification Grade.
   2. Quiet action, snap switch.
   3. Self grounding with grounding terminal.
   4. Back and side wired.
   5. Solid silver cadmium oxide contacts.
   6. Rugged thermoplastic and/or nylon housing and one-piece switch arm.
   8. Switch handle type: Toggle.
   10. Types as indicated on the Drawings:
       b. Double-pole.
       c. 3-way.
       d. 4-way.
       e. Keyed.
       f. Momentary contact.

B. Dry Non-Architecturally Finished Area Specific Requirements:
   1. Coverplate for use on surface mounted outlet boxes:
      a. Cast iron alloy, galvanized and factory painted finish.
      b. Single or multiple gang as required.
   2. Wallplate for use on recessed outlet boxes:
      a. High impact thermoplastic or nylon, color to match handle.
      b. Single or multiple gang as required.

C. Wet or Damp Non-architecturally Finished or Exterior Area Specific Requirements:
   1. Coverplate:
      a. Cast iron alloy, gasketed, stainless steel hardware, galvanized and factory painted
         finish.
      b. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted
         finish.
      c. Operator type:
         1) Front mounted lever type handle to operate snap switch.
         2) Push/pull operator to operate snap switch.
         3) Spring type door to cover snap switch.
      d. Wet location rated.
e. Single or multiple gang as required.

D. Corrosive and Dry Area Specific Requirements:
   1. Corrosion resistant nickel plated metal parts.
   2. Coverplate for use on metallic outlet boxes:
      a. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
      b. Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
      c. Single or multiple gang as required.
   3. Coverplate for use on non-metallic outlet boxes:
      a. High impact thermoplastic or nylon, color to match handle, stainless steel screws.
      b. Single or multiple gang as required.

E. Hazardous and Corrosive or Highly Corrosive and Dry, Wet or Damp Area Specific Requirements:
   1. Rated for Class I, Division 1 and 2, Groups C and D.
   2. Assembly consists of outlet box, snap switch and coverplate.
      a. NEMA 3X, 7 and 9 rated.
   3. Outlet box:
      a. High strength glass reinforced non-metallic compound.
      b. Aluminum grounding grid imbedded into enclosure.
   4. Snap switch (EFS Type):
      a. Not enclosed in separate sealing chamber requiring external sealing fittings.
   5. Coverplate:
      a. High strength glass reinforced non-metallic compound, gasketed and coated stainless
         steel hardware.
      b. Operator type: Non-metallic, front mounted lever to operate snap switch.

2.3 RECEPTACLES

A. Basic Requirements Unless Modified in Specific Requirements Paragraph of Receptacles and
   Per Designated Areas:
   1. Industrial Specification Grade.
   2. Straight blade.
   3. Brass triple wipe line contacts.
   4. One-piece grounding system with double wipe brass grounding contacts and self
      grounding strap with grounding terminal.
   5. Back and side wired.
   7. High impact nylon body.
   8. Receptacle body color:
      b. Generator or UPS power: Red.
   9. Duplex or simplex as indicated on the Drawings.
   10. Configuration: NEMA 5-20R.

B. Receptacle Type Specific Requirements:
   1. Basic receptacles:
      a. Weather-resistant when located in damp or wet areas as indicated on the Drawings.
         1) Identification: Letters “WR” on face of receptacle.
2. Ground Fault Circuit Interrupter (GFCI):
   a. Specification Grade.
   b. Class A protection.
   c. Feed through type.
   d. Test and reset buttons.
   e. Self-testing.
   g. Weather-resistant when located in damp or wet areas as indicated on the Drawings.
      1) Identification: Letters “WR” on face of receptacle.
   h. Additional standards: UL 943.

C. Dry Non-Architecturally Finished Areas Specific Requirements:
   1. Coverplate for use on surface mounted outlet boxes:
      a. Cast iron alloy, galvanized and factory painted finish.
      b. Cast aluminum, natural, lacquer or factory painted finish.
      c. Single or multiple gang as required.
   2. Wallplate for use on recessed outlet boxes:
      a. High impact thermoplastic or nylon, color to match body.
      b. Single or multiple gang as required.

D. Damp Non-Architecturally Finished Areas Specific Requirements:
   1. Coverplate:
      a. Cast iron alloy, gasketed, self-closing cover, stainless steel hardware, galvanized and factory painted finish.
      b. Cast aluminum, gasketed, self-closing cover, stainless steel hardware, natural, lacquer or factory painted finish.
      c. Weatherproof when receptacle is covered.
      d. Single or multiple gang as required.

E. Wet Non-Architecturally Finished Areas Specific Requirements:
   1. Coverplate:
      a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cords.

F. Exterior Locations Specific Requirements:
   1. Coverplate:
      a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cord.

G. Corrosive and Dry Area Specific Requirements:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Gray.
   3. Coverplate for use on metallic outlet boxes:
      a. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
      b. Cast aluminum, stainless steel hardware, natural, lacquer or factory painted finish.
      c. Single or multiple gang as required.
   4. Coverplate for use on non-metallic outlet boxes:
      a. High impact thermoplastic or nylon, gray in color, stainless steel screws.
      b. Single or multiple gang as required.

2.4 MISCELLANEOUS WIRING DEVICES
A. Manual Motor Starters: Horsepower rated with or without thermal overloads, see Specification Section 26 24 19.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 26 05 00.

C. See Specification Section 26 05 33 for device outlet box requirements.

D. Where more than one (1) receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

END OF SECTION
SECTION 26 28 00 - OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Low voltage circuit breakers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      c. C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures. (Equivalent to UL 489)
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      c. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 70 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Reports:
   a. As-left condition of all circuit breakers that have adjustable settings.

D. Power System Study:
   1. Short Circuit Study:
      a. Provide calculation methods and assumptions, base per unit quantities selected, one-line diagrams, source impedance data including utility company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions and recommendations.
      b. Notify Engineer in writing of equipment not properly rated for fault conditions. Identify any prohibited operating/switching scenarios that would over-duty certain identified equipment.
   2. Coordination Study:
      a. Provide determination of settings, ratings, or types for overcurrent protective devices supplied. Where necessary, appropriate compromise shall be made with system protection and service continuity considered to be of equal importance.
      b. Breakers shall be set to trip as quickly as possible without compromising overall coordination to limit arc flash hazard energy to the lowest level possible.
   3. Studies should be done before equipment approval.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Circuit breakers:
      a. Eaton.
      b. General Electric Company.
      c. Siemens.

B. No like, equivalent or "or-equal" item or substitution is permitted.

2.2 CIRCUIT BREAKERS

A. Molded Case Type:
   1. General:
      a. Standards: NEMA AB 1, UL 489.
      b. Unit construction.
      c. Over-center, toggle handle operated.
      d. Quick-make, quick-break, independent of toggle handle operation.
      e. Manual and automatic operation.
      f. All poles open and close simultaneously.
      g. Three (3) position handle: On, off and tripped.
      h. Molded-in ON and OFF markings on breaker cover.
      i. One-, two- or three-pole as indicated on the Drawings.
      j. Current and interrupting ratings as indicated on the Drawings.
      k. Bolt on type.
2. Thermal magnetic type:
   a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
   b. Frame size 150 amp and below:
      1) Non-interchangeable, non-adjustable thermal magnetic trip units.
   c. Frame sizes 225 to 400 amp (trip settings less than 400A):
      1) Interchangeable and adjustable instantaneous thermal magnetic trip units.
   d. Ground Fault Circuit Interrupter (GFCI) Listed:
      1) Standard: UL 943.
      2) One- or two-pole as indicated on the Drawings.
      3) Class A ground fault circuit.
      4) Trip on 5 mA ground fault (4-6 mA range).
   e. Ground Fault Equipment Protective Circuit Interrupter (GFEPCI) Listed:
      1) Standard: UL 1053.
      2) Trip on 30 mA ground fault (6-50 mA range).
3. Solid state trip type:
   a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.
   b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
      1) Standard rating.
      2) Interchangeable current sensor or rating plug.
      3) Adjustable long time pick-up setting.
         a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
      4) Adjustable short time pick-up setting.
      5) Adjustable instantaneous pick-up.
      6) Fixed ground fault pick-up, when indicated on the Drawings.
      7) 1200 Amp Breakers: ARC Flash Reduction Maintenance System.
4. Motor circuit protector:
   a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
   b. Sized for the connected motor.

PART 3  EXECUTION

3.1 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:
   1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
      a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
      b. Frame sizes 400 amp and larger shall be solid state trip type.
      c. Provide ground fault protection when indicated on the Drawings.
      d. Motor circuit protectors sized for the connected motor.
3.2 FIELD QUALITY CONTROL

A. Coordinated Power System Protection:
   1. Prepare a study to demonstrate that the equipment and system constructed within the
      scope of these Contract Documents, meet the specified requirements for equipment
      ratings, coordination and protection.
   2. Perform the studies in accordance with IEEE 242 and IEEE 399.
   3. Include the name of the software developer, software package and software version
      number in the computer generated studies.
   4. System short circuit study report:
      a. Begin the study at the main service electrical gear and extend down the system
         through all buses.
         1) Perform a balanced three-phase fault, bolted line-to-line fault and line-to-ground
            fault study.
      b. Prepare a one-line diagram to show the electrical system buses, transformers and all
         sources of fault current including motors.
      c. Utilize manufacturer's data for the actual proposed equipment (e.g., transformer
         impedance).
      d. Coordinate the available utility fault current with the power utility company.
      e. Show input data in tabular form in the report and/or on the one-line diagram.
         1) Input data shall include but is not limited to:
            a) Utility fault current or MVA and X/R ratio.
            b) Bus voltages.
            c) Conductor sizes and type of conduit.
            d) Motor sizes and contributions.
            e) Transformer sizes and impedances.
      f. Show available fault current at each bus in tabular form in the report and/or on the
         one-line diagram.
      g. Perform studies for both normal power and emergency/standby power scenarios.
   5. System protective coordination study report:
      a. Begin the study at the main service electrical gear and extend down the system
         through all buses as required to ensure a coordinated power system.
      b. Demonstrate that the maximum possible degree of selectivity has been obtained
         between devices specified for the protection of equipment and conductors from
         damage from overloads and fault conditions.
         1) Where necessary, an appropriate compromise shall be made between system
            protection and service continuity.
         2) Consider system protection and service continuity to be of equal importance.
      c. Prepare a one-line diagram to show the electrical system buses, transformers and
         protective devices.
      d. Utilize manufacturer's data for the actual proposed protective devices.
      e. Summarize the coordination study, conclusions and recommendations.
         1) As a minimum, include the following:
            a) The manufacturer's information used to prepare the study.
            b) Assumptions made during the study.
            c) Recommended taps and settings of all adjustable devices in tabulated form.
            d) Composite coordination time-current curves on log-log paper showing:
               (1) That the settings for each protective device will provide protection and
                   selectivity.
               (2) Identify each curve.
               (3) Cable and equipment damage points.
(4) Circuit interrupting device operating and interrupting times.
(5) One-line sketch of the part of the system being investigated.
(6) Include as many curves as possible on a graph while maintaining readability.

   e) Position time-current curves for each device to provide for maximum selectivity to minimize system disturbances during fault clearing.
   f) Advise the Engineer of potential coordination problems discovered during the study and include recommendations to resolve the problem.
   g) Submit the report for approval 90 days prior to equipment energization.

B. Adjustable Circuit Breakers:
   1. Set all circuit breaker adjustable taps as defined in the coordination study, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

C. Ground Fault Protection System:
   1. Single source system:
      a. Main breaker using the residual sensing method system.
      b. Main and feeder breakers: Utilize four (4) individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.

D. Testing:

   END OF SECTION
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SECTION 26 28 16 - SAFETY SWITCHES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a Summary Table or use Exhibit A that associates the safety switch features with connected equipment tag number. Exhibit A indicates minimum data required.
      c. See Specification Section 26 05 00 for additional requirements.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Siemens.
   5. Crouse-Hinds.

2.2 SAFETY SWITCHES
A. General:
   1. Non-fusible or fusible as indicated on the Drawings.
   2. Suitable for service entrance when required.
   3. NEMA Type HD heavy-duty construction.
   4. Switch blades will be fully visible in the OFF position with the enclosure door open.
   5. Quick-make/quick-break operating mechanism.
   6. Deionizing arc chutes.
   7. Manufacture double-break rotary action shaft and switchblade as one (1) common component.
   8. Clear line shields to prevent accidental contact with line terminals.
   9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
      a. Red and easily recognizable.
      b. Padlockable in the OFF position.
      c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
   1. Horsepower rated of connected motor.
   2. Voltage and amperage: As indicated on the Drawings.
   3. Short circuit withstand:
      a. Non-fused: 10,000A.
      b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
   1. Neutral kits.
   2. Ground lug kits.
   3. Auxiliary contact kits:
      a. Opens before main switch.
      b. Rated 10A at 125/250 Vac.
      c. One (1) N.O. and one (1) N.C. contact.

D. Enclosures:
   1. NEMA 4X rated (metallic):
      a. Body and cover: Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   2. NEMA 7 and NEMA 9 rated:
      a. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
      b. Drilled and tapped openings or tapered threaded hub.
      c. Gasketed cover bolted-down with stainless steel bolts.
      d. External mounting flanges.
      e. Operating handle padlockable in the OFF position.
   3. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and Short Circuit Protective Devices:
   1. Fuses.
   2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
PART 3 EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
   1. The VFD is to be disabled when the switch is in the open position.

D. Permitted uses of NEMA 4X Metallic Enclosure:
   1. Surface mounted in areas designated as wet and/or corrosive.

E. Permitted uses of NEMA 7 Enclosure:
   1. Surface mounted in areas designated as Class I hazardous.

F. Permitted uses of NEMA 9 Enclosure:
   1. Surface mounted in areas designated as Class II hazardous.
   2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

G. Permitted uses of NEMA 12 Enclosure:
   1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION
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SECTION 26 50 00 - INTERIOR AND EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Interior building and exterior building mounted luminaires.
      b. Exterior and site luminaires.
      c. Lamps and LEDs.
      d. Ballasts and drivers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
   2. Federal Communications Commission (FCC):
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   4. Illuminating Engineering Society of North America (IESNA):
      b. LM-80, Measuring Lumen Maintenance of LED Light Sources.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. LE 4, Recessed Luminaires, Ceiling Compatibility.
      a. SSL 1, Electronic Drivers for LED Devices, Arrays and Systems.
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc. (UL):
      a. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
      b. 924, Standard for Emergency Lighting and Power Equipment.
      c. 1012, Power Units Other Than Class 2.
      d. 1310, Class 2 Power Units.
      e. 1598, Luminaires.
      f. 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products.
   9. United States Department of Energy (USDOE):
1.3 DEFINITIONS

A. Useful Life for LED luminaire light sources:
   1. The operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.
   2. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Identify luminaire by Luminaire Schedule designation.
      c. Luminaire data sheet:
         1) Name of manufacturer.
         2) Complete order information (catalog number).
         3) Description of construction and optics.
         4) Total input wattage.
         5) Luminous efficacy (lumens/Watt).
         6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
         7) Dimensional size.
         8) Weight.
         9) UL nameplate data for luminaires used in Class 1, Division 1 and 2 areas.
        10) Effective Projected Areas (EPA) for pole mounted luminaires.
      d. Solid state Luminaire additional data:
         1) Voltage.
         2) Initial and IES L70 lumens.
         3) Luminous efficacy (lumens/Watt).
         4) Correlated Color Temperature (CCT).
         5) Color Rendering Index (CRI).
         6) Total Harmonic Distortion (THD).
         7) Lamp life.
         8) Driver manufacturer and model number.
         9) Driver life.
        10) Driver type (0-10V, constant voltage, constant current).
        11) Dimming range and control device compatibility.
        12) Remote driver: Maximum wire length to luminaire.
        13) Emergency battery driver:
           a) Compatibility with lighting module.
           b) Lumen output of lighting module in emergency operation.
           c) Battery life.
           d) Description of testing.
           e) Ambient operating temperature.
        14) Toxicity Characteristic Leaching Procedure (TCLP) compliance.
15) Warranty information.

e. Luminaire lamp data sheet:
   1) Name of manufacturer.
   2) Complete order information (catalog number).
   3) Wattage.
   4) Initial and mean lumens.
   5) Luminous efficacy (lumens/Watt).
   6) Correlated Color Temperature (CCT).
   7) Color Rendering Index (CRI).
   8) Lamp life.
   9) Base configuration.
   10) Toxicity Characteristic Leaching Procedure (TCLP) compliance.
   11) Warranty information.

f. Luminaire ballast (driver) data sheet:
   1) Name of manufacturer.
   2) Complete order information (catalog number).
   3) Type and quantity of lamps it operates.
   4) Ballast factor.
   5) Input Wattage.
   6) Inrush current.
   7) Voltage.
   8) End-of-life sensing shut off.
   9) Total Harmonic Distortion (THD).
   10) Dimming ballast:
       a) Dimming range.
       b) Compatible dimming control devices.
   11) Remote ballasts: Maximum wire length to luminaire.
   12) Emergency battery ballast:
       a) Lumen output of lamp in emergency operation.
       b) Battery life.
       c) Description of testing.
   13) Warranty information.

3. Test Reports:


B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 70 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
      b. Submittal data for each component covered by warranty.
      c. Warranty.

1.5 WARRANTY

A. Minimum of a five (5) year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15 percent of the individual light emitting diodes fail to illuminate.
PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Luminaires: Per Luminaire Schedule.
   2. Solid State Light Sources:
      a. Cree.
      b. Xicato.
      c. Luminaire manufacturer’s proprietary system.
   3. LED Driver: Luminaire manufacturer's standard.
   4. Emergency ballasts:
      a. Iota Engineering.
      b. Philips Bodine.

2.2 GENERAL REQUIREMENTS

A. All Luminaires and Electrical Components:
   1. UL labeled.
   2. Luminaires complete with lamps and ballasts or LED modules and drivers.
   3. Rated for area classification as indicated on the Drawings.
      a. In Class I, Division 1 and 2 areas, the temperature rating of the luminaires and lamp
         or LED combination shall not exceed the auto-ignition temperature of the atmosphere
         in which the Luminaire is used.

B. Provide all recessed luminaires with gaskets of rubber, fiberglass, or equivalent material to
   prevent light leaks around flush trim.
   1. Provide recessed luminaires with trim gaskets cemented in proper position.

C. Provide standard plaster frame for all recessed luminaires installed in plaster walls or ceilings.
   1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.

D. Coordinate luminaire mounting where recessed into building canopies prior to Submitting Shop
   Drawings. Confirm clearances and luminaire flange compatibility with construction.

E. Electrical components of recessed luminaires shall be accessible and removable through
   luminaire without having to remove luminaire from ceiling.

F. No live parts normally exposed to contact.

G. When intended for use in wet areas: Mark luminaire "Suitable for wet locations."

H. When intended for use in damp areas: Mark luminaire "Suitable for damp locations" or "Suitable
   for wet locations."

2.3 LUMINAIRES

A. Standards:
   1. UL 1598.
   2. UL 844 for hazardous locations.
3. NEMA LE 4 for recessed locations.

B. Housings:
   1. As indicated in the Luminaire Schedule and the following:
      a. Troffer luminaires:
         1) Minimum 22 gage sheet steel.
         2) Integral end plates and trim flanges to suit ceiling construction.
         3) Wire way covers with captive retainers to allow access to electrical components without use of tools.
      b. Down Light luminaires:
         1) Minimum 22 gage sheet steel, or minimum 16 gage sheet aluminum, unless noted otherwise.
         2) Auxiliary junction box secured to mounting frame.
      c. Extruded aluminum housings, where scheduled, shall be at least 1/8 IN thick.
      d. Punch and form housings prior to finishing (post-paint).

C. Trim (Recessed Mounted):
   1. As indicated in the Luminaire Schedule and the following:
      a. For square and rectangular luminaires, miter and continuously weld corners.
      b. Miter perimeter inverted T-Bar angles at corners.
      c. Do not butt or overlap squared ends.
      d. Finish joints smooth.

D. Castings:
   1. As indicated in the Luminaire Schedule and the following:
      a. Uniform quality, free from imperfections affecting strength and appearance.
      b. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.

E. Fasteners:
   1. As indicated in the Luminaire Schedule and the following:
      a. Aluminum or steel luminaires: Cadmium-plated or an equivalent.
      c. Bronze luminaires: Bronze or stainless steel.

F. Finishes:
   1. As indicated in the Luminaire Schedule and the following:
      a. Painted surfaces:
         1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish; acrylic, alkyd, epoxy, polyester or polyurethane.
         2) White finishes shall have minimum 85 percent reflectance.
      b. Unpainted surfaces:
         1) Interior: Clear anodic coating, satin finish.
         2) Exterior: Clear anodic coating.

G. Lens/Louver Frames:
   1. As indicated in the Luminaire Schedule and the following:
      a. Extruded aluminum with mitered corners.
      b. Hinging or other normal motion shall not cause lens or louver to drop out.
c. No light leak between frame and housing.

H. Lenses:
1. As Indicated in the Luminaire Schedule and the Following:
   a. 100 percent virgin, UV stabilized acrylic.
   b. Linear fluorescent luminaires: Male conical prismatic, minimum thickness 0.150 IN, size as required.
   c. Held securely in place but must also be removable for cleaning and relamping.
   d. Luminaires with directional lenses shall include a lens orientation device to ensure that lens installation provides light distribution as designed.
   e. No light leaks between the lens and the luminaire.

I. Reflectors:
1. As Indicated in the Luminaire Schedule and the Following:
   a. Down Light Reflector and Baffle Finishes: First-quality "Alzak" anodized specular finish.
   b. Troffer reflector finish: Integral reflectors shall be painted white after fabrication with a minimum reflectance value of 90 percent.

J. Gaskets:
1. As Indicated in the Luminaire Schedule and the Following:
   a. Gaskets at face plates or frames of recessed luminaires which serve as ceiling trim and which allow interior access.
   b. Moisture seal gaskets at exterior locations and in other designated wet areas.
   c. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks.

K. Ventilation:
1. Ventilation openings of adequate size and quantity to permit operation of lamps and ballast without affecting rated output or life expectancy. Include wire mesh screens.

L. Wiring:
1. Factory-wired to be compatible with the project electrical and controls systems.

M. Mounting Accessories:
1. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered.
2. All luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not effected during relamping or cleaning.
3. Recessed Luminaires:
   a. Plaster Frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
   b. Baffles and Gaskets: As required to prevent light leakage.
   c. Flanged luminaires are required in all ceiling systems except exposed grid lay-in panel type.
4. Luminaire Suspension Material:
   a. Unfinished Spaces:
      1) 1/2 IN minimum diameter swivel stem, unless otherwise noted.
      2) Safety chain on high bay type.
   b. Finished Spaces: Unless otherwise noted.
1) Manufactured cable or stem and outlet box canopy.
   a) Contemporary design with swivel self-aligning features.
   b) Size canopy to cover outlet box, minimize size of canopy not associated with outlet box.
   c) Finish to match luminaire.
2) Coordinate pendant location with ceiling tiles/ceiling grid.
   a) Submit coordinated mounting accessories as part of Shop Drawing submission.
3) Luminaires mounted on suspended ceiling grids should be provided with outlet box designed for grid mounting with direct cord entry and supported by outlet box.

2.4 SOLID-STATE LUMINAIRES - ADDITIONAL REQUIREMENTS

A. Standards:
   2. NEMA SSL 1.
   3. UL 1012, 1310, and 8750.
   4. UL 844 for hazardous locations.

B. Solid state modules and driver to be provided and warrantied by luminaire manufacturer.

C. Solid-State Modules:
   1. Minimum uniform color temperature of 3500K.
      a. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for frosted lensed luminaires, and 2 SDCM for other luminaire types (ANSI C78.377).
   2. Minimum color rendering index (CRI) of 80.
   3. LED module light output and efficacy: Measured in accordance with IES LM-79 standards.
   4. LED useful life and lumen maintenance: Measured in accordance with IES LM-80 standards.
   5. Driver and LED module: Minimum useful life of 50,000 HRS.
   6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.

D. Driver:
   1. Compatible with solid-state modules and control devices specified.
   2. Operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency).
   3. Input current Total Harmonic Distortion (THD): Less than 20 percent when operated at nominal line voltage.
   4. Power Factor: Greater than 0.90.
   5. Avoid interference with infrared devices and eliminate visible flicker.
   6. Comply with ANSI C62.41 Category A for Transient protection.
   7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
   8. Dimmable drivers capable of continuous dimming over a range of 100 percent to 1 percent of rated lumen output. Dimming controlled by a 0-10VDC signal, unless otherwise specified in Luminaire Schedule.
9. Control device must be compatible with type of driver and coordinated prior to submission of Shop Drawings. List of compatible dimming controllers must include the range of perceived brightness. No visible flicker throughout the dimming range.

10. Remote-mounting:
   a. Provide maximum allowable distances for secondary wire runs to luminaires.
   b. Provide remote mounting hardware and enclosures as required.

11. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.

E. Emergency Battery Driver:
   1. UL 924.
   2. Confirm compatibility with LED modules utilized.
   3. Consist of a high temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry.
   4. A solid state charging indicator light to monitor the charger and battery.
   6. The following product family shall be selected based on coordination with LED lamp type:
      a. Philips Bodine “BSL23C”: can operate up to 4.5W at 410mA.
      b. Philips Bodine “BSL26C”: can operate up to 5.1W at 265mA.
      c. Philips Bodine “BSL722”: can operate up to 23W at 770mA.
      d. Philips Bodine “BSL23C”: can operate up to 23W at 770mA in operating conditions ranging from -20 DegC (-4 DegF) to 60 DegC (140 DegF).
      e. Alternate manufacturer: Iota.

F. Luminaire properly heat sinked to assure LED junction temperature ratings are not exceeded.
   1. Provide ambient operating temperature range for which product is warrantied.

2.5 EXIT SIGNS AND EMERGENCY LIGHTING UNITS

A. Standards:
   1. UL 924.
   3. Local State or City requirements.

B. Exit Signs:
   1. Housing and finish: As indicated in the Luminaire Schedule.
   2. LED illuminated with integral driver.
   3. AC powered or AC and battery powered: As indicated in the Luminaire Schedule.
   4. Battery powered units:
      a. Battery type: As indicated in the Luminaire Schedule.
      b. Self-testing/self-diagnostic.
         1) Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
      c. Consist of battery, charger and electronic circuitry.
      d. Solid state charging indicator light to monitor the charger and battery.
      e. Single-pole test switch.
      f. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.
PART 3  EXECUTION

3.1  INSTALLATION

A. Coordinate Luminaire Types with Ceiling Construction:
   1. Provide mounting hardware for the ceiling system in which the luminaire is to be installed.

B. Fasten luminaires supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted luminaires.
   1. Do not support luminaire from conduit system.
   2. When luminaire is supported from outlet boxes, install per NFPA 70.
   3. Supports for luminaire mounted on exterior walls shall not be attached to exterior face of the wall.

D. Support surface mounted luminaires from the building structure and not from the ceiling suspension system.
   1. Luminaires up to 4 FT wide and 4 FT long: A minimum of four supporting points, one at each corner.
   2. Luminaires 8 FT long: A minimum of five support points, one at center of luminaire and one at each corner.
   3. Luminaires smaller than 2 FT in length: A minimum of two supporting points.

E. Provide pendant luminaires with swivel hangers which will allow luminaire to swing in any direction but will not permit stem to rotate.
   1. Provide hangers with enclosure rating (NEMA 1 or 4) equal to enclosure requirements of area in which they are installed.
   2. Swivel hangers for luminaires in mechanical equipment areas: Shock absorbing type.
   3. Secure low and high bay luminaires with safety chain or safety aircraft cable to the building structure.
      a. Chain or cable to prevent luminaire from falling more than 3 IN before the luminaire is caught by the chain or cable.

F. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.
   1. Locate luminaires in accordance with reflected ceiling plans.

G. Locate luminaire in exact center of ceiling tile unless otherwise indicated.
   1. Relocate misinstalled luminaire and replace damaged ceiling materials.

H. Mount luminaire at heights indicated in Specification Section 26 05 00 or per Luminaire Schedule or as indicted on the Drawings.

I. Install exterior luminaires so that water can not enter or accumulate in the wiring compartment.

J. Emergency Battery Ballasts:
   1. Where emergency battery ballasts are shown controlled via switching device, wire ballast so lamps will not operate when normal power is available and switching device turns lights off. Lamps will operate in emergency mode regardless of switch position.
2. Luminaire manufacturer to supply the emergency battery ballasts with luminaire.

K. Ground luminaire and ballasts.

3.2 LIGHTING CONTROL

A. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

3.3 ADJUST AND CLEAN

A. Replace all inoperable lamps with new lamps prior to final acceptance.

B. Aim all emergency lighting units, so that, the path of egress is illuminated.

END OF SECTION
DIVISION 31

EARTHWORK
SECTION 31 05 13 - SOILS FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subsoil materials.
   2. Topsoil materials.

B. Related Sections:
   1. Section 31 05 16 - Aggregates for Earthwork.
   2. Section 31 22 13 - Rough Grading.
   4. Section 31 23 23 - Fill.
   5. Section 31 37 00 - Riprap.
   6. Section 32 91 19 - Landscape Grading.
   7. Section 32 92 19 - Seeding and Soil Supplements.
   8. Section 32 93 00 - Plants.

1.2 REFERENCES


B. American Association of State Highway and Transportation Officials:

C. ASTM International (ASTM):
   3. D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   5. D3017 – Test Method for Moisture Content of Soil and Soil–Aggregate in Place by Nuclear Methods (Shallow Depth).
1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Samples: Submit, in air-tight containers, 10 LBS sample of fill to testing laboratory.
C. Materials Source: Submit name of imported materials source.
D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each subsoil material from single source throughout the Work.
B. Perform Work in accordance with the Standard Specifications for Road and Bridge Construction (SSRBC), Current Edition, of Illinois Department of Transportation.
C. Maintain one copy of IDOT Construction Manual and SSRBC on site.

PART 2 - PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Types: Conforming to the Standard Specifications for Road and Bridge Construction in Illinois, Current Edition (IDOT), Section 204, and/or as indicated on the Plans.
B. Subsoil Fill:

   1. Excavated and Re-Used Material:
      a. Material excavated from site shall have a Standard Dry Density of not less than 90 LBS/CF when tested according to AASHTO T 99 (Method C and shall not possess an organic content greater than ten percent (10% when tested according to AASHTO T 194.
   2. Graded.
   3. Free of lumps larger than 3 IN, rocks larger than 2 IN, and debris.

2.2 TOPSOIL MATERIALS

A. Topsoil: As defined under Section 211 Conforming to Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).
B. Topsoil:

   1. Imported borrow.
   2. Loamy soil and the A horizon soil profile as defined in the IDOT Geotechnical Manual.
3. Reasonably free of roots, rocks larger than 1 IN, subsoil, debris, large weeds, and foreign matter.
   a. Screening: Single screened. 90 percent passing the No. 10 (2.00mm sieve.
4. Acidity range pH) of 5.0 to 8.0 per ASTM D4972.
5. Containing minimum of 1 percent and maximum of 10 percent organic matter.
6. To be restored to original depth, at minimum, or as shown on Plans.
7. In the event that the Contractor elects to import material, a sample of material not less than 10 LBS shall be inspected and approved by the Owner prior to delivery.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and Inspection Services Testing and analysis of soil material.
B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698.
C. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D698.
D. When tests indicate materials do not meet specified requirements, change material and retest.
E. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.
B. Stockpile excavated material meeting requirements for subsoil materials.
C. Remove excess excavated materials not intended for reuse, from site.
D. Remove excavated materials not meeting requirements for subsoil materials from site.
E. Remove lumped soil, boulders, and rock in accordance with Section 31 23 16.26 – Rock Removal.

3.2 STOCKPILING

A. Stockpiling and all associated work shall be considered incidental to the Contract and only completed if deemed necessary by the contractor due to scheduling.
B. Stockpile materials on site at locations designated by Engineer.
C. Stockpile in sufficient quantities to meet Project schedule and requirements.
D. Separate differing materials with dividers or stockpile apart to prevent mixing.
E. Prevent intermixing of soil types or contamination.
F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
G. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.
H. Stockpile shall be stabilized in accordance with municipal and county standards. This includes but is not limited silt fence, seeding and stabilization such as mulch and hay.

3.3 STOCKPILE CLEANUP
A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
B. Leave unused materials in neat, compact stockpile.
C. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
D. Seed stockpiled area and borrow areas with specified seed mix and provide any additional reseeding, fertilization and/or watering necessary to establish germinated grass seed.

END OF SECTION 31 05 13
SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   2. Fine aggregate materials.

B. Related Sections:
   2. Section 31 22 13 - Rough Grading.
   4. Section 31 23 23 - Fill.
   6. Section 31 37 00 - Riprap.
   7. Section 32 11 23 - Aggregate Base Courses.
   8. Section 32 91 19 - Landscape Grading.
   9. Section 33 31 00 - Sanitary Utility Sewerage Piping.
  10. Section 33 51 00 - Natural-Gas Distribution.

1.2 REFERENCES

A. Standard Specifications for Road and Bridge Construction (SSRBC), Current Edition (Illinois Department of Transportation).

B. American Association of State Highway and Transportation Officials:

C. ASTM International:
   4. D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Materials Source: Submit name of imported materials suppliers.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.
C. Maintain one copy of the standards, on site.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate as indicated on plans as defined under Article 1004 of Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate as indicated on plans as defined under Section 1003 of Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and inspection services.
B. Coarse Aggregate Material - Testing and Analysis: Perform according to AASHTO T180.
C. Fine Aggregate Material - Testing and Analysis: Perform according to AASHTO T180.
D. When tests indicate materials do not meet specified requirements, change material and retest.
E. Provide materials of each type from the same source throughout the Work.

PART 3 - EXECUTION

3.1 STOCKPILING

A. Stockpile materials on site at locations designated by Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 31 05 16
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SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing surface debris.
   2. Removing designated paving, and curbs.
   3. Removing designated trees, shrubs, and other plant life.
   4. Removing abandoned utilities.
   5. Excavating topsoil.

B. Related Sections:
   1. Section 02 41 16 - Structure Demolition: Removing underground storage tanks and designated utilities.
   2. Section 31 22 13 - Rough Grading.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for non-residual herbicide. Indicate compliance with applicable codes for environmental protection.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Herbicide: Glyphosate, triclopyr or dicamba type, or as approved by authority having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify existing plant life designated to remain is tagged or identified.
C. Identify waste area for placing removed materials.

3.2 PREPARATION

A. Call Local Utility Line Information service at J.U.L.I.E. (811 or 1-800-892-0123) not less than two working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage. Any utilities removed or damaged in addition to those indicated on the plans or within the Specifications without prior approval of the Engineer or Owner will not be subject for payment.

B. In case of damage, notify Engineer at once so required protective measures can be taken.

C. Omission or inclusion of utility items from plans does not constitute non–existence or definite location. Secure and examine local utility records for location data.

D. Cap or remove utilities in accordance with instructions by Owners of utilities.

E. Protect trees, plant growth, and features designated to remain, as final landscaping.

F. Protect bench marks, monuments, survey control points, and existing structures from damage or displacement. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.

G. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.

H. Any pavements or concrete improvements including but not limited to curbs, pavement and sidewalk that are not indicated as removed or removed and replaced and are deemed damaged by the Engineer shall be replaced by the Contractor in a manner approved by the Engineer. No additional compensation will be granted unless approved in writing by the Owner.

I. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.

J. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.

K. Avoid surcharge or excavation procedures that may result in heaving, caving, or slides.

L. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.
M. Dispose of waste materials, legally, off site. Burning, as a means of waste disposal, is not permitted.

3.4 CLEARING

A. Clear areas required for access to site and execution of Work.

B. Remove trees and shrubs indicated. Remove stumps, main root ball, root system to depth of 12 IN, and surface rock.

C. Clear undergrowth and deadwood, without disturbing subsoil.

D. Apply herbicide to remaining stumps to inhibit growth.

E. Wherever possible, existing trees to be preserved.

3.5 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Remove paving, and curbs as indicated.

C. When partially remove paving, and curbs as indicated on Drawings, neatly saw cut edges at right angle to surface.

D. Remove abandoned utilities where indicated on Drawings. Indicated removal termination point for underground utilities on Record Documents.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

F. Do not burn or bury materials on site. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil.

C. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on–site or on adjoining property.

D. Stockpile in area designated on site to depth not exceeding 8 FT and protect from erosion. Stockpile material on impervious material until disposal.

E. Remove excess topsoil not intended for reuse, from site.

END OF SECTION 31 10 00
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SECTION 31 22 13 - ROUGH GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating topsoil.
   2. Excavating subsoil.
   3. Cutting, grading, filling, rough contouring, and compacting the site for site structures, building pads, and to match existing conditions.

   B. Related Sections:
   1. Section 02 41 16 - Structure Demolition.
   2. Section 31 05 13 - Soils for Earthwork: Soils for Fill.
   4. Section 31 10 00 - Site Clearing: Excavating Topsoil.
   5. Section 31 23 16 - Excavation: Building Excavation.
   6. Section 31 23 16.3 - Trenching: Trenching and Backfilling for Utilities.
   7. Section 31 23 18 - Rock Removal.
   8. Section 31 23 23 - Fill: General Building Area Backfilling.

1.2 REFERENCES


C. American Association of State Highway and Transportation Officials:
   2. AASHTO T99 – Moisture Density Relations of Soils Using a 5.5 IBS Rammer 12 IN Drop.

D. ASTM International:

1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Samples: Submit, in air-tight containers, 10 LBS sample of each type of fill to testing laboratory.
   C. Materials Source: Submit name of imported materials suppliers.

1.4 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
   B. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.5 QUALITY ASSURANCE
   B. Maintain one copy of document on site.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Topsoil: Type as specified in Section 31 05 13.
   B. Subsoil Fill: Type as specified in Section 31 05 13.
   C. Structural Fill: Type as specified in Section 31 05 16.
   D. Granular Fill: Type as specified in Section 31 05 16.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify site conditions under provisions of Section 01 40 00.

C. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

3.2 PROTECTION

A. Protect trees, shrubs, lawns and other features remaining as portion of final landscaping.

B. Protect benchmarks, existing structures, fences, sidewalks, curbs, roads and paving from excavating equipment and vehicular traffic.

C. Protect above or below ground utilities which are to remain.

D. Repair damage.

3.3 PREPARATION

A. Call Local Utility Line Information service (J.U.L.I.E.) at 1-800-892-0123 (or 811) not less than two working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Stake and flag locations of known utilities.

B. Identify required lines, levels, contours, and datum.

C. Notify utility company to remove and relocate utilities as indicated on Drawings.

D. Protect utilities indicated to remain from damage.

E. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Engineer.

F. Protect plant life, lawns, and other features remaining as portion of final landscaping.

G. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
3.4 TOPSOIL EXCAVATION
   A. Excavate topsoil from areas to be further excavated, re-landscaped, or regraded, without mixing
      with foreign materials for use in finish grading.
   B. Do not excavate wet topsoil.
   C. Stockpile in area designated on site to depth not exceeding 8 FT and protect from erosion.
      Stockpile material on impervious material, until disposal or reuse.
   D. Remove excess topsoil not intended for reuse, from site.
3.5 SUBSOIL EXCAVATION
   A. Excavate subsoil from areas to be further excavated, re-landscaped, or regraded.
   B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture
      content.
   C. When excavating through roots, perform Work by hand and cut roots with sharp axe.
   D. Remove excess subsoil not intended for reuse, from site.
   E. Stockpile subsoil in area designated on site to depth not exceeding 8 FT and protect from erosion.
      Stockpile material on impervious material, until disposal or reuse.
   F. Benching Slopes: Horizontally bench existing slopes greater than 1: 4 to key placed fill
      material to slope to provide firm bearing.
   G. Stability: Replace damaged or displaced subsoil as specified for fill.
3.6 FILLING
   A. Install Work in accordance with Illinois Department of Transportation, Division of Highways,
   B. Fill areas to contours and elevations with unfrozen materials.
   C. Place fill material in continuous layers and compact.
   D. Maintain optimum moisture content of fill materials to attain required compaction density.
   E. Slope grade away from building minimum 2 percent slope for minimum distance of 10 FT,
      unless noted otherwise.
   F. Make grade changes gradual. Blend slope into level areas.
   G. Repair or replace items indicated to remain damaged by excavation or filling.
3.7  TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.
B. Top Surface of Subgrade: Plus or minus 1/10 FT from required elevation.

3.8  FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
B. Perform laboratory material tests in accordance with AASHTO T180.
C. Perform in place compaction tests in accordance with the following:
D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
E. Frequency of Tests: As determined by Engineer.

END OF SECTION 31 22 13
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SECTION 31 23 16 - EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Soil densification.
   2. Excavating for building foundations.
   3. Excavating for paving, roads, and parking areas.
   4. Excavating for slabs-on-grade.
   5. Excavating for site structures.

B. Related Sections:
   1. Section 31 05 13 - Soils for Earthwork: Stockpiling excavated materials.
   2. Section 31 05 16 - Aggregates for Earthwork: Stockpiling excavated materials.
   6. Section 31 23 23 - Fill.
   7. Section 33 51 00 - Natural-Gas Distribution.

1.2 REFERENCES

A. Local utility standards when working within 24 IN of utility lines.

B. ASTM International:
   1. D698 – Moisture Density Relations of Soils and Soil Aggregate Mixtures, Using a 5.5 LB Rammer and a 12 IN Drop.
   3. D2922 – Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

C. Shop Drawings: Indicate soil densification grid for each size and configuration footing requiring soils densification.
1.4 QUALITY ASSURANCE
   A. Perform Work in accordance with Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).
   B. Maintain one copy of document on site.

1.5 QUALIFICATIONS
   A. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Illinois.

PART 2 - PRODUCTS (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 PREPARATION
   A. Call Local Utility Line Information service (J.U.L.I.E.) at 1-800-892-0123 (or 811) not less than two working days before performing Work.
      1. Request underground utilities to be located and marked within and surrounding construction areas.
      2. Stake and flag locations of known utilities.
   B. Identify required lines, levels, contours, and datum.
   C. Notify utility company to remove and relocate utilities as indicated on Drawings.
   D. Protect utilities indicated to remain from damage.
   E. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Engineer.
   F. Protect plant life, lawns, and other features remaining as portion of final landscaping.
   G. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.2 EXCAVATION
   A. Blasting with any type of explosive is prohibited.
   B. Provide dewatering system necessary to successfully complete compaction and construction requirements. Dewatering shall be considered incidental to the Contract.
C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Engineer.

D. Underpin adjacent structures which may be damaged by excavation work.

E. Excavate subsoil to accommodate building foundations, paving, slabs-on-grade, site structures, and construction operations.

F. Excavate to working elevation for piling work.

G. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 23.

H. Slope banks with machine to angle of repose or less until shored.

I. Do not interfere with 45 degree bearing splay of foundations.

J. Grade top perimeter of excavation to prevent surface water from draining into excavation.

K. Hand trim excavation. Remove loose matter.

L. Remove lumped subsoil, boulders, and rock up to 1/3 CY measured by volume. Remove larger material as specified in Section 31 23 23.

M. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume Work.

N. Correct areas over-excavated with backfill and compact replacement as specified for authorized excavation or replace with fill concrete as directed.

O. Remove excess and unsuitable material from site.

P. Stockpile excavated material in area designated on site in accordance with Section 31 05 13 and Section 31 05 16.

Q. Repair or replace items indicated to remain damaged by excavation.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform inspection of excavation and controlled fill operations in accordance with applicable code.

C. Request visual inspection of bearing surfaces by Engineer before installing subsequent work.
3.4 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

D. The Contractor shall be responsible for shoring and bracing all utilities and signs including but not limited to gas mains, water mains, sanitary sewers, power poles, traffic control devices, irrigation systems and public and private signage. In the event that shoring, bracing, or removal and replacement is required this cost shall be incidental to the contract. No modification to the location or routing of utilities shall be made, unless approved by the Engineer.

END OF SECTION 31 23 16
SECTION 31 23 16.13 - TRENCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating trenches for utilities.
   2. Compacted fill from top of utility bedding to subgrade elevations.
   3. Backfilling and compaction.

B. Related Sections:
   1. Section 03 31 30 – Concrete, Materials and Proportioning.
   2. Section 03 31 31- Concrete Mixing, Placing, Jointing and Curing.
   3. Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.
   5. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
   7. Section 31 23 16 - Excavation: General building excavation.
  10. Section 31 37 00 - Riprap.
  11. Section 32 91 19 - Landscape Grading: Filling of topsoil over backfilled trenches to finish grade elevation.
  12. Section 33 31 00 - Sanitary Utility Sewerage Piping: Sanitary sewer piping and bedding from building to utility service.
  13. Section 33 51 00 - Natural-Gas Distribution.

1.2 REFERENCES


C. American Association of State Highway and Transportation Officials (AASHTO):

D. ASTM International:
3. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft.-lbf./ft\(^3\).

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
C. Materials Source: Submit name of imported fill materials suppliers.
D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

B. Maintain one copy of document on site.

1.6 QUALIFICATIONS

A. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Illinois.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.
PART 2 - PRODUCTS

2.1 FILL MATERIALS
   A. Subsoil Fill: Type as specified in Section 31 05 13.
   B. Structural Fill: Type as specified in Section 31 05 13 and Section 31 05 16.
   C. Granular Fill: Type as specified in Section 31 05 16.

2.2 ACCESSORIES

PART 3 - EXECUTION

3.1 LINES AND GRADES
   A. Lay pipes true to the lines and grades indicated on Drawings.
      1. The Engineer reserves the right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
   B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION
   A. Call Local Utility Line Information service at J.U.L.I.E. (811 or 1-800-892-0123) not less than two working days before performing Work.
      1. Request underground utilities to be located and marked within and surrounding construction areas.
   B. Identify required lines, levels, contours, and datum locations.
   C. Protect plant life, lawns, and other features remaining as portion of final landscaping.
   D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
   E. Maintain and protect above and below grade utilities indicated to remain.
   F. Establish temporary traffic control when trenching is performed in public right-of-way. Relocate controls as required during progress of Work.
3.3 GENERAL

A. Excavate subsoil required for utilities.
B. Remove lumped subsoil, boulders, and rock up to 1/3 CY, measured by volume. Larger material will be removed under Section 31 23 16.26.
C. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.
D. Do not interfere with 45 degree bearing splay of foundations.
E. Hand trim for trim for bell and spigot pipe joints. Remove loose matter.
F. When subsurface materials at bottom of trench are loose or soft, excavate to a greater depth as directed by Engineer until suitable material is encountered. Notify Engineer promptly upon discovery.
G. Cut out soft areas of subgrade not capable of compaction in place. Backfill with fill and compact to density equal to or greater than requirements for subsequent backfill material.
H. Correct areas over excavated areas with granular backfill and compact replacement as specified for authorized excavation or replace with fill concrete as directed.
I. Stockpile excavated material in area designated on site and remove excess material not being used from site.

3.4 TRENCHING

A. Excavate subsoil required for utilities.
B. Remove lumped subsoil, boulders, and rock up of 1/3 CY, measured by volume. Remove larger material as specified in Section 31 23 18.
C. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.
D. Excavate bottom of trenches maximum 2 FT wider than outside diameter of pipe.
E. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe.
F. Do not interfere with 45 degree bearing splay of foundations.
G. When Project conditions permit, slope side walls of excavation starting 2 FT above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this Section.
H. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Architect/Engineer until suitable material is encountered.
I. Cut out soft areas of subgrade not capable of compaction in place. Backfill and compact to density equal to or greater than requirements for subsequent backfill material.


K. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Engineer.

L. The trench shall be excavated to the depth required so as to provide a uniform and continuous bearing and support for the pipe on bedding material at every point between joints, except where pipe slings or other lifting tackle are withdrawn.

M. Where the bottom of the trench has been excavated by mistake to a greater depth than required, the Contractor shall refill this area using approved material. No additional compensation shall be given to the Contractor. Refilling with earth to bring the bottom of the trench to the proper grade will not be permitted.

N. Trenching in Advance of Pipe Laying: The trench for the pipe lines shall not be opened for a distance of more than 200 FT at any one time, unless authorized by the Engineer. At no time will the Contractor be permitted to leave more than 50 FT of trench open at the end of a working day. Adequate protection of open trench shall be provided by the Contractor and reviewed by the Engineer or Owner.

O. Stockpile excavated material in area designated on site in accordance with Section 31 05 13 and Section 31 05 16.

3.5 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 FT deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.6 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
C. Compact backfill in accordance with Section 31 23 18.
D. Place geotextile fabric as indicated on plans, prior to placing next lift of fill.
E. Place fill material in continuous layers and compact.
F. Employ placement method that does not disturb or damage foundation perimeter drainage, utilities in trench.
G. Maintain optimum moisture content of fill materials to attain required compaction density.
H. Do not leave more than 50 FT of trench open at end of working day.
I. Protect open trench to prevent danger to the public.

3.7 TOLERANCES
A. Section 01 40 00 - Quality Requirements: Tolerances.
B. Top Surface of Backfilling under Paved Areas: Plus or minus 1 IN from required elevations.
C. Top Surface of General Backfilling: Plus or minus 1 IN from required elevations.

3.8 FIELD QUALITY CONTROL
A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
B. Perform laboratory material tests in accordance with ASTM D1557, ASTM D698, and AASHTO T180.
C. Perform in place compaction tests in accordance with the following:
D. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.
E. Frequency of Tests: As directed by Engineer.

3.9 PROTECTION OF FINISHED WORK
A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
B. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION 31 23 16.13
SECTION 31 23 16.26 - ROCK REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

1. Removing identified and discovered rock during excavation.
2. Expansive tools to assist rock removal.

B. Related Sections:

1. Section 31 22 13 - Rough Grading.
2. Section 31 23 16 - Excavation: Building Excavation.
5. Section 31 37 00 - Riprap.

1.2 REFERENCES

A. Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

1.3 DEFINITIONS

A. Rock: Solid mineral material of a size that cannot be removed with a 3/4 CY capacity excavator.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Survey Report: Submit survey report on conditions of buildings near locations of rock removal.

1.5 PROJECT CONDITIONS

A. Conduct survey and document conditions of buildings near locations of rock removal.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
   B. Verify site conditions and note subsurface irregularities affecting Work of this Section.

3.2 PREPARATION
   A. Identify required lines, levels, contours, and datum.

3.3 ROCK REMOVAL BY MECHANICAL METHOD
   A. Contractor shall be responsible for contacting Engineer upon exposure of rock.
   B. Blasting is not permitted.
   C. Excavate and Remove Rock by the Mechanical Method:
      1. Drill holes and use expansive tools, wedges or mechanical disintegration compound to fracture rock.
   D. Cut away rock at bottom of excavation to form level bearing.
   E. Remove shaled layers to provide sound and unshattered base for foundations.
   F. In utility trenches, excavate to 6 IN below invert elevation of pipe and 24 IN wider than pipe diameter.
   G. Remove excavated materials and reuse for site landscaping unless directed by Engineer to remove materials from site.
   H. Correct unauthorized rock removal as directed by Engineer.

3.4 FIELD QUALITY CONTROL
   A. Provide for visual inspection of bearing surfaces and cavities formed by removed rock.

END OF SECTION 31 23 16.26
SECTION 31 23 18 - SITE BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Section includes building perimeter and site structure backfilling to subgrade elevations; site filling and backfilling; fill under paving; fill for over–excavation and consolidation and compaction as scheduled.

B. Related Requirements:
1. Section 31 05 13 – Soils for Earthwork.
2. Section 31 05 16 – Aggregates for Earth Work.
3. Section 31 10 00 – Site Clearing.
5. Section 31 23 16 – Excavation.
9. Section 31 23 23 – Fill.
10. Section 31 25 00 – Erosion and Sedimentation.
11. Section 31 37 00 – Riprap.

1.2 REFERENCE STANDARDS

A. Illinois Department of Transportation (IDOT):

B. American Association of State Highways and Transportation Officials (AASHTO):
1. AASHTO T180 – Moisture Density Relations of Soils Using a 10 lb. Rammer and an 18” Drop.

C. ASTM International:
1. ASTM C33, Standard Specification for Concrete Aggregates.
5. ASTM D2922 – Test Methods for Density of Soil and Soil–Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS
A. Section 01 33 00 – Submittals: Requirements for submittals.

PART 2 PRODUCTS

2.1 FILL MATERIALS
A. Subsoil Fill: As specified in Section 31 05 13 and as indicated on plans.
B. Granular Fill: As specified in Section 31 05 16 and as indicated on plans.
C. Concrete: Lean concrete with a compressive strength of 3000 psi.

2.2 ACCESSORIES

PART 3 EXECUTION

3.1 EXAMINATION
A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
B. Verify subdrainage, dampproofing or waterproofing installation has been inspected.
C. Verify underground structures are anchored to their own foundations to avoid flotation after backfilling
D. Verify structural ability of unsupported walls to support loads imposed by the fill.

3.2 PREPARATION
A. Compact subgrade to density requirements for subsequent backfill materials.
B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill and compact to density equal to or greater than requirements for subsequent fill material.
C. Scarify subgrade surface to a depth of six inches (6”) to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.
3.3 BACKFILLING

A. Backfill areas to contours and elevations with unfrozen materials.
B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
C. Place geotextile fabric as called for on the plans.
D. Place fill material in continuous layers and compact.
E. Employ a placement method that does not disturb or damage other work.
F. Maintain optimum moisture content of backfill materials to attain required compaction density.
G. Backfill against supported foundation walls. Do not backfill against unsupported walls.
H. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
I. Slope grade away from building minimum two inches (2") in ten feet (10’), unless noted otherwise.
J. Make gradual grade changes. Blend slope into level areas.
K. Remove surplus backfill materials from site.
L. Leave fill material stockpile areas free of excess fill materials.

3.4 COMPACTION

A. General:
   1. Select the material and equipment required to attain the required density. Obtain approval for proposed methods of compaction. Should the methods of compaction prove unsatisfactory, take remedial measures and obtain approval for the required changes.
   2. Control soil compaction during construction for compliance with density specified for each area classification. No segregation of large or fine particles permitted.
   3. Compacting of materials by jetting is not permitted.

B. Compaction Equipment:
   1. Provide compaction equipment of suitable size and number, and in satisfactory working condition to complete the Work.

C. Percentage Maximum Density Requirements:
   1. Provide not less than the following density of the same soil material compacted at optimum moisture content, for the actual density of each layer of soil material-in-place.
      a. Sitework:
1) Under Paved Areas, Sidewalks and Piping:
   a) Compaction Density for Cohesive Soils: 95% per ASTM D698.
   b) Compaction Density for Cohesionless Soils: 75% relative density per ASTM D4253 and D4254.

2) Under Unpaved Areas:
   a) Compaction Density for Cohesive Soils: 90% per ASTM D698.
   b) Compaction Density for Cohesionless Soils: 60% relative density per ASTM D4253 and D4254.

b. Structures:
   1) Inside of structures under foundations, under equipment support pads, under slabs-on-grade and scarified existing subgrade under fill material:
      a) Compaction Density: 95% per ASTM D698.
   2) Outside structures next to walls, piers, columns and any other structure exterior member: 90% per ASTM D698.

   c. Specific Areas:
      1) Outside structures under equipment support foundations:
         a) Compaction Density: 95% per ASTM D698.
      2) Trenches Under and Adjacent to Pavement within two feet:
         a) Compact each layer of backfill material to 95% Modified Proctor Density in accordance with ASTM D1557 or AASHTO T180.
      3) Trenches in Open Areas:
         a) Compact each layer if material to 90% Modified Proctor Density in accordance with ASTM D1557 or AASHTO T180.
      4) Lawn and Plant Areas:
         a) Compact to 4” of subgrade and each layer of backfill or fill material to minimum 90% Modified Proctor Density in accordance with ASTM D1557 or AASHTO T180.
      5) If open-graded gravel fill is utilized for which field density tests cannot be performed, the material shall be compacted until firm and dense. As a minimum, roll with 8-ton vibratory roller at least 2 passes in both directions.

D. Moisture Content:
   1. On and off-site borrow should be placed when within 2% of optimum moisture content based on ASTM D1557 or AASHTO T180.
   2. All aggregate shall be placed with a moisture content according to the Standard Specifications for Road and Bridge Construction (SSRBC) in Illinois.

3.5 TOLERANCES

A. Section 01 40 00 – Quality Requirements: Tolerances.

B. Top Surface of General Backfilling: Plus or minus one inch (1”) from required elevations.

3.6 INSTALLATION OF GEOTEXTILE FABRIC

A. Install geotextile fabric in accordance with the requirements of SSRBC Section 210.
3.7 FIELD QUALITY CONTROL

A. Section 01 70 00 – Execution Requirements: Testing, adjusting, and balancing.

B. Compaction testing shall be performed in accordance with ASTM D1557, ASTM D698 or AASHTO T180.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: As directed by Engineer.

E. Proof roll compacted fill surfaces under all paved surfaces.

3.8 PROTECTION

A. Section 01 70 00 – Execution Requirements: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION 31 23 18
SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dewatering system.
   2. Surface water control system.
   3. Monitoring wells.
   4. System operation and maintenance.
   5. Water disposal.

B. Related Sections:
   1. Section 00 31 00, Available Project Information: Subsurface investigation report including boring logs, soil profiles, groundwater levels, and laboratory soils analyses.
   2. Section 31 05 16 - Aggregates for Earthwork: Filter sand.
   3. Section 31 23 16 - Excavation: Excavation for structures below ground water table.
   5. Section 31 25 00 - Erosion and Sedimentation Controls: Surface water runoff control.

1.2 REQUIREMENTS

A. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain groundwater table to an elevation below lowest foundation subgrade or bottom of pipe trench and to allow material to be excavated in a reasonably dry condition.
   1. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize excavation slopes where sheeting is not required.

B. Operate dewatering system continuously until backfill work has been completed.

C. Reduce hydrostatic head below any excavation to extent that water level in the construction area is below prevailing excavation surface.

D. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata as per the Storm Water Pollution Prevention Plan.

E. Maintain stability of sides and bottom of excavation.

F. Construction operations are performed in the dry.
   1. Control of surface and subsurface water are part of dewatering requirements. Maintain adequate control so that the stability of excavated and constructed slopes are not adversely affected by saturated soil including water entering prepared subbase and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action, that erosion is controlled and that flooding of excavations or damage to structures does not occur.
2. Drain surface water away from excavations. Protect excavations from becoming wet from surface water, or insure excavations are dry before additional work is undertaken.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Drawings and Design Data:
   1. Submit Drawings and data showing the method to be employed in dewatering excavated areas no later than thirty (30) days prior to the commencement of excavation.
   2. Submittal shall include location, depth and size of wellpoints, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey the water from site to adequate disposal.
   3. Materials submitted shall be in a format acceptable for inclusion in required permit applications to any and all regulatory agencies for which permits for discharge water from the dewatering system are.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Conduct additional borings and investigations to supplement subsurface investigations identified in Section 00 31 00 as required to complete dewatering system design.

C. Call Local Utility Line Information service at J.U.L.I.E. (811 or 1-800-892-0123) not less than two working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

D. Employ licensed land surveyor to provide following documentation:
   1. Survey existing adjacent buildings, structures, and improvements for position and elevation of principal elements before and after completion of dewatering operations.

3.2 PREPARATION

A. Protect existing adjacent buildings, structures, and improvements from damage caused by dewatering operations.
3.3 DEWATERING SYSTEM

A. Install dewatering system in accordance with approved Drawings.

B. Locate system components to allow continuous dewatering operations without interfering with installation of permanent Work and existing public rights-of-way, sidewalks, and adjacent buildings, structures, and improvements.

C. Install a dewatering system to lower and control groundwater in order to permit excavation, construction of structure and placement of backfill materials, to be performed under dry conditions. Make the dewatering system adequate to pre-drain the water-bearing strata above and below the bottom of structure foundations, utilities and other excavations.

D. In addition, reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, to extent that water levels in construction area are a minimum of 12 IN below prevailing excavation surface at all times.

3.4 SURFACE WATER CONTROL SYSTEM

A. Provide ditches, berms, and other devices to divert and drain surface water from excavation area as specified in Section 31 25 00.

B. Divert surface water and seepage water within excavation areas into sumps and pump water into storm drains in accordance with requirements of agencies having jurisdiction.

C. Control and remove unanticipated water seepage into excavation.

3.5 SYSTEM OPERATION AND MAINTENANCE

A. Operate dewatering system continuously until backfilling is complete.

B. Provide 24 HR supervision of dewatering system by personnel skilled in operation, maintenance, and replacement of system components.

C. Conduct daily observation of dewatering system and monitoring system. Make required repairs and perform scheduled maintenance.

D. Fill fuel tanks before tanks reach 25 percent capacity.

E. Start emergency generators at least twice each week to check operating condition.

F. When dewatering system cannot control water within excavation, notify Engineer and stop excavation work.

1. Supplement or modify dewatering system and provide other remedial measures to control water within excavation.

2. Demonstrate dewatering system operation complies with performance requirements before resuming excavation operations.
G. Modify dewatering and surface water control systems when operation causes or threatens to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells.

H. Correct unanticipated pressure conditions affecting dewatering system performance.

I. Do not discontinue dewatering operations without Engineer's approval.

3.6 WATER DISPOSAL

A. Dispose of water removed from trenches and excavations in such a manner as will not endanger portions of work under construction or completed. Dispose of water in such a manner that complies with the stipulations of any and all required permits for disposal of water and in accordance with all required Federal, State and local laws, regulations, rules and ordinances.

3.7 STANDBY EQUIPMENT

A. Provide complete standby equipment, installed and available, for immediate operation as may be required, to adequately maintain de-watering on a continuous basis and in the event that all or any part of the system may become inadequate or fail.

3.8 CORRECTIVE ACTION

A. If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, instability of slopes or damage to foundations and/or structures), perform work necessary for reinstatement of foundation soil, at no additional cost to the Owner.

3.9 REMOVAL

A. Insure compliance with all conditions of regulating permits and provide such information to the Engineer and Construction Manager. Obtain written approval from Engineer and Construction Manager before discontinuing operation of dewatering system.

END OF SECTION 31 23 19
SECTION 31 23 23 - FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.

B. Related Sections:

1. Section 03 31 30 – Concrete, Materials and Proportioning.
2. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
3. Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.
5. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
7. Section 31 23 16 - Excavation.
9. Section 31 23 18 - Backfilling.
10. Section 31 37 00 - Riprap.
12. Section 33 51 00 - Natural-Gas Distribution.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):


B. ASTM International (ASTM):

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.

C. Samples: Provide samples of materials as required by the Engineer that will be used from furnished material.

D. Materials Source: Submit name of imported fill materials suppliers.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

F. Test Reports: Field density test reports. Submit gradation test for all furnished material.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with the Standard Specifications for Road and Bridge Construction (SRBC), Current Edition, of Illinois Department of Transportation.

B. Maintain one copy of IDOT Construction Manual and SSRBC on site.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: As specified in Section 31 05 13.

B. Structural Fill: As specified in Section 31 05 13 and Section 31 05 16.

C. Granular Fill: As specified in Section 31 05 16.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

C. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

D. Verify structural ability of unsupported walls to support loads imposed by fill.
3.2 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.
B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill and compact to density equal to or greater than requirements for subsequent fill material.
C. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.3 BACKFILLING

A. All backfill to follow Specifications in Section 31 23 18.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements, Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
B. Perform laboratory material tests in accordance with AASHTO T180.
C. Perform in place compaction tests in accordance with the following:
D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
E. Proof roll compacted fill surfaces under slabs-on-grade, pavers, paving, and foundations.

3.5 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
B. Reshape and re-compact fills subjected to vehicular traffic.

3.6 SCHEDULE

A. Fill Under Asphalt and Concrete Paving:
   1. Compact subsoil to 95 percent of its maximum dry density.

END OF SECTION 31 23 23
SECTION 31 23 23.33 - FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flowable fill for:
   a. Structure backfill.
   b. Utility bedding.
   c. Utility backfill.
   d. Filling abandoned utilities.

B. Related Requirements:

1. Section 31 23 16 - Excavation: General building excavation.
4. Section 32 91 19 - Landscape Grading: Filling of topsoil over backfilled trenches to finish grade elevation.
5. Section 33 31 00 - Sanitary Utility Sewerage Piping: Sanitary sewer piping and bedding from building to utility service.
6. Section 33 51 00 - Natural-Gas Distribution.

1.2 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.

B. Excavatable Flowable Fill: Lean cement concrete fill used where future excavation may be required, such as fill for utility trenches, bridge abutments, and culverts.

C. Non-Excavatable Flowable Fill: Lean cement concrete fill used where future excavation is not anticipated, such as fill below structure foundations and filling abandoned utilities.

1.3 REFERENCE STANDARDS

A. ASTM International:

7. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
C. Field Quality-Control Submittals:
   1. Mix Design:
      a. Furnish flowable fill mix design for each specified strength.
      b. Furnish separate mix designs when admixtures are required for the following:
         1) Flowable fill Work during hot and cold weather.
         2) Air entrained flowable fill Work.
      c. Identify design mix ingredients, proportions, properties, admixtures, and tests.
   2. Furnish test results to certify flowable fill mix design properties meet or exceed specified requirements.
D. Delivery Tickets:
   1. Furnish duplicate delivery tickets indicating actual materials delivered to Project Site.
E. Qualifications Statements: Submit qualifications for supplier.

1.5 QUALITY ASSURANCE

B. Maintain 1 copy of each standard affecting the Work of this Section on Site.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Section 01 50 00 - Temporary Facilities and Controls specifies ambient condition control facilities for product storage and installation.
B. Minimum Conditions: Do not install flowable fill during inclement weather or when ambient temperature is less than 40 DegF.

1.7 FIELD MEASUREMENTS

A. Verify field measurements before installing flowable fill to establish quantities required to complete the Work.

PART 2 - PRODUCTS

2.1 FLOWABLE FILL

A. Furnish materials according to Standard Specifications for Road and Bridge Construction in Illinois, Current Edition (Illinois Department of Transportation) Section 593.

B. Flowable Fill: Excavatable type and non-excavatable type.

2.2 MIXES

A. Mix and deliver flowable fill according to ASTM C94/C94M, Option C.

B. Flowable Fill Design Mix:

1. Cement Content:
   a. Excavatable: 75 to 100 LBS/CY.
   b. 100 to 150 LBS/CY.

2. Fly Ash Content:
   a. Excavatable: None. 150-600 pcf.

3. Water Content:
   a. Excavatable: As specified.
   b. Non-Excavatable: As specified.

4. Air Entrainment:
   a. Excavatable: 5 to 35 percent.
   b. Non-Excavatable: 5 to 15 percent.

5. 28-Day Compressive Strength:
   a. Excavatable: Maximum 100 psi.
   b. Minimum 125 psi.

6. Unit Mass (Wet):
a. Excavatable: 80 to 110 pcf.
b. 100 to 125 pcf.

7. Temperature, Minimum, at Point of Delivery:
   a. Excavatable: 50 DegF.

C. Provide water content in design mix to produce self-leveling, flowable fill material at time of placement.

D. Design mix air entrainment and unit mass are for laboratory design mix and source quality control only.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Test and analyze properties of flowable fill design mix and certify results for the following:

1. Design mix proportions by weight of each material.
2. Aggregate: ASTM C33 for material properties and gradation.
3. Properties of plastic flowable fill design mix including:
   a. Temperature.
   b. Slump.
   c. Air entrainment.
   d. Wet unit mass.
   e. Yield.
   f. Cement factor.

4. Properties of hardened flowable fill design mix including:
   a. Compressive strength at 1 day, 7 days, and 28 days. Report compressive strength of each specimen and average specimen compressive strength.
   b. Unit mass for each specimen and average specimen unit mass at time of compressive strength testing.

C. Prepare delivery tickets containing the following information:

1. Project designation.
2. Date.
3. Time.
4. Class and quantity of flowable fill.
5. Actual batch proportions.
6. Free moisture content of aggregate.
7. Quantity of water withheld.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting Work.
B. Verify excavation specified in Section 31 23 16 trenching specified in Section 31 23 16.13 is complete.
C. Verify utility installation is complete and tested before placing flowable fill.
D. Verify excavation is dry and dewatering system is operating.

3.2 PREPARATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Support and restrain utilities to prevent movement and flotation during installation of flowable fill.
C. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.
D. Protect utilities and foundation drains to prevent intrusion of flowable fill.

3.3 INSTALLATION - FILL, BEDDING, AND BACKFILL
A. Place flowable fill by chute, pumping or other methods approved by Engineer.
   1. When required, place flowable fill under water using tremie procedure.
   2. Do not place flowable fill through flowing water.
B. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.
C. Place flowable fill evenly on both sides of utilities to maintain alignment.
D. Place flowable fill to elevations indicated on Drawings without vibration or other means of compaction.

3.4 INSTALLATION - FILLING ABANDONED UTILITIES
A. Verify pipes and conduits are not clogged and are sufficiently empty to permit gravity installation of flowable fill for entire length indicated to be filled.
B. Seal lower end of pipes and conduits by method to contain flowable fill and to vent trapped air caused by filling operations.

C. Place flowable fill using method to ensure there are no voids.
   1. Fill pipes and conduits from high end.
   2. Fill manholes, tanks, and other structures from grade level access points.

D. After filling pipes and conduits seal both ends.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Perform inspection and testing according to ASTM C94/C94M.
   1. Take samples for tests for every 150 CY of flowable fill, or fraction thereof, installed each day.
   2. Sample, prepare and test four compressive strength test cylinders according to ASTM D4832. Test one specimen at 3 days, one at 7 days, and two at 28 days.
   3. Measure temperature at point of delivery when samples are prepared.

C. Perform in place penetration (density) tests using hand held penetrometer to measure penetration resistance of hardened flowable fill according to ASTM C403.
   1. Perform tests at locations as directed by Engineer.

D. Defective Flowable Fill: Fill failing to meet the following test requirements or fill delivered without the following documentation.
   1. Test Requirements:
      a. Minimum temperature at point of delivery.
      b. Compressive strength requirements for each type of fill.

   2. Documentation: Duplicate delivery tickets.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Remove spilled and excess flowable fill from Project Site.

C. Restore facilities and Site areas damaged or contaminated by flowable fill installation to existing condition before installation.

END OF SECTION 31 23 23.33
SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Silt fence.
   2. Erosion control blanket.
   3. Inlet Filter.

B. Related Sections:
   1. Division 3 - Concrete.
   2. Section 07 92 00 - Joint Sealant.
   3. Section 31 05 13 - Soils for Earthwork.
   4. Section 31 05 16 - Aggregates for Earthwork.
   5. Section 31 10 00 - Site Clearing.
   6. Section 31 23 16 - Excavation.
   7. Section 31 23 23 - Fill.
   8. Section 31 37 00 - Riprap.
   9. Section 32 13 13 - Concrete Paving.
  10. Section 32 91 19 - Landscape Grading.
  11. Section 32 92 19 - Seeding and Soil Supplements.

1.2 REFERENCES

A. Standard Specifications for Road and Bridge Construction (SSRBC), Current Edition, Illinois Department of Transportation (IDOT):
   1. SSRBC Section 280 – Temporary Erosion Control.


C. Standards and Specifications for Soil Erosion and Sediment Control (the Yellow Book) published by the Illinois Environmental Protection Agency.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on erosion control blanket.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
1.4 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.5 QUALITY ASSURANCE
A. Perform Work in accordance with the Standard Specifications for Road and Bridge Construction (SRBC), Current Edition, of Illinois Department of Transportation.
B. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 SILT FENCE
A. As indicated on the plans or as deemed necessary by the Engineer or Owner in accordance with SSRBC Section 1080.02.

2.2 DITCH CHECKS
A. As indicated on the plans or as deemed necessary by the Engineer or Owner.

2.3 EROSION CONTROL BLANKET
A. Erosion Control Blanket shall be one of the following for slopes flatter than 3:1, as identified on the Plans or as determined by the Engineer:
   1. Curlex Type I as manufactured by American Excelsior Company – Arlington, Texas.
   2. NAG S-75 North American Green Straw Revegetation Mat.
   3. Approved Equals upon review by Engineer.
B. Heavy Duty Erosion Control Blanket shall be one of the following for slopes steeper than 3:1, as identified on the Plans or as determined by the Engineer:
   1. NAG C-215 ECRM North American Green Coconut Revegetation Mat.
   2. Boom Environmental Products – Series 700 Blanket.
   3. Approved Equals upon review by Engineer.

2.4 INLET FILTER
1. Inlet Filter shall be:
   a. FleXstorm sediment basket or approved equal installed as per plan or at the direction of the Engineer.
PART 3 - EXECUTION

3.1 EROSION AND SEDIMENT CONTROL

A. Erosion Control: Conduct work to minimize erosion of site. Construct stilling areas to settle and detain eroded material. Remove eroded material washed off site. Clean streets daily of any spillage of dirt, rocks or debris from equipment entering or leaving site.

B. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.

C. Minimize amount of bare soil exposed at one time.

D. Silt fence shall be placed at locations indicated on plans or as deemed necessary by the Engineer prior to construction within those areas.

E. Provide temporary measures such as berms, dikes, and drains to prevent water flow.

F. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

G. Provide, maintain and remove alternate erosion control measures as necessary or as directed by Engineer.

3.2 EROSION CONTROL BLANKET INSTALLATION

A. Cover seeded areas and slopes with erosion control fabric.

B. Provide Erosion Control Blanket in accordance with SSRBC Section 25 1. 04 on seeded areas sloped 3:1 or less.

C. Provide Heavy Duty Erosion Control Blanket in accordance with SSRBC Section 25 1. 03 (Method 1) on seeded areas sloped greater than 3:1.

D. Roll fabric onto slopes without stretching or pulling.

E. Lay fabric smoothly on surface, bury top end of each section in 6 IN deep excavated topsoil trench. Provide 12 IN overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

F. Secure outside edges and overlaps at 36 IN intervals with stakes.

G. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

H. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 IN.
3.3 MAINTENANCE AND SPECIAL REQUIREMENTS

A. Provide, maintain and remove silt fence and other soil erosion control devices as shown on plans and in accordance with details as shown on plans.

B. All areas disturbed by the contractor shall restored to their original condition and approved by the Engineer. Restoration is intended to restore areas both paved and unpaved included but not limited to areas disrupted during construction in addition to those areas indicated as paved, sodded, mulched, and paved.

C. Contractor shall also be responsible for the monitoring and documentation of all aspects of the SWPPP.

3.4 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

3.5 INLET FILTER

A. Install as per plans.

3.6 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights shall not exceed 35 FT. Slope stockpile sides at 2:1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 7 days.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.7 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements, 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect erosion control devices on a weekly basis and after each runoff event as per plan. Make necessary repairs to ensure erosion and sediment controls are in good working order.
3.8 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

C. Do not damage structure or device during cleaning operations.

D. Do not permit sediment to erode into construction or site areas or natural waterways.

E. Clean channels when depth of sediment reaches approximately 1/2 channel depth.

END OF SECTION 31 25 00
SECTION 31 32 13.19 - LIME SOIL STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and treating soil.
2. Placing soil lime mix.

B. Related Sections:

1. Section 03 31 30 – Concrete, Materials and Proportioning.
2. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
3. Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.
4. Section 31 05 13 - Soils for Earthwork.
5. Section 31 05 16 - Aggregates for Earthwork.
6. Section 31 23 16 - Excavation: General Site and Building Excavation.
8. Section 31 23 23 - Fill: General Site and Building Backfilling.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:


B. ASTM International:


C. National Lime Association:


1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
1. Geotechnical Engineer to provide determination for lime soil stabilization use during construction and to provide lime/soil mix report and analysis.

B. Product Data:

1. Submit mix design and materials mix ratio to achieve specified requirements.
3. Submit data for curing seal.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE


B. Perform Work in accordance with Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

C. Maintain one copy of each document on site.

PART 2 - PRODUCTS

A. Subsoil: Existing reused.

B. Lime: ASTM C207.

2.2 EQUIPMENT

A. Equipment: Capable of excavating subsoil, mixing and placing materials, wetting, consolidation, and compaction of material.

2.3 SOIL LIME MIX

A. Mix materials in accordance with Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Do not place fill over frozen or spongy subgrade surfaces.

3.2 EXCAVATION

A. Protect adjacent structures from damage by this Work.
B. Excavate subsoil to depth sufficient to accommodate soil stabilization and construction operations.

C. Proofroll subgrade to identify soft areas; excavate those areas.

D. Notify Engineer of unexpected subsurface conditions. Discontinue affected Work in area until notified to resume Work.

E. Correct areas over-excavated in accordance with Section 31 23 23.

F. Remove excess excavated material from site.

3.3 SOIL TREATMENT AND BACKFILLING

A. Place geotextile fabric over subsoil surface, lap edges and ends.

B. Site mix subsoil, backfill and compact. Blend treated subsoil mix to achieve mix formulation and required stabilization.

C. Mix and wait 16 HRS minimum and no more than 72 HRS maximum before placing.

D. Place mix material in continuous layers, maximum 8 IN.

E. Maintain optimum moisture content of mix materials to attain required stabilization.

F. Do not exceed 30 minutes in placing adjacent mixed material.

G. Commence compaction of mix no later than 60 minutes after placement.

H. Compact mix to ASTM D698.

I. Slope grade away from building minimum 2 IN in 10 FT, unless noted otherwise.

J. Shape to required line, grade, and cross section.

K. Make grade changes gradual. Blend slope into level areas.

L. At end of day, terminate completed Work by forming straight and vertical construction joint.

M. Replace damaged fill with new mix to full depth of original mix.

N. Remove surplus mix materials from site.

3.4 CURING

A. Immediately following compaction of mix, seal top surface with curing seal.

B. Do not permit traffic for 72 HRS after sealing top surface.
3.5 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Top Surface of Fill: Plus or minus one inch from required elevations.

3.6 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements, 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

END OF SECTION 31 32 13.19
SECTION 31 37 00 - RIPRAP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Riprap placed loose.

B. Related Sections:

1. Section 31 0516 - Aggregates for Earthwork.
2. Section 31 22 13 - Rough Grading.
5. Section 31 23 23 - Fill.
7. Section 32 91 19 - Landscape Grading: Topsoil placement.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Samples: Submit, in air-tight containers, 10 LBS sample of riprap materials to testing laboratory.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

C. Maintain one copy of document on site.

PART 2 - PRODUCTS

2.1 MATERIALS

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

3.2 PLACEMENT

A. Place geotextile fabric over substrate, lap edges and ends.

B. Place riprap at culvert pipe ends, at embankment slopes, and as indicated on Drawings.

C. Installed Thickness: 5 IN average or as indicated on the Plans.

D. Place rock evenly and carefully to minimize voids, place rock in one consistent operation to preclude disturbance or displacement of substrate.

E. At Retaining Wall: Individual riprap units, 6 IN thickness; placed prior to finish topsoil.

END OF SECTION 31 37 00
DIVISION 32

EXTERIOR IMPROVEMENTS
SECTION 32 11 23 - AGGREGATE BASE COURSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aggregate subbase.
   2. Aggregate base course.

B. Related Sections:
   1. Section 31 22 13 - Rough Grading: Preparation of site for base course.
   3. Section 31 23 23 - Fill: Compacted fill under base course.
   4. Section 31 37 00 - Riprap.
   5. Section 32 12 16 - Asphalt Paving.
   6. Section 32 13 13 - Concrete Paving: Finish concrete surface course.
   7. Section 32 91 19 - Landscape Grading: Topsoil fill at areas adjacent to aggregate base course.
   8. Section 33 05 13 - Manholes and Structures: Manholes including frames.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 – Moisture Density Relations of Soils Using a 10 LB Rammer and an 18 IN Drop.

B. ASTM International:
   2. ASTM D2940 - Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways or Airports.

C. Illinois Department of Transportation (IDOT):
1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data.
C. Materials Source: Submit name of aggregate materials suppliers.
D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.
B. Perform Work in accordance with Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).
C. Maintain one copy of document on site.

PART 2 - PRODUCTS

2.1 AGGREGATE MATERIALS

A. SSRBC Article 351.05, Aggregate Base Course, Type B: Comply with SSRBC Article 1004.04, Gradation CA 6, compacted.
   1. No substitute or recycled material is permitted without written approval from the Engineer.

B. Subbase Aggregate: ASTM D2940; graded type.
   1. Percent Passing per Sieve Size:
      a. 2 IN: 100.
      b. No. 4: 30 to 60.
      c. No. 200: Zero to 12.

C. Base Aggregate: ASTM D2940; graded type.
   1. Percent Passing per Sieve Size:
      a. 2 IN: 100.
      b. 1-1/2 IN: 95 to 100.
      c. 3/4 IN: 70 to 92.
      d. 3/8 IN: 50 to 70.
      e. No. 4: 35 to 55.
      f. No. 30: 12 to 25.
      g. No. 200: Zero to 8.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify compacted substrate is dry and ready to support paving and imposed loads.

C. Verify substrate has been inspected, gradients and elevations are correct.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

A. Prior to the placement of aggregate base course all areas shall be proof-rolled in accordance with Article 351 of the SSRBC. Any areas of failure as indicated by the Soils Engineer shall be corrected by the Contractor and retested.

B. Spread aggregate over prepared substrate to a total compacted thickness as indicated on the Final Engineering Plans.

C. Roller compact aggregate to 95 percent maximum density.

D. Level and contour surfaces to elevations, profiles, and gradients indicated.

E. Add small quantities of fine aggregate to coarse aggregate when required to assist compaction.

F. Maintain optimum moisture content of fill materials to attain specified compaction density.

G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation From Flat Surface: 1/4 IN measured with 10 FT straight edge.

C. Maximum Variation from Thickness: 1/4 IN.

D. Maximum Variation from Elevation: 1/2 IN.
3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Compaction testing will be performed according to ASTM D1557, ASTM D698, AASHTO T180, ASTM D2922, and ASTM D3017.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: As directed by Engineer.

3.6 COMPACTION

A. Compact materials to 98 percent of maximum density as determined from test strip, according to ASTM D2940.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 70 00 – Execution Requirements: Protecting finished work.

B. Reshape and recompact fills subjected to vehicular traffic.

END OF SECTION 32 11 23
SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving base course, binder course, and wearing course.
5. Asphalt paving overlay for existing paving.
6. Surface slurry.

B. Related Requirement:
2. Section 31 23 23 - Fill: Compacted subbase for paving.
3. Section 31 05 16 - Aggregates for Earthwork.
4. Section 32 11 23 - Aggregate Base Courses: Compacted subbase for paving.
5. Section 33 05 13 - Manholes and Structures: Manholes including frames.

C. Standard Specifications for Road and Bridge Construction (SSRBC), Current Edition, Illinois Department of Transportation:
1. SSRBC Section 106, Control of Materials.
2. SSRBC Section 311, Granular Subbase.
3. SSRBC Section 355, Hot-Mix Asphalt Base Course.
4. SSRBC Section 406, Hot-Mix Asphalt Binder and Surface Course.
5. SSRBC Section 440, Removal or Existing Pavement and Appurtenances.
6. SSRBC Section 442, Pavement Patching.
7. SSRBC Section 780, Pavement Striping.
8. SSRBC Section 783, Pavement Marking and Marker Removal.


1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit product information for asphalt and aggregate materials.
2. Submit mix design with laboratory test results supporting design.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
1.3 QUALITY ASSURANCE

A. Mixing Plant: Perform Work in accordance with Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

B. Source Quality Control:
   1. Comply with SSRBC Section 106.
   2. Obtain Hot Mix Asphalt mixtures from IDOT approved plants.
   3. Provide Engineer with copies of all material tickets.

PART 2 - PRODUCTS

2.1 GRANULAR SUBBASE

A. SSRBC Article 311.05, Subbase Granular Material, Type B: Comply with SSRBC Article 1004.04, Gradation CA 6, compacted.

2.2 PRIME COAT

A. Prime Coat for aggregate surfaces: Comply with SSRBC Article 406.02, Grade MC-30.

B. Prime Coat for Hot Mix Asphalt and concrete surfaces: Comply with SSRBC Article 406.02.

C. Aggregate (Prime Coat): Comply with SSRBC Article 1003.03(c).

2.3 ASPHALT PAVING

A. Hot Mix Asphalt Base Course:
   a. Comply With SSRBC Article 1030.04, IL-19.0 or IL-25.0.
   b. No Rap materials shall be used in this mixture.

B. Hot Mix Asphalt Binder Course:
   a. Comply With SSRBC Article 1030.04, IL-19.0, N50.
   b. No Rap materials shall be used in this mixture.

C. Hot Mix Asphalt Surface Course:
   a. Comply With SSRBC Article 1030.04, IL-12.5.
   b. No Rap materials shall be used in this mixture.

D. PAVEMENT STRIPING
   1. Thermoplastic Pavement Marking: Comply with SSRBC Section 780 and 1095.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.
B. Submit proposed mix design for review prior to beginning of Work.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with applicable provisions of SSRBC Sections 311, 355, 406 and 440 and details and cross section show on Plans.

B. Construct finished surfaces to match existing.

3.2 REMOVAL OF EXISTING PAVEMENT AND APPURTENANCES

A. Remove existing pavement as shown on plans in conformance with provisions or SSRBC Section 440.

3.3 EXAMINATION

A. Verify that Hot Mix Asphalt base course has been prepared in accordance with SSRBC Section 355 and is ready to support paving and imposed loads.

B. Verify that previously placed base course or binder course conforms to alignment, grade and cross-section show on Drawings.

C. Section 01 70 00: Requirements for installation examination.

D. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

3.4 PREPARATION

A. The Engineer shall verify that all areas anticipated to be paved are in acceptable condition. Any deficient areas shall be reported to the Contractor for repair prior to the placement of prime.

B. Priming:

1. Apply prime coat in accordance with SSRBC Articles 403.05, 403.09 and 403.10.

2. Rate of application for prime coat placed on aggregate courses: 0.50 GAL/SY.

3. Rate of application for prime coat placed on previous HMA courses: 0.10 GAL/SY.

4. Apply aggregate at a uniform rate of 4 LBS/SY immediately after application or bituminous materials if road will be open to traffic.

5. Allow prime coat on Hot Mix Asphalt courses to cure for 12 HRS. Allow prime coat on other course to cure for at least 24 HRS.

6. Additional prime may be required by the Engineer in the event of inclement weather or excessive traffic.

7. All adjacent pavements shall be provided with a full depth saw cut.
C. Prepare subbase in accordance with Standard Specifications for Road and Bridge Construction, Current Edition (Illinois Department of Transportation).

3.5 DEMOLITION

A. Saw cut and notch existing paving as indicted on Drawings.
B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.
C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.6 INSTALLATION

A. Subbase:
   1. Comply with requirements of SSRBC Section 311 for placing and compacting granular sub-base.
B. Hot Mix Asphalt Mixtures:
   1. Comply with requirements of SSRBC Section 406 for placement and compaction of Leveling Binder, Hot Mix Asphalt Binder Course and Hot Mix Asphalt Surface Course.

3.7 PAVEMENT MARKINGS

A. All markings shall be in accordance with Section 780 of the SSRBC.
B. Any pavement markings removed shall be replaced in kind.

3.8 CLEAN-UP

A. The Contractor shall be responsible for removal of all excess pavement and prime coat and leaving all adjacent areas in a workman like condition.

3.9 FIELD QUALITY CONTROL

A. Testing of in-place Hot Mix Asphalt surface or pavement shall be performed by Testing Laboratory in conformance with requirements of SSRBC Section 406 and 1030.05.
B. Density of finished binder and surface courses shall be determined by nuclear test methods or from cores obtained at locations determined by Owner. Density shall meet the requirements of SSRBC Article 1030.05.
C. Repair or remove and replace unacceptable surface or pavement as directed by Owner.
3.10 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

END OF SECTION 32 12 16
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SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Granular subbase.
   2. Concrete paving for:
      a. Concrete sidewalks.
      b. Concrete curb and gutters.
      c. Concrete pavement.

B. Related Requirements:
   1. Section 07 92 00 – Joint Sealant.
   2. Section 31 22 13 - Rough Grading: Preparation of site for paving.
   3. Section 31 23 23 - Fill: Compacted Subbase for Paving.
   4. Section 32 11 23 - Aggregate Base Courses.
   5. Section 32 12 16 - Asphalt Paving.
   7. Section 33 05 13 - Manholes and Structures.

1.2 REFERENCE STANDARDS

A. American Concrete Institute (ACI):
   1. ACI 301 – Specifications for Structural Concrete for Buildings.
   2. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

B. ASTM International (ASTM):
   1. A185 – Welded Steel Wire Fabric for Concrete Reinforcement.
   3. A615 – Deformed and Plain Billet-Steel for Concrete Reinforcement.
   4. C33 – Concrete Aggregates.
   5. C94 – Ready Mix Concrete.
   7. C260 – Air Entraining Admixtures for Concrete.
   9. C494 – Chemical Admixtures for Concrete.

   1. SSRBC Section 106 – Control of Materials.
   2. SSRBC Section 311 – Granular Subbase.
   3. SSRBC Section 353 – Portland Cement Concrete Base Course.
   4. SSRBC Section 420 – Portland Cement Concrete Pavement.
5. SSRBC Section 424 – Portland Cement Concrete Sidewalk.
6. SSRBC Section 440 – Removal of Existing Pavement and Appurtenances.
7. SSRBC Section 442 – Pavement Patching.
8. SSRBC Section 606 – Concrete Gutter, Curb, Median, and Paved Ditch.
9. SSRBC Section 1020 – Portland Cement Concrete.
10. SSRBC Section 1021 – Concrete Admixtures.
11. SSRBC Section 1022 – Concrete Curing Materials.
12. SSRBC Section 1023 – Protective Coat.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Design Data:
   1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
      a. Hot and cold weather concrete work.
   2. Identify mix ingredients and proportions, including admixtures.
   3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.

1.4 QUALITY ASSURANCE


B. Obtain cementitious materials from same source throughout.

C. Maintain one copy of document on site.

D. Source Quality Control:
   1. Comply with SSRBC Section 106.
   2. Obtain Portland Cement Concrete from IDOT approved plants.
   3. Provide Engineer with copies of all material tickets.

PART 2 - PRODUCTS

2.1 GRANULAR SUBBASE

A. SSRBC Article 311.05, Subbase Granular Material, Type B: Conform to SSRBC Article 1004.04 Gradation CA-6.

B. Sub-base shall be placed in accordance with the approved Engineering Plans.
2.2 CONCRETE

A. Pavement:
   1. Conform to SSRBC, Section 1020, Class PV, Minimum 3,500 psi (6.1 Bag Mix) at 14 days with 5 percent to 8 percent Air Entrainment.
   2. No fly ash allowed.

B. Curb and Gutter:
   1. Conform to SSRBC, Section 1020, Class SI, Minimum 3,500 psi (6.1 Bag Mix) at 14 days with 5 percent to 8 percent Air Entrainment.
   2. No fly ash allowed.

C. Sidewalk:
   1. Conform to SSRBC, Section 1020, Class SI, Minimum 3,500 psi (6.1 Bag Mix) at 14 days with 5 percent to 8 percent Air Entrainment.
   2. No fly ash allowed.

2.3 ACCESSORIES

A. Dowel Bars: Conform to SSRBC, Section 10 06 .11, Epoxy Coated.

B. Expansion Joint: Conform to SSRBC, Section 1051.

C. Protective Coat: Conform to SSRBC, Section 1023.

2.4 SOURCE QUALITY CONTROL

A. Submit proposed mix design of each class of concrete to Engineer for review prior to commencement of Work.

B. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with applicable provisions of SSRBC Sections 311, 420, 424, 440 and 606 and details and cross sections shown on Plans.

B. Construct finished surfaces to match existing.

C. In the event the Engineer feels that the Contractor is not completing work per the IDOT specifications, the Engineer may require the contractor to furnish additional testing at the expense of the Contractor. The Engineer will determine the limits and frequency of this testing.
3.2 EXAMINATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify compacted granular subbase is dry and ready to support paving and imposed loads.
   1. Proof roll subbase to identify soft spots.
   2. Remove soft subbase and replace with compacted fill as specified in Section 31 23 23.

C. Verify gradients and elevations of base are correct.

3.3 PREPARATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Moisten substrate to minimize absorption of water from fresh concrete.

C. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete paving.

D. Notify Engineer minimum 24 HRS prior to commencement of concreting operations.

E. Remove existing pavement, sidewalk, gutter, and curb and gutter as shown on the plans in conformance with provisions of SSRBC, Section 440.

3.4 INSTALLATION
1. Portland Cement Concrete Pavement:
   a. Prior to placement of any concrete, the Contractor shall contact the Engineer and Owner a minimum of 48 HRS prior to the placement. The Contractor must receive approval of the Engineer. Any concrete placed over an unapproved base is subject to removal at the discretion of the Engineer.
   b. Construction Portland Cement Concrete Pavement of type, width and thickness indicated on the plans and in conformance with the provisions of SSRBC Section 420.
   c. Depositing Concrete:
      1) Concrete shall be handled from the mixer to the place of final deposit in carts, buggies and shall not be spouted nor delivered by spout or trough, nor dumped into carts with a free fall from the mixer of more than 3 FT. Every possible precaution shall be taken to prevent separation or loss of ingredients while transporting the concrete.
      2) Concrete shall be spaded and rodded to thoroughly embed all reinforcement and fixtures. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. Special care shall be taken to secure dense concrete around all inserts.
   d. Construction expansion joints at locations indicated on the plans and in accordance with SSRBC requirements.
2. Portland Cement Concrete Sidewalk:
   a. Construct Portland Cement Concrete Sidewalk of type, width and thickness indicated on the Plans in conformance with provisions of SSRBC Section 424.
   b. Construct 1/2 IN thick expansion joints between sidewalk and all structures which extend through sidewalk.
   c. Construct 3/4 IN thick expansion joints at intervals of not more than 50 FT. Where sidewalk is adjacent to curb or pavement with expansion joints, place joints in walk opposite existing joints. Place expansion joints where sidewalk abuts pavements, curbs, structures and other sidewalks.

3. Portland Cement Concrete Gutter and Combination Curb and Gutter:
   a. Construct gutter Type B (Modified) and Type B-6.12 curb and gutter to lines and grades indicated on the plans and in accordance with SSRBC Section 606.
   b. Construct expansion joints with 3/4 IN preformed non-extruding joint fillers and two 3/4 IN smooth steel dowels at 100 FT maximum intervals, at 5 FT on either side of drainage structures, at beginning and ending of radii, at abutments with sidewalk and curb and gutter, and as directed by Engineer.
   c. Saw contraction joints to 2 IN minimum depth at 10 FT intervals or as directed by Engineer. Saw joints no earlier than 6, nor later than 24 HRS, after placement of concrete.

B. Curing and Protection:

   1. Apply protective coat in conformance with SSRBC Article 420.18.
   2. All exposed surfaces of concrete shall be protected against wash by rain. All concrete shall be kept set for a period of five days after placing, except that two days' curing shall be considered sufficient if high-early strength Portland cement or concrete is used.
   3. When placing concrete at or below a temperature of 40 DegF or whenever, in the opinion of the Owner, atmospheric temperatures will probably fall below this limit within the next 24 HR period after placing concrete, the mixing water and aggregates shall be heated and the freshly placed concrete protected by adequate housing or covering and heating.
   4. Concrete when placed in the forms shall have a temperature of not less than 70 DegF nor more than one 100 DegF. Freshly placed concrete shall be maintained at a temperature of 50 to 80 DegF or greater for a period of not less than 4 days after placing. The methods of protection and curing shall be such as to prevent evaporation of moisture from the concrete and injury to the surface.
   5. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
   6. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
3.5 DEFECT ASSESSMENT

A. Any concrete work that is not adequately formed or for any reason is out of alignment or level or shows a defective surface shall be considered as not conforming with the intent of these Specifications and shall be removed from the job by the Contractor at his expense unless the Owner grants permission to patch the defective area which shall be done in accordance with the best practice. Permission to patch any such area shall not be considered a waiver of the Owner’s right to require complete removal of the defective work if the patching does not, in his opinion, satisfactorily restore the quality of the concrete and appearance of the surface.

3.6 FIELD QUALITY CONTROL

A. Testing: Make two concrete test cylinders for every 50 CY of concrete placed. Make a minimum of two test cylinders each day concrete curb and gutter is placed.

B. Repair or remove and replace unacceptable surface or pavement as directed by Engineer.

C. Inspect reinforcing placement for size, spacing, location, support.

D. Testing firm will take cylinders and perform slump and air entrainment tests according to ACI 301.

E. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.7 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

C. Do not permit pedestrian and vehicular traffic over paving until 75 percent design strength of concrete has been achieved.

END OF SECTION 32 13 13
SECTION 32 31 29 - WOOD FENCE AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fence framework, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts and center drop for gates.
4. Gates and related hardware.

B. Related Sections:

1. Division 00 Procurement and Contracting Requirements.
2. Division 01 General Requirements.
3. 03 31 30 - Concrete, Materials and Proportioning.
4. 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
5. 31 05 13 - Soils for Earthwork.
6. 31 05 16 - Aggregates for Earthwork.
7. 31 22 13 - Rough Grading.
8. 31 23 16 - Excavation.

1.2 REFERENCES

A. ASTM International:


B. American Welding Society (AWS):
1.3 SYSTEM DESCRIPTION

A. Fence Height: as indicated on Drawings.

B. Line Post Spacing: At 8 FT intervals or as recommended by manufacturer.

C. Fence Post and Rail Strength: Conform to ASTM F1043 Light Industrial Fence quality.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Approval Submittals:
   1. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates and schedule of components prior to installation.
   2. Product Data: Acknowledgement that products submitted meet requirements of standards referenced.
   3. Installation instructions: Submit manufacturer’s installation instructions for this specific project prior to installation.
   4. Manufacturer’s completed warranty registration.

C. Quality Control Submittals:
   1. Source quality control test results.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

C. Operation and Maintenance Data: Provide O&M manual documentation

D. Standard Manufacturer Warranty: Provide two (2) executed copies of the standard manufacturer’s warranties required by this Section.

1.6 QUALITY ASSURANCE

A. The Contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified for fence installation.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this Section with minimum 5 years documented experience or approved by manufacturer.

C. Installer bonded and licensed in the State of Illinois.

D. Utilize only AWS certified welder.

1.8 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Identify each package with manufacturer's name.

C. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism, and theft.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Fence and Gate system shall conform to materials indicated on IDOT “Standard 641001-01 – Sight Screen Cedar Stockade Fence Type S” and Ameristar “AdapTrack” with modifications noted under article 2.2 of this Specification.

2. Substitutions: Section 01 60 00 - Product Requirements.

2.2 MATERIALS AND COMPONENTS

A. Wood Fence:

1. 8-foot tall fence for fence panels and posts shall conform to the requirements of IDOT “Standard 641001-01 – Sight Screen Cedar Stockade Fence Type S”.
   a. Concrete shall be substituted for aggregate post hole fill.
   b. South fence posts where supporting cantilever gate shall be 2.5 IN square x 12 GA steel tubing. Steel shall be coated per Table 1 below:
2. Pickets, rails and posts shall be pre-cut to specified lengths. Pickets shall be 2.25 IN – 3 IN diameter cedar pickets. Rails shall be wood, 3 IN x 4 IN. Posts shall be wood, 8 IN x 8 IN x 14 FT. Pickets shall be fastened to rails with galvanized common wire nails as indicated on Plan and Detail A of Standard 641001-01. Rails shall be fastened to posts with hardware indicated on Plan and Detail B of Standard 641001-01.

B. Wood Cantilever Gate:
1. The gate system shall include a rigid gate panel (supplied by others) that employs an AdapTrack™ cantilever gate adapter kit, manufactured by Ameristar Fence Products, Inc. containing all components necessary (i.e., track, truck brackets and truck assemblies, lower guide roller assemblies, fittings and fasteners) to convert the rigid gate panel to a cantilever gate system.
   a. 8-foot tall gate with 20 FT minimum clear gate opening.
   b. Coordinate track placement on interior of fenced-in lift station area with other site improvements, including grading, generator equipment pad, underground utilities, etc.
   c. Coordinate installation of gate with clearance required for generator access.
   d. Facing of gate shall utilize cedar pickets to match fencing. Pickets, rails and posts shall be pre-cut to required lengths.
   e. Design gates for operation by one person.
   f. The top track shall conform to the Ameristar® AdapTrack™ cross-section, manufactured by Ameristar Fence Products, Inc., in Tulsa, Oklahoma.
   g. The material used for the AdapTrack™ shall be manufactured from ASTM B221 aluminum (designation 6005-T5) with a yield strength of 35,000 PSI.
   h. Contractor to verify with manufacturer if diagonal truss bracing is necessary.
   i. 2-3/8” gate panel frame brackets shall be supplied with each kit. Two upper suspension rollers and two lower guide rollers shall be included with each kit.

3. Hardware:
   a. Per manufacturer recommendation.
   b. Gate must be lockable with City-supplied padlock. Contractor to coordinate selection of hardware with City, accordingly.

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</tr>
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PART 3 - EXECUTION

3.1 PREPARATION

A. All new installation shall be laid out by the Contractor in accordance with the construction plans.

3.2 FENCE INSTALLATION

A. Fence post shall be spaced according to Standard 641001-01, plus or minus 1/2 IN. For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with hardware according to Standard 641001-01. Posts shall be set in concrete footers having a minimum depth of 42 IN. See Related Sections for Specifications that shall govern material requirements for the concrete footer. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient for strength for the intended application.

3.3 FENCE INSTALLATION MAINTENANCE

A. When cutting/drilling steel posts adhere to the following steps to seal the exposed steel surfaces:
   1. Remove all metal shavings from cut area.
   2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry (for steel fence).
   3. Apply 2 coats of custom finish paint matching fence color.
   4. Manufacturer cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray

B. Use of non-manufacturer recommended parts or components will not be permitted.

3.4 GATE INSTALLATION

A. Gate shall be installed at south side of fenced-in lift station area as indicated on the Drawings.

B. Gate posts shall be spaced according to the manufacturers’ gate Drawings, dependent on standard out-to-out gate dimensions and gate hardware selected.

C. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles.
   1. The manufacturers’ gate Drawings shall identify the necessary gate hardware required for the application.
   2. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer’s recommendations.
   3. The AdapTrack™ extrusion shall be mechanically fastened to gate panel framing as shown in manufacturer’s literature.
   4. Set gate posts in accordance with the gate elevation drawing.
5. Attach truck brackets and upper suspension rollers to gate posts per end view (cross-section) in construction drawings; slide AdapTrack™ toprail onto rollers.
6. Install lower guide rollers and gate stops.

3.5 CLEANING

A. The Contractor shall clean the jobsite of excess materials.

B. Post-hole excavations shall be scattered uniformly away from posts.

END OF SECTION 32 31 19
SECTION 32 91 13 - SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparation of subsoil.
   2. Soil testing.
   3. Placing topsoil.

B. Related Sections:
   1. Section 31 22 13 - Rough Grading: Rough grading of site.
   3. Section 32 91 19 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the Work of this Section.
   4. Section 32 92 19 - Seeding.
   5. Section 32 93 00 - Plants.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit minimum 10 OZ sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.

C. Test Reports: Indicate topsoil nutrient and pH levels with recommended soil supplements and application rates.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with the Standard Specifications for Road and Bridge Construction in Illinois, Current Edition (IDOT) standard.

B. Maintain one copy of document on site.

1.4 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate with installation of underground sprinkler system piping and watering heads.
PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Topsoil: As specified in Section 31 05 13.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify prepared soil base is ready to receive the Work of this Section.

3.2 PREPARATION OF SUBSOIL

A. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated sub-soil.

C. Scarify subsoil to depth of 3 IN where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.

3.3 PLACING TOPSOIL

A. Spread topsoil to minimum depth of 6 IN over area to be seeded. Rake until smooth.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Install edging at periphery of seeded areas in straight lines to consistent depth.

END OF SECTION 32 91 13
SECTION 32 91 19 - LANDSCAPE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Final grade topsoil for finish landscaping.

B. Related Sections:

1. Section 31 22 13 - Rough Grading: Site contouring.
3. Section 31 23 23 - Fill: Backfilling at building areas.
4. Section 32 92 19 - Seeding and Soil Supplements.
5. Section 32 93 00 - Plants: Topsoil fill for trees, plants and ground cover.

1.2 REFERENCES

A. Standard Specifications for Road and Bridge Construction (SSRBC), Current Edition, Illinois Department of Transportation (IDOT):
   1. SSRBC Section 211 – Topsoil and Compost.

1.3 DEFINITIONS

A. Weeds: Vegetative species other than that specified to be established in a given area.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Furnish each topsoil material from single source throughout the Work.


C. Maintain one copy on site.
PART 2 - PRODUCTS

2.1 MATERIAL

A. Topsoil: Fill as specified in Section 32 93 00.

B. Source Quality Control:
   1. If there is doubt as to topsoil suitability as determined by the Engineer, provide analysis of topsoil under provisions of Section 01 40 00 – Quality Requirements: Testing, inspection and analysis requirements.
   2. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content and pH value.
   3. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.
   4. Testing shall not be required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory or Engineer. Indicate, by test results, information necessary to determine suitability.

PART 3 - EXECUTION

3.1 GENERAL

A. All areas disturbed by the contractor shall be restored to their original condition and approved by the Engineer. Restoration is intended to restore areas disrupted during excavation, transportation of excavated material, installation of underground utilities, and all areas disturbed through the stockpiling or storage of materials and equipment.

B. The contractor will be responsible for any additional maintenance of the rehabilitated items until the item has been restored to its original conditions as deemed by the Engineer.

3.2 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify building and trench backfilling have been inspected and approved by the Engineer. Engineer at their own discretion require compaction and density testing prior to the placement of topsoil.

C. Verify substrate base has been contoured and compacted.

3.3 PREPARATION

A. Protect landscaping and other features remaining as final Work.

B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.
3.4 SUBSTRATE PREPARATION

A. Eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove debris, roots, branches, stones, undesirable plants, and foreign materials in excess of 1/2 IN in size. Remove contaminated subsoil.

C. Scarify surface to depth of 6 IN where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.5 PLACING TOPSOIL

A. Topsoil shall not be placed until the area to be covered has been shaped, trimmed and finished in accordance with Section 31 22 13 and this Section. All irregularities or depressions in the surface due to weathering or other causes shall be filled or smoothed out before the topsoil is placed. If the existing surface has become hardened or crusted, it shall be disked or raked or otherwise broken up so as to provide a bond with the layer of topsoil to be applied.

B. Place topsoil in areas where seeding, sodding, and planting is required to nominal depth of 6 IN. Place topsoil during dry weather on dry unfrozen subgrade.

C. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.

D. Remove roots, weeds, rocks, and foreign material while spreading.

E. Manually spread topsoil close to plant material and buildings to prevent damage.

F. Surface of topsoil shall conform to the lines, grades and minimum thickness shown on the plans.

G. Lightly compact placed topsoil.

H. Remove surplus subsoil and topsoil from site.

I. Leave stockpile area and site clean and raked, ready to receive landscaping.

J. If required by the Engineer, one rolling of the entire surface shall be provided.

3.6 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Top of Topsoil: Plus or minus 1/2 IN.
3.7 PROTECTION OF INSTALLED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect landscaping and other features remaining as final Work.

C. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

D. Prohibit construction traffic over topsoil.

END OF SECTION 32 91 19
SECTION 32 92 19 - SEEDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fertilizing.
   2. Seeding.
   3. Hydroseeding.
   4. Mulching.
   5. Maintenance.

B. Related Sections:
   1. Section 31 22 13 - Rough Grading: Rough grading of site.
   3. Section 32 91 13 - Soil Preparation
   4. Section 32 91 19 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the Work of this Section.
   5. Section 32 93 00 - Plants.

1.2 REFERENCES

A. ASTM International:

B. Standard Specifications for Road and Bridge Construction (SSRBC), Current Edition, Illinois Department of Transportation (IDOT):
   1. SSRBC Section 250 – Seeding.
   2. SSRBC Section 251 – Mulch.


1.3 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for seed mix, fertilizer, mulch, and other accessories.
C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.6 QUALITY ASSURANCE
A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.
C. Maintain one copy of document on site.

1.7 QUALIFICATIONS
A. Installer: Company specializing in performing work of this Section with minimum 5 years documented experience or approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.9 MAINTENANCE SERVICE
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.
B. Maintain seeded areas immediately after placement until grass is well established and exhibits vigorous growing condition for two cuttings.
PART 2 - PRODUCTS

2.1 SEED MIXTURE

A. Furnish materials according to the Standard Specifications for Road and Bridge Construction in Illinois, Current Edition (IDOT) standard.

B. Description:
   1. Seed Mixture, SSRBC 250.07 Class 1A – Salt Tolerant Lawn Mixture.
      a. Bluegrass: 60 LBS/acre.
      b. Perennial Ryegrass: 20 LBS /acre.
      c. Audubon Red Fescue: 20 LBS /acre.
      d. Rescue 911 Hard Fescue: 20 LBS /acre.
      e. Fults Salt Grass: 60 LBS /acre.

2.2 SEED PROTECTION MATERIALS

A. Erosion Control Blanket: As specified in Section 31 25 00.

2.3 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.


C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

D. Herbicide:
   1. Seeded Areas (with no blanket): Ronstar 2G as manufactured by Rhone–Poulenc.
      a. Application Rate: 3 LBS ai/A (150 LBS per acre).
   2. Blanketed Areas: Snapshot TG as manufactured by DowElanco.
      a. Application Rate: 3.75 LBS ai/A (150 LBS per acre).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify prepared soil base is ready to receive the Work of this Section.
3.2 PREPARATION

A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove debris, roots, branches, stones, in excess of 1/2 IN in size. Remove contaminated subsoil.

3.3 FERTILIZING

A. Include this article only when fertilizer is included in this Section.

B. Apply lime and fertilizer based on the results of the soil test(s) in Section 32 91 19.

C. Apply after smooth raking of topsoil and prior to roller compaction.

D. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

E. Mix thoroughly into upper 2 IN of topsoil.

F. Lightly water to aid the dissipation of fertilizer. Irrigate uniformly the top level of soil.

3.4 SEEDING

A. Conform to SSRBC Sections 250.06.

B. Apply seed at a total rate of 300 LBS of seed mix per acre evenly in two intersecting directions. Rake in lightly.

C. Planting Season: Contractor is responsible for assuring that seeding is performed when conditions will allow for proper germination and growth.

D. Do not sow immediately following rain, when ground is too dry or when winds are over 12 mph.

E. Roll seeded area with roller not exceeding 112 LBS.

3.5 HYDROSEEDING

A. Apply fertilizer, mulch and seeded slurry with a hydraulic seeder at a rate of 2400 LBS per acre evenly in one pass.

B. After application, apply water with a fine spray immediately after each area has been hydroseeded. Saturate to 4 IN of soil and maintain moisture levels 2 to 4 IN.
3.6  SEED PROTECTION

A. Identify seeded areas with stakes and string around area periphery. Set string height to 12 IN and space stakes on 10 FT intervals.

B. Cover seeded slopes with erosion control fabric in accordance with Section 31 25 00.

3.7  MAINTENANCE

A. Mow grass at regular intervals to maintain at maximum height of 2-1/2 IN. Do not cut more than 1/3 of grass blade at each mowing. Perform first mowing when seedlings are 40 percent higher than desired height.

B. Neatly trim edges and hand clip where necessary.

C. Immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps.

D. Water to prevent grass and soil from drying out.

E. Roll surface to remove minor depressions or irregularities.

F. Control growth of weeds. Apply herbicides. Remedy damage resulting from improper use of herbicides.

G. Immediately reseed areas showing bare spots.

H. Repair washouts or gullies.

I. Protect seeded areas with warning signs during maintenance period.

3.8  PROTECTION OF INSTALLED WORK

A. Section 01 70 00 – Execution Requirements: Protecting installed Work.

B. Prohibit construction traffic over seeded areas.

END OF SECTION 32 92 19
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SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparation of subsoil and topsoil.
   2. Topsoil bedding.
   3. Trees, plants, and ground cover.
   4. Mulch.
   5. Fertilizer.
   6. Pruning.
   7. Maintenance.

B. Related Sections:
   2. Section 31 23 23 - Fill: Rough grading of site.
   3. Section 32 91 19 - Landscape Grading: Preparation of subsoil and placement of topsoil in preparation for the Work of this Section.
   4. Section 32 92 19 - Seeding and Soil Supplements.

C. Allowances: Include under provisions of Section 01 20 00 - Price and Payment Procedures. Allowance includes furnishing of trees, plants and ground cover. Installation is included in this Section and is part of Contract Sum/Price.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI A300 - Tree Care Operations - Tree, Shrub and Other Woody Plant Maintenance - Standard Practices.
   2. ANSI Z60.1 - Nursery Stock.

B. Forest Stewardship Council:
   1. FSC Guidelines - Forest Stewardship Council Guidelines.

C. Illinois Standard Specifications for Road and Bridge Construction (SSRBC):
   1. Section 253 - Planting Woody Plants.

1.3 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.
B. Plants: Living trees, plants, perennial, and ground cover specified in this Section, and described in SSRBC, Sections 253.01 and 254.01.

1.4 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit list of plant material sources, data for fertilizer and other accessories.
C. Submit minimum 10 OZ sample of topsoil proposed. Forward sample to testing laboratory in sealed containers to prevent contamination.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Operation and Maintenance Data: Include pruning objectives, types and methods; types, application frequency, and recommended coverage of fertilizer; and watering.

1.6 QUALITY ASSURANCE
A. Tree Pruning: ANSI A300 and SSRBC 253.09 Pruning for Woody Plants
C. Maintain one copy of document on site.

1.7 QUALIFICATIONS
A. Nursery: Company specializing in growing and cultivating plants with 3 years documented experience.
B. Installer: Company specializing in installing and planting plants with 5 years documented experience or approved by nursery.
C. Tree Pruner: Company specializing in performing work of this Section with minimum 3 years documented experience or approved by manufacturer.
D. Maintenance Services: Performed by installer.

1.8 PRE-INSTALLATION MEETINGS
A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this Section.
1.9 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
   B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
   C. Protect and maintain plant life until planted.
   D. Deliver plant life materials immediately prior to placement. Keep plants moist.
   E. Plant material damaged as a result of delivery, storage or handling will be rejected.

1.10 ENVIRONMENTAL REQUIREMENTS
   A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
   B. Do not install plant life when ambient temperatures may drop below 35 DegF or rise above 90 DegF.
   C. Do not install plant life when wind velocity exceeds 30 mph.

1.11 COORDINATION
   A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

1.12 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
   B. Furnish one year warranty for trees, plants, and ground cover.

1.13 MAINTENANCE SERVICE
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.
   B. During the period of establishment, the Contractor shall properly care for all plant Maintenance per SSRBC Sections 253 and 254. All requirements for proper care during the period of establishment shall be considered as included in the cost of the contract and shall be performed within five days following notification by the Engineer.
C. Maintain Plant Life Immediately After Placement:
   1. For Woody Materials: Continue maintenance until termination of establishment period. During the period of establishment, additional watering shall be performed at least once within every 30 days during the months of May through December. The Engineer may direct the Contractor to adjust the watering rate and frequency depending on weather conditions.
   2. Perennial plants must undergo a 30-day period of establishment. Additional waterings shall be performed at least once within every seven days for four weeks following installation. Water shall be applied at the rate of 2 GAL/SY. Should excess moisture prevail, the Engineer may delete any or all of the additional watering cycles. In severe weather, the Engineer may require additional waterings.

D. During the period of establishment, weeds and grass grown shall be removed from within the earthen saucer of individual trees and from the area within the mulched plan beds. This weeding shall be performed twice during each of the months of May through September. The Contractor will not be relieved in any way from the responsibility for unsatisfactory plants due to the extent of weeding.

E. Maintenance Includes:
   1. Cultivation and weeding plant beds and tree pits.
   2. Applying herbicides for weed control. Remedy damage resulting from use of herbicides.
   3. Remedy damage from use of insecticides.
   4. Irrigating sufficient to saturate root system.
   5. Pruning, including removal of dead or broken branches.
   6. Disease control.
   7. Maintaining wrapping, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.
   8. Replacement of mulch.

PART 2 - PRODUCTS

2.1 TREES, PLANTS, AND GROUND COVER

A. Planting Stock:
   1. Species: According to Standardized Plant Names, official code of American Joint Committee on Horticulture Nomenclature.
   2. Identification: Label individual plants or each bundle of plants when tied in bundles.
   3. Plants: No. 1 Grade conforming to "American Standard for Nursery Stock" of American Association of Nurserymen (AAN); well-branched, vigorous and balanced root and top growth; free from disease, injurious insects, mechanical wounds, broken branches, decay and other defects.
   4. Trees: Furnish with reasonably straight trunks, well balanced tops, and single leader.
   5. Deciduous plants: Furnish in dormant state, except those specified as container grown.

B. Trees, Plants and Ground Cover: Species and size identifiable in plant schedule, grown in climatic conditions similar to those in locality of the Work.
2.2 SOIL MATERIALS
   A. Topsoil: Materials to be furnished as per SSRBC Section 211 and 1081.05

2.3 SOIL AMENDMENT MATERIALS
   A. When soil tests indicate soil amendment, apply soil conditioners or fertilizers to amend soil to specified conditions.
   B. Water: Clean, fresh, and free of substances or matter capable of inhibiting vigorous growth of plants.

2.4 MULCH MATERIALS
   A. Mulching Material: Composted, shredded hardwood bark, dark brown in color as approved by the Engineer. To be furnished per SSRBC Sections 211 and 1081.06.

2.5 ACCESSORIES
   A. Wrapping Materials: Burlap.
   B. Stakes: Softwood lumber, pointed end.
   C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.
   D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.
   E. Decorative Cover: Fir bark chips or as approved by Engineer.
   F. Membrane: 20 mil thick, water permeable polyolefin fabric.

2.6 SOURCE QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.
   B. Test and analyze existing topsoil.
   C. Provide recommendation for fertilizer and soil amendment application rates for specified planting as result of testing. Shall meet SSRBC Section 1081.08 requirements.
   D. Testing is not required when recent tests are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
B. Verify prepared subsoil is ready to receive work.
C. Saturate soil with water to test drainage.
D. Verify required underground utilities are available, in proper location, and ready for use.

3.2 PREPARATION OF SUBSOIL
A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
C. Scarify subsoil to depth of 3 IN where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
D. Dig pits and beds three times wider than plant root system.

3.3 PLACING TOPSOIL
A. Spread topsoil to minimum depth of 6 IN over area to be planted. Rake smooth.
B. Place topsoil during dry weather and on dry unfrozen subgrade.
C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
E. Install topsoil into pits and beds intended for plant root balls, to minimum thickness of 6 IN.

3.4 FERTILIZING
A. Apply starter fertilizer.
B. Apply after initial raking of topsoil.
C. Mix thoroughly into upper 2 IN of topsoil.
D. Lightly water soil to aid dissipation of fertilizer.
3.5 PLANTING

A. All planting procedures to follow SSRB Sections 253 and 254.

B. Place plants for best appearance for review and final orientation by Engineer.

C. Set plants plumb position and set 2 IN higher than depth grown in nursery.

D. Container Grown Plants: Remove non-biodegradable root containers with care so as not to disturb the ball of soil that contains the root system.

E. Balled and Burlapped Plants: Set plants in pits or beds, partly filled with prepared plant mix, at minimum depth of 6 IN under each plant. After plant is placed in the hole, all cords and burlap shall be removed from the trunk. Wire baskets shall be removed from at least the upper one half of the planting ball. All materials to be disposed of properly.

F. Bare Root Plants: The roots shall be carefully spread in a natural position and prepared backfill shall be worked in around the roots so each root is individually packed to eliminate air pockets. The plant shall be gently raised and lowered to ensure contact of the roots with the soil. Backfill soil mixture in 6 IN layers. Maintain plant life in vertical position.

G. Saturate soil with water when pit or bed is half full of topsoil and again when full.

H. Water Saucer: All plants, with the exceptions of seedling, shall be placed individually and not specified to be bedded with other plants, shall have a water saucer constructed of soil equal to one half the diameter of the planting hole width and 4 IN in depth.

3.6 PLANT RELOCATION AND RE-PLANTING

A. Relocate plants as directed by Architect/Engineer.

B. Ball or pot removed plants when temporary relocation is required.

C. Replant plants in pits or beds, partly filled with prepared topsoil mixture, at minimum depth of 6 IN under each plant. After plant is placed in the hole, all cords and burlap shall be removed from the trunk. Wire baskets shall be removed from at least the upper one half of the planting ball. All materials to be disposed of properly.

D. Bare Root Plants: The roots shall be carefully spread in a natural position and prepared backfill shall be worked in around the roots so each root is individually packed to eliminate air pockets. The plant shall be gently raised and lowered to ensure contact of the roots with the soil. Backfill soil mixture in 6 in layers. Maintain plant life in vertical position.

E. Saturate soil with water when pit or bed is half full of topsoil and again when full.

F. Water Saucer: All plants, with the exceptions of seedling, shall be placed individually and not specified to be bedded with other plants, shall have a water saucer constructed of soil equal to one half the diameter of the planting hole width and 4 IN in depth.
3.7 PLANT SUPPORT

A. Brace plants vertically with plant protector wrapped guy wires and stakes.

B. Tree Support Method per Tree Caliper:
   1. 1 in stake with one tie.
   2. 1 to 2 in stakes with two ties.
   3. 2 to 4 in guy wires.
   4. Over 4 in Four guy wires with eye bolts and turnbuckles.

3.8 TREE PRUNING

A. When pruning trees is required, lightly prune trees according to SSRBC 253.09 and ANSI A300 Maintenance Pruning Type: Crown Cleaning.

3.9 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Plants will be rejected when ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.10 SCHEDULE

A. Plant Schedule: See Drawings.

END OF SECTION 32 93 00
DIVISION 33

UTILITIES
SECTION 33 01 30.16 - TV INSPECTION OF SEWER PIPELINES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipeline flushing and cleaning.
   2. TV inspection of sewer pipelines.
   3. Audio-video recording of pipeline interior.

B. Related Requirements:
   1. Section 33 01 30.61 - Sewer and Pipe Joint Sealing.
   2. Section 33 31 00 - Sanitary Utility Sewerage Piping.

1.2 COORDINATION

A. Coordinate Work of this Section with Owner.

1.3 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section.

1.4 SCHEDULING

A. Schedule Work of this Section to coincide with relining sewers and existing sewer work.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit completed narrated DVDs identified by Project name, street name, right-of-way property name, and manhole numbers.

C. DVDs become property of Owner.

D. Inspection Logs:
   1. Submit cleaning and TV inspection logs for each section of sewer line to be rehabilitated and three (3) copies of color DVDs for Work performed.
   2. Include following minimum information:
      a. Stationing and location of lateral services, wyes, or tees.
b. Clock time references.
c. Pipe joints.
d. Infiltration/inflow defects.
e. Cracks.
f. Leaks.
g. Offset joints.
h. Other information required to assess condition of sewer.

E. Submit specific detailed description of proposed bypass pumping system, including written description of plan addressing quantity, capacity, and location of pumping equipment.

F. Submit spill plan to address any spills that might occur.

G. Qualifications Statement: Submit qualifications for applicator.

1.6 QUALITY ASSURANCE

A. Perform Work according to accepted industry standards.

PART 2 - PRODUCTS

2.1 DVDs

A. Description: Digital video formatted discs.

B. Audio track containing simultaneously recorded narrative commentary and evaluations of videographer, describing in detail condition of pipeline interior.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Verify location of sewer pipelines to be inspected.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.

B. Flush and clean pipeline to remove sludge, dirt, sand, stone, grease, and other materials to ensure clear view of interior conditions.
C. Intercept flushed debris at next downstream manhole using weir or screening device; remove and dispose of debris off Site.

D. Furnish temporary bypass pumping system around Work area for time required to complete TV inspection.

3.3 APPLICATION

A. Closed-Circuit TV Camera System:

1. Use cameras specifically designed and constructed for closed-circuit sewer line inspection. Use camera equipment with pan and tilt capability to view each lateral connection at multiple angles.

2. Use camera capable of moving both upstream and downstream with minimum 1,000 FT horizontal distance within one setup and direct-reading cable position meter.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements.

B. Pipeline Inspection:

1. Audio-video record sections of sewer pipeline between designated manholes.

2. Identify and record locations of flat grades, dips, deflected joints, open joints, broken pipe, protrusions into pipeline, and points of infiltration.

3. Locate and record service connections.

4. Record locations of pipeline defects, connection horizontal distance in feet, and direction from manholes.

5. Video record with pipe section plugged to view 100 percent of inside pipe diameter; use flow-control methods as specified for bypass pumping system to eliminate surcharging and reduce flow.

END OF SECTION 33 01 30.16
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SECTION 33 01 30.61 - SEWER AND PIPE JOINT SEALING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe cleaning and flushing.
   2. Plugging.
   4. Joint testing.
   5. Joint sealing.

B. Related Requirements:
   1. Section 33 01 30.16 - TV Inspection of Sewer Pipelines: Audio-video inspection for roots and other blockages.
   2. Section 33 01 30.62 - Manhole Grout Sealing: Cleaning, plugging, and grout sealing of defective manholes as required by Work of this Section.
   3. Section 33 05 13 – Manholes and Structures

1.2 REFERENCE STANDARDS

A. ASTM International:

1.3 SCHEDULING

A. Furnish Work schedule when sewer piping section is out of service for joint sealing.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit sealant and root growth inhibitor data.

C. Reports:
   1. Submit weekly report with daily entries showing:
      a. Location of joints sealed and successfully tested.
      b. Results of air or liquid joint tests before and after sealing joints.
      c. Volume of joint sealant or joint sealant/root treatment additive pumped.
d. Pounds of acrylamide and N,N'-methylenebisacrylamide mixture used.
e. Pounds of ammonium persulfate used.
f. Gallons of root treatment additive material used each day, including gallons of
triethanolamine.
g. Elevation of ground water.
h. Location of pipe fractures and misalignment.
i. Location of leaking joints, including non-leaking joints failing air test.
j. Location of connections discharging continuous flow or incorrectly connected to
sewer main.

2. Submit weekly reports on form approved by Architect/Engineer prior to start of testing
and sealing.

D. DVDs:
   1. Submit completed DVDs before and after joint sealing, identified by disc number, Project
   name, and location taken.
   2. Indicate pipe joints and connections and include audio track of simultaneously recorded
   narrative commentary and evaluations of electrographer describing condition of pipe
   interior in detail.
   3. Take groundwater measurements while video recording.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Prior to starting Work, submit certifications attesting to:
   1. Composition and manufacturer of joint sealing material and root treatment additive.
   2. Chemical compatibility of sealant material and root treatment additive material.
   3. Calibration of meters used to measure joint sealant and root treatment additive.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:
   1. Submit qualifications for manufacturer and applicator.
   2. Submit manufacturer's approval of applicator.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout
   procedures.

B. Project Record Documents: Record actual locations of repaired joints.

1.6 QUALITY ASSURANCE

A. Perform Work according to the Standard Specifications for Road and Bridge Construction in
B. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Protect materials from damage by storing in secure location.

PART 2 - PRODUCTS

2.1 GROUT SEALANT

A. Chemical Grout:

1. Mixture of dry acrylamide and dry N,N'-methylenebisacrylamide in proportions capable of diluting aqueous solutions and, when properly catalyzed, forming stiff gels.

2. Make solution at concentrations as high as 3 LBS/GAL of water.

3. Chemical grout capable of tolerating ground water dilution and reacting in moving water.

4. Viscosity of less than 0.0000418 LBF-S/SF, remaining constant until gelation concurs.

5. Reaction time controllable from 10 seconds to 1 HR.

6. Reaction produces continuous and irreversible gel at chemical concentrations as low as 0.4 LBS/GAL of water.

B. Catalyst:

1. Ammonium persulfate.

2. Use in combination with activator.

3. Use of catalyst containing (dimethylamino)propionitrile is prohibited.

C. Activator: Triethanolamine or other compounds of equivalent properties.

D. Inhibitor: Potassium ferricyanide.

E. Root Growth Inhibitor:
1. Dichlorobenzonitrile meeting recommendations of grout manufacturer.
2. Root treatment additive capable of remaining active for minimum of two (2) years.
3. Active ingredient for destroying root intrusions: Sodium methyldithiocarbamate.
4. Root Cell Inhibiting Agent:
   a. 2,6-dichlorobenzonitrile (dichlobenil).
   b. For each application, disperse root control agent into clear, cool water free of acid, alkali, oxidizing agents, or large amounts of oil or other organic compounds or materials.
   c. Use tanks for transportation or storage of makeup water free of material listed above.

F. Portland Cement: ASTM C150, Type II.
G. Fine Aggregate: ASTM C33 gradation.
H. Packer for Joint Sealing:
   1. Bladder:
      a. Provide air-impervious, pneumatically inflatable bladder on each end of mounting cylinder.
      b. Seal ends of each bladder to cylinder by broad, confining bands.
   2. Connect at each end by winch-powered cables.
   3. Form positive seal between inflated bladders and interior periphery of sewer pipe and form annular void between inflated end bladders.
   4. Design to allow restricted quantity of sewage flow through packer at designated times.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.
B. Verify which sewer pipes require joint sealing.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.
B. Pipe Cleaning and Flushing:
   1. Perform cleaning of pipe interior to extent necessary to pass equipment and materials required for joint sealing.
2. Flush foreign material cleaned from interior of sewer pipe, intercept, remove, and properly dispose.
3. Dumping of raw sewage on private property, in city streets, or into surface or groundwater is not permitted.

C. TV Inspection of Piping:
   1. Perform TV inspection of sewer pipe after cleaning as specified in Section 33 01 30.16 - TV Inspection of Sewer Pipelines.
   2. Cut roots flush with inside periphery of pipe.
   3. Visually inspect joints with TV camera before and after sealing.

D. Plugging:
   1. Conditions Requiring Plugging of Pipes:
      a. Depth of flow within sewer pipe is greater than 20 percent of inside diameter of sewer pipe.
      b. Exposing complete inside periphery of sewer pipe is required to conduct inspection, sealing, or testing.
   2. Repair damage resulting from plugging sewer piping.

E. Bypassing Sewage:
   1. Bypass sewage when plugging cannot control flows.
   2. Install and operate pump to manage bypassing of peak sewage flow rate.
   3. Provide standby pump of equal or greater capacity at bypass location.
   4. Provide safety precautions including barricades, lights, and flaggers as specified in Section 01 50 00 - Temporary Facilities and Controls.

3.3 APPLICATION

A. Root Control:
   1. Apply chemical root control agent by foaming or soaking according to conditions in piping under treatment.
   2. Foam Application:
      a. Agent: Solution containing not less than 24 percent by weight of anhydrous vapam (sodium methyldithiocarbamate) and not less than 1.7 percent by weight of dichlobenil (2,6-dichlorobenzonitrile); containing surfactant capable of producing foam able to transmit pressure of 30 psig and yielding 20 GAL of foam for each gallon of solution.
      b. Foam Concentration: Deliver foam to pipe to yield approximately 20 GAL of foam for each gallon of 5 percent solution.
   3. Soaking Application:
Agent: Aqueous solution containing 28 percent by weight or more of anhydrous vapam (sodium methyldithiocarbamate) and 1 percent by weight or more of dichlobenil (2,6-dichlorobenzonitrile) active layer of foam on contacted surfaces.

Application:

1) Fill entire pipe with freshly prepared and well-mixed solution containing not less than 1 percent by volume of chemical agent specified above.
2) Fully charge for soaking period of 1 HR or not less than 30 minutes and replenish solution to maintain its level above upper end of section under treatment and concentration at 1 percent by volume of root control agent.
3) Following specified soaking period, pass solution downstream to treat additional segments of piping, add additional root control agent to maintain concentration of solution at 1 percent, and charge each segment for designated soaking period by addition of solution.

B. Joint Sealing:

1. Seal joints that fail pre-sealing test.
2. Monitor and record actual maintenance pressures when grouting and testing joints.
3. Pass sealing materials from dual independent pumping system through instantaneously controlled system and read flow meter to annular void in packer through dual hose systems.
4. When sealant material injected into joint exceeds 15 GAL in 8 IN pipe, stop injection. Do not resume sealing of joint until other joints in manhole run are sealed.
5. Re-clean and repeat sealing process until positive seal is achieved.
6. Clean joint after sealant material has set.
7. Examine joint repair for visible defects using TV camera and fix defects prior to testing of post-joint seal.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Pre-Sealing Joint Test: Air test each joint between manholes as follows:

1. Conduct pre-sealing test as specified for post-sealing test.
2. Record failure of pre-sealing test in weekly report.
3. Notify Architect/Engineer when pre-sealing test passes. Record passing tests in weekly report and discontinue joint sealing and post-sealing test sequence for passed joint.

C. Post-Sealing Joint Test:

1. Perform visual inspection of joint.
2. Apply positive air pressure in void area to raise void pressure to 3 psig above maximum ground water pressure and allow to stabilize due to temperature effect.
3. Complete air pressure stabilization.
   a. Test Pressure: Not less than maximum ground water pressure nor more than 7.5 psig above maximum ground water pressure at initiation of test procedure.
4. Record initial test pressure, stabilized test pressure, and period of time required to have 1.0 psig pressure drop from stabilized test pressure.

5. Minimum Test Duration:
   
   a. Pipe Diameter 8 IN: Zero minutes, 18 seconds.
   b. Pipe Diameter 10 IN: Zero minutes, 28 seconds.
   c. Pipe Diameter 12 IN: Zero minutes, 40 seconds.
   d. Pipe Diameter 15 IN: 1 minute, 3 seconds.
   e. Pipe Diameter 18 IN: 1 minute, 31 seconds.
   f. Pipe Diameter 21 IN: 2 minutes, 4 seconds.
   g. Pipe Diameter 24 IN: 2 minutes, 16 seconds.
   h. Pipe Diameter 27 IN: 2 minutes, 42 seconds.

6. When pressure drop exceeds 1.0 psi from stabilized test pressure during minimum time specified above, joint has failed.

7. Discontinue test when minimum time has been completed and 1.0 psi pressure drop has not occurred from stabilized test pressure; in this circumstance, joint has satisfactorily passed test.

8. Use the following procedure for sealed joint failing air test:
   
   a. Visually inspect.
   b. Reseal.
   c. Visually inspect.
   d. Retest until successful test is obtained or sealant limit is attained.

END OF SECTION 33 01 30.61
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SECTION 33 01 30.62 - MANHOLE GROUT SEALING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manhole interior cleaning.
   2. Manhole sealing.

B. Related Requirements:
   1. Section 33 31 00 – Sanitary Utility Sewerage Piping.
   2. Section 33 34 00 – Sanitary Utility Sewerage Force Mains.
   4. Section 33 05 13 – Manholes and Structures.

1.2 REFERENCE STANDARDS

A. ASTM International:

1.3 SCHEDULING

A. Schedule Work of this Section to coincide with relining sewers and existing sewer work.

B. Furnish Work schedule when sewer piping section is out of service for joint sealing.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit product data on grout, and sealant.

C. Shop Drawings.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Test and Evaluation Reports: Indicate vacuum and exfiltration testing results.

F. Manufacturer Instructions: Submit detailed instructions on application requirements, including storage and handling procedures.
G. Qualifications Statements:

1. Submit qualifications for manufacturer and applicator.
2. Submit manufacturer's approval of applicator.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.
B. Project Record Documents: Record actual locations of sealed manholes.

1.6 QUALITY ASSURANCE

B. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
B. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
C. Protect materials from damage by storing in secure location.

PART 2 - PRODUCTS

2.1 GROUT SEALANT

A. Chemical Grout:

1. Mixture of dry acrylamide and dry N, N-methylenebisacrylamide in proportions capable of diluting aqueous solutions and, when properly catalyzed, forming stiff gels.
2. Make solution at concentrations as high as 3 LBS/GAL of water.
3. Able to tolerate ground water dilution and react in moving water.
4. Viscosity of less than 0.000041771 LBS-F/ SF, remaining constant until gelation concurs.
5. Reaction time controllable from 10 seconds to 1 HR.
6. Reaction produces continuous and irreversible gel at chemical concentrations as low as 0.4 LBS/GAL of water.

B. Catalyst: Use ammonium persulfate in combination with activator; use of catalyst containing (dimethylamino) propionitrile is prohibited.

C. Activator: Triethanolamine or other compounds of equivalent properties.

D. Inhibitor: Potassium ferricyanide.

E. Root Growth Inhibitor:
   1. Dichlorobenzonitrile meeting recommendations of grout manufacturer.
   2. Root treatment additive capable of remaining active for minimum of two (2) years.
   3. Active ingredient for destroying root intrusions: Sodium methyldithiocarbamate.
   4. Root Cell Inhibiting Agent:
      a. 2,6-dichlorobenzonitrile.
      b. For each application, disperse root control agent into clean, cool water free of acid, alkali, oxidizing agents, or large amounts of oil or other organic compounds or materials.
      c. Use tanks for transportation or storage of makeup water free of material listed above.

F. Portland Cement: ASTM C150, Type II.

G. Fine Aggregate: ASTM C33 gradation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Verify which manholes require grouting.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.
B. Manhole Interior Cleaning:

1. Clean each defective or fouled manhole interior with high-velocity water jet to remove grease, dirt, sludge, and roots.
2. Cut remaining roots flush with manhole interior.
3. Flush foreign material cleaned from interior of manhole; remove and properly dispose of material off Site.
4. If leaks are not readily identifiable upon completion of cleaning operation, use blower to dry manhole interior for positive identification of leaks and sweep areas.

3.3 APPLICATION

A. Grout Sealing:

1. Drill hole at each identifiable leakage point from inside manhole extending through sidewall of manhole.
2. Insert metal rod through hole to determine if exterior void space exists.
3. Fill exterior void spaces with chemical grout mix, pumping into void space until refusal is recorded by rise in pressure on pump pressure gauge.
4. Ensure that hole through manhole wall is kept open and free of chemical grout; plug hole and allow one hour for chemical grout to set.
5. Upon completion of grouting, pump manhole sealant until refusal at minimum pressure of 3.0 psig through probe-type injection equipment.
6. Deposit sealant from interior surface of set chemical grout through drilled hole to inside surface of manhole.
7. Upon setting of manhole sealant, remove excess material protruding into interior of manhole.

END OF SECTION 33 01 30.62
SECTION 33 05 13 - MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Modular precast concrete manholes and structures with tongue-and-groove joints and masonry transition to cover frame, covers, anchorage, and accessories.

B. Related Requirements:
1. Division 03 - Concrete.
2. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
5. Section 31 23 23 - Fill: Backfilling after manhole and structure installation.
6. Section 31 37 00 - Riprap.
7. Section 33 31 00 - Sanitary Utility Sewerage Piping.
8. Section 33 34 00 - Sanitary Utility Sewerage Force Mains.
9. Section 33 01 30.62 - Manhole Grout Sealing: Execution requirements for grout sealing as required by this Section.
10. Section 33 05 13 - Manholes and Structures.

1.2 REFERENCE STANDARDS

A. American Association of State Highway Transportation Officials (AASHTO):

B. American Concrete Institute ACI):

C. ASTM International ASTM):
7. C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

1.3 DESIGN REQUIREMENTS

A. Equivalent strength shall be based on structural design of reinforced concrete as outlined in ACI 318.
B. Design of lifting devices for Pre-cast structures shall conform to ASTM C913.
C. Design of joints for pre-cast structures shall conform to ASTM C913. Joints shall be designed for a leakage not to exceed 0.025 GAL/HR/FT of joint at 3 FT of head.
D. In addition to the requirements listed above, items in this section shall be in accordance with the details shown on the plans as well as the City of St. Charles’s applicable ordinances and engineering design standards.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit data for manhole covers, component and accessories construction, features, configuration, and dimensions.
C. Shop Drawings:
   1. Indicate structure locations and elevations.
   2. Indicate sizes and elevations of piping and all sizes and elevations of penetrations.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
F. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with Standard Specifications for Water and Sewer Main Construction in Illinois (SSWSMC), Current Edition (Illinois Society of Professional Engineers) and current City of St. Charles standards and details.
B. Maintain one copy of each on site at all times.
1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

D. Store pre-cast concrete manholes and drainage structures to prevent damage to the Owner’s property or other public or private property. All property damaged from materials storage or handling shall be repaired at the Contractor’s expense.

E. Clearly mark each pre-cast structure by indentation or waterproof paint to indicate the date of manufacture, manufacturer, and identifying symbols and/or numbers shown on the Contract Drawings to indicate its intended use.

1.8 AMBIENT CONDITIONS

A. Section 01 60 00 – Product Requirements.

B. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

C. Maintain materials and surrounding air temperature to minimum 50 DegF prior to, during, and 48 HRS after completion of masonry Work.

D. Cold Weather Requirements: Comply with ACI 530/530.1.

PART 2 - PRODUCTS

2.1 SANITARY SEWER MANHOLES

A. Precast Manhole Components:
   1. Reinforced pre-cast concrete of size and dimensions shown on the Plans and in accordance with ASTM C478 with gaskets in accordance with ASTM C923.
   2. Provide precast reinforced concrete monolithic manhole base with precast invert and benches.
   3. Exterior to be coated with factory application of bitumastic coating.
      a. Conseal CS-55 or approved equal.
B. Steps:
   1. Polypropylene coated steel reinforcing rods with load and pullout ratings meeting OSHA standards.
   2. Provide steps with a minimum width of 12 IN and minimum projection of 5 IN.
   3. Steps shall be embedded into the wall a minimum of 3 IN and provided on 16 IN vertical centers.
   4. Acceptable Manufacturers:
      a. M.A. Industries PS1-PF or approved equal.

C. Mortar and Grout:
   1. Mortar shall be one part Portland cement to not less than one part nor more than two parts plaster sand mixed with the least amount of clean water necessary to provide working mortar.

D. Frames and Covers:
   1. Manhole frame and cover shall be East Jordan No. 1020 frame and solid lid.
   2. Castings shall conform to the requirements of gray iron castings in accordance with ASTM A48.
   3. Provide frames and lids with self-sealing lids with watertight gasket, machined flat bearing surface and concealed pickholes.
   4. Lid design as shown on Plans and in accordance with City of St. Charles standard details.
   5. Provide bolted and gasketed covers as indicated on the Plans.

E. External Gasketed Couplings:
   1. Sanitary manholes shall be equipped with external gasketed coupling conforming to ASTM C443 and ASTM C923 with stainless steel exterior band and internal expanding band on all connections.

F. External Chimney Seals:
   1. Provide external frame to cone chimney seal for all sanitary manholes.
   2. Acceptable Manufacturers:
      b. Cretex Specialty Products (Classic Seal).
      c. Sealing Systems, Inc. (Infi-Shield).
      d. Approved Equal.

G. Manhole Encapsulation System:
   1. Acceptable Manufacturers:
      b. Approved Equal.
   2. Description:
      a. Manhole encapsulation system shall be required for all manholes located within the roadway only.
      b. Manhole encapsulation system shall be a heat-shrinkable, wraparound sleeve to create a barrier to water infiltration and to protect manhole support structure and frame from ground moisture, preventing corrosion and freeze-thaw damage.
      c. System shall accommodate ground movement and resist soil stress.
b. Width: 6 IN minimum.
c. Length of Bulk Roll: 100 FT.
d. Bonding: Bond to primed concrete surfaces.
e. Compatibility: Compatible with concrete, steel, iron, and fiberglass.
f. Closure: Separate closure seal to secure sleeve in place during installation and seal overlap area.

4. Functional Performance of Heat-Shrinkable Sleeves:
   a. Peel Strength, ASTM D1000: 8.6 pli.
   b. Lap Shear, ASTM D1002: 1.5 psi.
   c. Water Absorption, ASTM D570: 0.05 percent maximum.
   d. Low Temperature Flexibility, ASTM D2671: -40 DegF.

5. Physical Properties of Heat-Shrinkable Sleeves:
   a. System Type: High shrink.
   b. Supplied Thickness: 101 mils.
   c. Fully Recovered Thickness: 125 mils.
   d. Shrink Factor: 40 percent minimum.

6. Sleeve Adhesive:
   a. Softening Point, ASTM E28: 212 DegF.

7. Sleeve Backing:
   b. Elongation, ASTM D638: 600 percent.
   c. Hardness, ASTM D2240, Shore D: 46.
   d. Abrasion Resistance, ASTM D1044: 35 mg.

8. Primer:
   a. Use: Primes steel, concrete, and fiberglass surfaces for installation of sleeve.
   b. Compatibility: Compatible with common substrates and sleeve adhesive.

2.2 STORM SEWER MANHOLES

A. Precast Manhole Components:
   1. Reinforced pre-cast concrete of size and dimensions shown on the Plans and in accordance with ASTM C478 with gaskets in accordance with ASTM C923.
   2. Provide precast reinforced concrete monolithic manhole base with precast invert and benches.

B. Steps:
   1. Polypropylene coated steel reinforcing rods with load and pullout ratings meeting OSHA standards.
   2. Provide steps with a minimum width of 12 IN and minimum projection of 5 IN.
   3. Steps shall be embedded into the wall a minimum of 3 IN and provided on 16 IN vertical centers.
   4. Acceptable Manufacturers:
      a. M.A. Industries PS1-PF or approved equal.

C. Mortar and Grout:
   1. Mortar shall be one part Portland cement to not less than one part nor more than two parts plaster sand mixed with the least amount of clean water necessary to provide working mortar.
2.3 STORM SEWER CATCH BASINS AND INLETS
A. Reinforced pre-cast concrete of size and dimensions shown on the plans and in accordance with ASTM C478 with gaskets in accordance with ASTM C923.
B. Shaft Construction and Concentric/Eccentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female joints, nominal shaft diameter of 48 IN.
C. Base Pad: Pre–Cast or Cast–In–Place Concrete of type specified in Section 03 31 30.

2.4 VALVE VAULTS
A. Vault Sections: Reinforced Pre–cast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C923.
B. Mortar and Grout:
   1. Mortar shall be one part Portland cement to not less than one part nor more than two parts plaster sand mixed with the least amount of clean water necessary to provide working mortar.
C. Reinforcement: Formed steel wire, gage as shown on plans, galvanized finish.
D. Frames and Covers:
   1. Castings shall conform to the requirements of gray iron castings in accordance with ASTM A48.
   2. Provide frames and lids as indicated on the plans and in accordance with City of St. Charles standard details.
E. External Gasketed Couplings:
   1. Valve Vault shall be equipped with external gasketed coupling conforming to ASTC C443 and C923 with stainless steel exterior band and internal expanding band on all connections.
F. Base Pad: Pre–cast or Cast–in–place concrete of type specified in Section 03 31 30, leveled top surface.

2.5 FRAME AND COVERS
A. Castings shall conform to the requirements of gray iron castings in accordance with ASTM A48.
B. Provide frames and lids as indicated on the plans and in accordance with City of St. Charles standard details.

2.6 CONFIGURATION
A. Shaft Construction: Concentric with concentric or eccentric cone top section as shown on Plans; lipped male/female joints, sleeved to receive pipe/conduit sections.
B. Shape: As shown on Plans.
C. Clear Inside Dimensions: As shown on Plans.
D. Design Depth: As shown on Plans.
E. Clear Cover Opening: As shown on Plans.
F. Pipe and Conduit Entry: Furnish opening as indicated on Plans.
G. Steps: 12 IN wide, 16 IN OC vertically placed perpendicular to flow, set into manhole wall or as shown on Plans.

2.7 BEDDING AND COVER MATERIALS
A. Manhole Bedding: Fine or Coarse Aggregate as indicated on the plans and as specified in Section 31 05 16.
B. Pipe Bedding and Cover: As specified in Section 33 31 00.
C. Soil Backfill from 1 FT above Pipe to Finish Grade: Subsoil with no rocks over 6 IN in diameter, frozen earth or foreign matter unless noted otherwise on Plans.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Section 01 30 00 – Administrative Requirements: Coordination and Project Conditions.
C. Verify that items provided by other Sections of Work are properly sized and located.
D. Verify that built-in items are in proper location and are ready for roughing into Work.
E. Verify correct size of manhole and structure excavation.

3.2 PREPARATION
A. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.
B. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.
C. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.

D. Inspect pre-cast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units from the construction site and replace at no additional cost to the Owner.

E. Coordinate with other sections of Work to provide correct size, shape, and location.

3.3 INSTALLATION

A. Excavation:
   1. Excavate for vaults in accordance with Section 31 23 16 in the location and to depth shown. Provide clearance around the sidewalls of the structure as required for construction.
   2. If groundwater is encountered, prevent accumulation of water in excavations. Place manholes or drainage structures in a dry trench.
   3. Where the possibility exists of a watertight structure becoming buoyant in a flooded excavation, take necessary steps to avoid flotation of the structure.

B. Place base pad, trowel top surface level.

C. Place vault sections plumb and level, trim to correct elevations, anchor to base pad. Backfill excavations for manholes and drainage structures in accordance with Section 31 23 18.

D. Form and place vault cylinder plumb and level, to correct dimensions and elevations.

E. Cut and fit for pipe/conduit.

F. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.

G. Vaults shall be sealed with two rows of bituminous mastic.

H. Coordinate with other sections of Work to provide correct size, shape, and location.

3.4 PRE-CAST CONCRETE MANHOLE INSTALLATION

A. Excavation:
   1. Excavate for manholes in accordance with Section 31 23 16 in the location and to depth shown. Provide clearance around the sidewalls of the structure as required for construction.
   2. If groundwater is encountered, prevent accumulation of water in excavations. Place manholes in a dry trench.
   3. Where the possibility exists of a watertight structure becoming buoyant in a flooded excavation, take necessary steps to avoid flotation of the structure.

B. To ensure safety, lift pre-cast components at the lifting points designated by the manufacturer.
C. When lowering manholes into excavations and joining pipe to units, take precautions to ensure interior of the pipeline and structure remains clean.

D. Place monolithic manhole base and bottom section firmly and fully on minimum of six (6) IN aggregate bedding, compacted in accordance with Section 31 23 18, plumb and level. Backfill excavations for manholes in accordance with Section 31 23 18.

E. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position the base section before placing additional sections.

F. Manhole section joints shall be sealed with two rings of bituminous mastic, each joint.

G. Seal all lift lug holes.

H. Any voids in the bench or trough shall be sealed with non-shrinking grout.

I. Mortar shall not be used to dress interior sanitary manhole joints.

J. Remove foreign materials from joint surfaced and verify that sealing materials are placed properly. Avoid misalignment by using guide devices affixed to the lower section.

K. Install manhole encapsulation system per this Section and as called for on the Plans.

L. Verify that manholes installed satisfy required alignment and grade.

M. Remove knockouts or cut structure to receive piping so as not to create openings more than that required to receive pipe. Fill annular space with mortar.

N. Cut pipe to finish flush with interior of structure.

O. Shape inverts through manhole as shown on the Contract Drawings.

3.5 MANHOLE ENCAPSULATION SYSTEM INSTALLATION

A. Examine surfaces to receive manhole encapsulation system. Notify Engineer if surfaces are not acceptable. Do not begin surface preparation until unacceptable conditions have been corrected.

B. Prepare surfaces in accordance with manufacturer’s instructions.

C. Ensure surfaces are clean, dry and free of frost, surface rust, foreign objects, sharp edges, and projections that could damage manhole encapsulation system.

D. Install manhole encapsulation system in accordance with manufacturer’s instructions.

E. Install system to create barrier to water infiltration and protect manhole support structure from ground moisture and freeze/thaw damage.
3.6 FRAME AND LID INSTALLATION

A. Set frames using mortar and masonry as required.

B. Frames shall be sealed with two rows of bituminous mastic.

C. Adjustments shall be made by no more than two adjusting rings totaling a maximum of 8 inches in height.

D. Castings and adjustment rings shall be sealed using trowelable mastic to minimize settling.

E. Set frame and cover 2 IN above finished grade for manholes with covers located within unpaved areas to allow the area to be graded away from cover beginning 1 IN below the top surface of the frame.

F. Set cover frames and cover level without tipping, to correct elevations.

G. Provide external chimney seals on all sanitary manholes.

3.7 CATCH BASINS, MANHOLES, INLETS, AND FLARED END SECTIONS INSTALLATION

A. Form bottom of excavation clean and smooth to correct elevation.

B. Place base pad, with provision for storm sewer pipe end sections.

C. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.

D. Establish elevations and pipe inverts for inlets and outlets as indicated.

E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

F. Flared end sections shall be equipped with toe-block and grate.

G. Riprap shall be installed immediately adjacent to the flared end sections and as indicated on the Plans. See Section 31 37 00 – Riprap.

3.8 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements.

B. Test cast-in-place concrete as specified in Section 03 31 30 - Cast-in-Place Concrete.

C. Vertical Adjustment of Existing Manholes:
   1. Where required, adjust top elevation of existing manholes to finished grades shown on Drawings.
2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.

3. Remove concrete without damaging existing vertical reinforcing bars when removal of an existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to require vertical reinforcement, as indicated on the Contract Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 03 31 30.

D. All structures shall be inspected prior to backfill.

3.9 TESTING

A. All new sanitary manholes shall be vacuum tested as follows:

B. Test manhole from top of frame down.

C. Plug all incoming and outgoing sewer and service lines and restrain plugs.

D. Draw vacuum of 10 IN Hg.

E. Time for vacuum to drop to 9 IN Hg shall not be less than 40, 50, or 60 seconds for manhole diameters of 48, 60 and 72 IN, respectively.

F. For manholes deeper than 20 FT, test times shall be increased by 2 seconds per foot of additional manhole depth.

G. Manholes that fail shall be externally sealed and retested by the Contractor at no additional compensation until manhole is able to pass test.

END OF SECTION 33 05 13
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SECTION 33 31 00 - SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary sewerage piping.
2. Pipe markers.
4. Bedding and cover materials.

B. Related Requirements:

1. Section 03 31 30 - Concrete, Materials and Proportioning.
2. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
5. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
6. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this Section.
7. Section 31 23 16.3 - Trenching: Execution requirements for trenching required by this Section.
8. Section 31 23 23 - Fill: Requirements for backfill to be placed by this Section.

1.2 DEFINITIONS

A. Bedding: Fill placed under, beside, and directly over pipe, prior to subsequent backfill operations.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 10 LB Rammer and an 18 IN Drop.

B. ASTM International:

2. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
6. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft³ (600 kN-m/m³).
7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft³ (2,700 kN-m/m³).
16. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. American Water Works Association:
1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
3. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.

1.4 COORDINATION
A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

1.5 PRE-INSTALLATION MEETINGS
A. Section 01 30 00 - Administrative Requirements: Requirements for pre-installation meeting.

1.6 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer information indicating pipe material to be used and pipe accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Indicate special procedures required to install specified products.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.7 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record locations of pipe runs, connections, manholes, catch basins, cleanouts, and invert elevations including videotapes provided by the Contractor to the Owner and Engineer.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.8 QUALITY ASSURANCE


C. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SANITARY SEWERAGE PIPING

A. Ductile-Iron Pipe:

1. Manufacturers:
   a. As specified in Section 40 05 19.

2. Ductile Iron Pipe Materials:
a. As specified in Section 40 05 19.
3. Fittings: Ductile iron.
4. Joints:
   a. Rubber gasket joint devices.
   b. Comply with AWWA C111.

2.2 MANHOLES
   A. As specified in Section 33 05 13.

2.3 MATERIALS
   A. Bedding and Cover:
      2. Cover: Fill as specified in Section 31 05 16 - Aggregates for Earthwork.
      3. Soil Backfill from Above Pipe to Finish Grade:
         a. Soil as specified in Section 31 05 13 - Soils for Earthwork.
         b. Subsoil with no rocks over 6 IN in diameter, frozen earth, or foreign matter.

2.4 MIXES
   A. Grout: As specified in Section 33 01 30.62 - Manhole Grout Sealing.

2.5 ACCESSORIES
   A. Pipe Markers and Trace Wire: As specified in Section 10 14 00.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
   B. Verify that trench cut or excavation base is ready to receive Work.
   C. Verify that excavations, dimensions, and elevations are as indicated on Drawings.
3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Correct over-excavation with coarse aggregate.

C. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

D. Protect and support existing sewer lines, utilities, and appurtenances.

E. Utilities:
   1. Maintain profiles of utilities.
   2. Coordinate with other utilities to eliminate interference.
   3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION:

A. Bedding:
   2. Place bedding material at trench bottom.
   3. Level materials in continuous layer not exceeding 6 IN.
   4. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Piping:
   1. Install pipe, fittings, and accessories according to SSWSMC, and seal joints watertight.
   2. Lay pipe to slope gradients as indicated on Drawings.
   3. Maximum Variation from Indicated Slope: 1/8 IN in 10 FT.
   4. Polyethylene pipe encasement in accordance with AWWA C105 shall be installed with all ductile-iron pipe.
   5. Install bedding and haunching per trench detail shown on Drawings and per SSWSMC.
   7. Do not displace or damage pipe when compacting.
   8. Connect to building sanitary sewer outlet and municipal sewer system.

C. Install Site sanitary sewage system piping to within 5 feet of building, and connect to building sanitary waste system.

D. Manholes:
   1. Excavate for manholes as specified in Section 31 23 16 - Excavation.
   2. Form bottom of excavation clean and smooth, and to correct elevation.
3. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
4. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.

E. Mount lid and frame level in grout, secured to top cone section to indicated elevation. Sanitary Lateral Installation.
   1. Construct laterals from wye or tee branch to terminal point at right-of-way or where indicated on Drawings.
   2. Where depth of main pipeline warrants, construct riser type laterals from wye or tee branch.

F. Connection to Existing Structures:
   1. The existing structure shall be inspected by the Engineer prior to connection.
   2. All connections shall be cored. “Breaking-In” to a structure will not be permitted.
   3. Rebar shall be cut to a smooth finish. Damaged rebar shall be replaced.
   4. Seal pipe connections with non-shrink concrete grout.

G. Backfill

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Request inspection by Engineer prior to and immediately after placing bedding.

C. Testing:
   1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
   2. Perform testing on site sanitary sewerage piping (pressurized and gravity) at the Contractor’s expense in accordance with the pipe material Specification Section.
   3. If piping material does not specify testing standards, perform testing on site sanitary sewerage system at the Contractor’s expense in accordance with Standard Specifications for Water and Sewer Main Construction in Illinois (SSWSMC), Section 31-1.11 and City of St. Charles Standards. The sewer shall meet the requirements of the following:
      a. Low Pressure Air Test, per SSWSMC 31-1.13C.
      b. Deflection Test (flexible pipe), per SSWSMC 31-1.13D.
   4. All tests must be conducted in the presence of the Owner’s representative and Engineer.
   5. Contractor shall televis all new sanitary sewers. Prior to televising the Contractor must completely fill all line segments with water from a hydrant. Filling the sanitary sewer with upstream effluent shall not be permitted. The Contractor shall furnish one copy of the televising DVD to the Engineer for review.
   6. Frequency of Tests: As directed by Engineer.
3.5 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 31 00
SECTION 33 34 00 - SANITARY UTILITY SEWERAGE FORCE MAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Force mains.
   2. Bedding and cover materials.

B. Related Requirements:
   1. Section 03 31 30 – Concrete, Materials and Proportioning.
   2. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
   3. Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.
   4. Section 31 05 13 - Soils for Earthwork: Soil backfill from above pipe to finish grade.
   5. Section 31 05 16 - Aggregates for Earthwork: Aggregate for pipe bedding and cover.
   7. Section 31 23 23 - Fill: Requirements for fill over underground pipe markers.
   8. Section 33 31 00 - Sanitary Utility Sewerage Piping: Connections to sanitary sewerage system.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10 LBS) Rammer and a 457-mm (18 IN) Drop.

B. American Water Works Association:
   1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
   4. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
   5. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 12 In. (100 mm through 300 mm), for Water Transmission and Distribution.

C. ASTM International:
   2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft³.
7. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. Ductile Iron Pipe Research Association (DIPRA):


1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with connection to existing municipal sewer utility service.

1.4 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Requirements for pre-installation meeting.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer information indicating pipe material used, pipe accessories, valves and restrained joint details and materials.
C. Shop Drawings:
   1. Indicate piping piece numbers and locations.
   2. Indicate restrained joint locations.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for restrained joints, including establishing lengths of restrained joint piping required.
F. Manufacturer Instructions: Indicate special procedures required to install specified products.
G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
H. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record invert elevations and actual location of pipe runs and connections.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Design ductile-iron pipe restrained joints according to DIPRA standards.

B. Perform Work according to the Standard Specifications for Road and Bridge Construction in Illinois, Current Edition (IDOT) standards.

C. Perform Work in accordance with Standard Specifications for Water and Sewer Main Construction in Illinois (SSWSMC), Current Edition

D. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

C. Licensed Professional: Professional Engineer experienced in design of specified Work and licensed In City of St. Charles in State of Illinois.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:
   1. Store materials according to manufacturer instructions.
   2. Do not place materials on private property without written permission of property owner.
3. Do not stack pipe higher than recommended by pipe manufacturer.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Store gaskets for mechanical and push-on joints in cool and dry location, out of direct sunlight, and not in contact with petroleum products.
3. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 FORCE MAIN

A. Ductile-Iron Pipe:
1. Manufacturers:
   a. As specified in Section 40 05 19.
2. Ductile Iron Pipe Materials:
   a. As specified in Section 40 05 19.

B. Ductile-Iron Fittings:
1. As specified in Section 40 05 19.

C. Joints:
1. As specified in Section 40 05 19.
2. Rubber Gaskets, Lubricants, Glands, Bolts, and Nuts: Comply with AWWA C111.

D. Pipe Markers and Trace Wire: As specified in Section 10 14 00.

2.2 MATERIALS

A. Bedding and Cover:
2. Cover: Fill as specified in Section 31 05 16 - Aggregates for Earthwork.
3. Soil Backfill from above Pipe to Finish Grade: Soil as specified in Section 31 05 13 - Soils for Earthwork.
4. Subsoil: No rocks more than 6 IN in diameter, frozen earth, or foreign matter.
2.3 MIXES

A. Grout: As specified in Section 33 01 30.62.

2.4 ACCESSORIES

A. Underground Pipe Markers:
   1. Plastic Ribbon Tape:
      a. Brightly colored, continuously printed.
      b. Minimum 6 IN wide by 4 mil thick.
      c. Manufactured for direct burial service.
   2. Trace Wire:
      a. Electronic detection materials for nonconductive piping products.
      b. Unshielded, 10 AWG, THWN-insulated copper wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that trench cut or excavation base is ready to receive Work.

C. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Correct over-excavation with coarse aggregate.

C. Remove large stones or other hard matter capable of damaging pipe or of impeding consistent backfilling or compaction.

3.3 INSTALLATION

A. Bedding:

2. Place bedding material at trench bottom.
3. Level materials in continuous layers not exceeding 6 IN in depth.
4. Maintain optimum moisture content of bedding material to attain required compaction density.
B. Piping:
   1. Install pipe, fittings, and accessories as indicated on Drawings.
   2. Route piping in straight line.
   3. Install bedding and haunching per trench detail shown on drawings and per SSWSMC.
   4. Backfilling and Compacting:
      a. As specified in Section 31 23 16.13 - Trenching.
      b. Do not displace or damage pipe while compacting.
   5. Connect to municipal sewer system.
   6. Pipe Markers: As specified in Section 10 14 00- Utility Identification.

C. Thrust Restraints:
   1. Provide pressure pipeline with restrained joints or concrete thrust blocking at bends, tees, and changes in direction.
   2. Construct concrete thrust blocking as indicated on Drawings.
   3. Refer to City of St. Charles Thrust Block Detail in the plans.

3.4 FIELD QUALITY CONTROL
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
   B. Inspections: Request inspection by Engineer prior to and immediately after placing bedding.
   C. Pressure Testing:
      1. Pressure testing of the main shall be completed in accordance with Standard Specifications for Water and Sewer Main Construction in Illinois (SSWSMC), Current Edition and AWWA C600 at the greater of either 150 psi or twice the operating pressure.
         a. Deflection Test (flexible pipe), per SSWSMC 31-1.13D.
      2. Contractor shall be responsible for providing all equipment, labor and materials required to complete pressure testing of the water main.
      3. Contractor shall be responsible for all costs associated with repeated testing attempts.
   D. Compaction Testing:
      2. Testing Frequency: As directed by Engineer.

3.5 PROTECTION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
   B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 34 00
SECTION 33 51 00 - NATURAL GAS DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Valves.
   3. Pressure-regulating valves.
   4. Propane storage tanks.
   5. Underground pipe markers.

B. Related Requirements:
   1. Section 03 31 30 – Concrete, Materials and Proportioning.
   2. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
   3. Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.
   4. Section 09 96 00 – High – Performance Coatings.
   5. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
   7. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this Section.
   8. Section 31 23 16.13 - Trenching: Execution requirements for trenching required by this Section.
   9. Section 31 23 23 - Fill: Requirements for backfill to be placed by this Section.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg Rammer and a 457-mm Drop.

B. American Society of Mechanical Engineers:
   1. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
   2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
   3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   5. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
   6. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 175 psi (Sizes NPS 1/2 through NPS 2.
   8. ASME Section VIII - Division 1, Boiler and Pressure Vessel Code (BPVC): Rules for Construction of Pressure Vessels.

C. American Water Works Association:
   1. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

D. American Welding Society:
   1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

E. ASTM International:
   11. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

F. NFPA:

1.3 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Requirements for pre-installation meeting.

1.4 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Product Data: Submit manufacturer information on pipe materials, pipe fittings, valves, and accessories.
C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of pipe mains, valves, connections, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Welding Materials and Procedures: Comply with ASME BPVC Section IX and applicable state regulations.

B. Comply with NFPA 54, NFPA 58, ASME B31.8.

C. Perform Work according to applicable code and local gas company requirements.

D. Perform Work according to Owner’s Engineering standards.

E. Maintain 1 copy of each standard affecting Work of this Section on Site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Deliver and store valves in shipping containers with labeling in place.

D. Store materials according to manufacturer instructions.

E. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.
1.8 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. PE Pipe and Fittings in Section 40 05 31 - Thermoplastic Process Pipe.
B. Steel Pipe in Section 40 05 23.

2.2 VALVES

A. Up to 2 IN: 150 psig WOG, bronze body, bronze tapered plug, non–lubricated, Teflon packing, threaded ends with cast iron curb box, cover, and key.
B. Over 2 IN: 125 psig WOG, Cast iron body and tapered plug, non–lubricated, Teflon packing, threaded ends, with cast iron curb box, cover, and key.
C. Furnish valves with manufacturer's name and pressure rating marked on valve body.

2.3 PRESSURE-REGULATING VALVES

A. Valves: Single stage, malleable iron body, corrosion–resistant, pressure regulator with atmospheric vent, elevation compensator; with threaded ends for 2 IN and smaller, flanged ends larger than 2 IN.
B. Furnish valves with manufacturer's name and pressure rating marked on valve body.
C. Capacity: Inlet and outlet gas pressures, specific gravity, and flow rate as indicated on Drawings.

2.4 MATERIALS

A. Bedding and Cover:
   2. Cover: Fill as specified in Section 31 05 16 - Aggregates for Earthwork.
   3. Soil Backfill from Above Pipe to Finish Grade: Soil Type as specified in Section 31 05 13 - Soils for Earthwork.
B. Subsoil: No rocks more than 6 IN in diameter, frozen earth, or foreign matter.
2.5 ACCESSORIES

A. Underground Pipe Markers:
   1. Plastic Ribbon Tape: See Section 10 14 00 – Utility Identification
   2. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Natural Gas Service" in large letters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that building service connection and utility gas main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

C. Bevel plain end ferrous pipe, 2-1/2 IN in diameter and larger. Thread ferrous pipe, 2 IN in diameter and smaller.

D. Remove scale and dirt on inside and outside of piping before assembly.

E. Prepare piping connections with flanges, threading, and unions.

F. Correct over-excavation with coarse aggregate.

G. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 INSTALLATION

A. Excavation and Bedding:
   2. Place bedding material at trench bottom.
   3. Level fill materials in continuous layers not exceeding 6 IN in depth, and compact to 95 percent maximum density.
4. Backfill around sides and to top of pipe with cover fill, tamp in place, and compact to 95 percent maximum density.
5. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Piping:
1. Main Maintain at least 5 FT of horizontal separation and 2 FT of vertical separation from all other utilities.
2. Route piping in straight line.
3. Install piping to conserve space and to not interfere with use of Site space.
4. Install piping to allow for expansion and contraction without stressing pipe or joints, as approved by Architect/Engineer.
5. Install valves and other fittings as indicated on Drawings.
6. Establish elevations of buried piping with not less than 24 IN of cover in non-traveled areas, and 48 IN of cover in driveways and parking areas.
7. Lay pipe on bedding.
8. Wrap couplings and fittings of steel pipe with polyethylene tape and heat-shrink over pipe.
9. Backfill trench in accordance with Section 31 23 18 - Site Backfilling.
10. Do not displace or damage pipe while compacting.
11. Pipe Markers:
   a. Install plastic ribbon tape trace wire continuous over top of pipe. Plastic ribbon tape shall be in accordance with Section 10 14 00 – Utility Identification
12. Valve Boxes:
   a. Center and plumb valve boxes over valves.
   b. Set box cover flush with finished ground surface.
   c. Prevent shock or stress from being transmitted through valve box to valve.
   d. Paint valves and valve boxes with rust-inhibitive primer and one coat of epoxy paint.

C. Service Connections:
1. Install sleeve in foundation wall for gas service main, and seal enlarged sleeve watertight.
2. Anchor service main to interior surface of foundation wall.
3. Install service regulator adjacent to building wall as indicated on Drawings.
4. Install pressure-regulating valve and riser pipe as to prevent undue stress upon service pipe.
5. For plastic service pipe, use steel pipe riser from below ground to regulator.
6. Install regulator vent with rain- and insect-proof opening, terminating away from building openings.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Compaction testing will be performed in accordance with ASTM D1557.

C. Gas lines will be pressure tested in accordance with standards set forth by natural gas provider.
D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

1. Frequency of Tests: As directed by Engineer.

END OF SECTION 33 51 00
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DIVISION 40

PROCESS INTERCONNECTIONS
SECTION 40 05 06 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe pressure testing.
   2. Cleaning, disinfection and purging.
   3. Pipe penetrations.
   4. Restrained joints.

B. Related Requirements:
   1. Section 07 92 00 - Joint Protection.
   2. Section 09 96 00 - High Performance Industrial Coatings.
   3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
   4. Section 40 05 19 - Ductile Iron Process Pipe.
   5. Section 40 05 31 - Thermoplastic Process Pipe.
   6. Section 40 05 51 - Common Requirements for Process Valves.

1.2 DEFINITIONS

A. FM: Factory Mutual Insurance Company; FM Global is the communicative name of the company.

B. WH: Warnock Hersey; indicates compliance to relevant building codes, association criteria, and product safety and performance standards.

1.3 REFERENCE STANDARDS

A. American Water Works Association (AWWA):
   1. C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

B. American Welding Society (AWS):
   1. D1.1/D1.1M - Structural Welding Code - Steel.

C. ASME International (ASME):
   2. B31.3 - Process Piping.
   3. B31.9 - Building Services Piping.
4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding, Brazing, and Fusing Qualifications.

D. ASTM International:
1. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

E. Expansion Joint Manufacturers Association, Inc.:
1. EJMA Standards.

F. NSF International:
1. 61 - Drinking Water System Components - Health Effects.
2. 372 - Drinking Water System Components - Lead Content.

G. UL:
2. 1479 - Fire Tests of Through-Penetration Firestops.

1.4 COORDINATION
A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with installation of valves and equipment.

1.5 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data:
   1. Submit manufacturer catalog information for each specified product.
   2. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
C. Shop Drawings:
   1. Identification:
a. Submit list of wording, symbols, letter size, and color coding for pipe identification.


2. Indicate restrained joint details and materials.
3. Submit layout Drawings showing piece numbers and location, indicating restrained joint locations.
4. Indicate layout of piping systems, including flexible connectors, expansion joints and compensators, loops, offsets, and swing joints.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.7 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.
B. Perform Work according to ASME B31.9 for installation of piping systems and according to ASME BPVC-IX for welding materials and procedures.
C. Perform Work according to ASME B31.3, ASME B31.9 and applicable code for installation of piping systems.
D. Through-Penetration Firestopping of Fire-Rated Assemblies shall be in full compliance with Section 07 84 00 - Firestopping.
E. Through-Penetration Firestopping of Non-fire-rated Floor and Roof Assemblies shall be in full compliance with Section 07 92 00 - Joint Sealant.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.
C. Welders: ASME qualified within previous 12 months for employed weld types.
D. Licensed Professional: Professional Engineer experienced in design of specified Work and licensed in State of Illinois.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
1.10 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish manufacturer's standard warranty for items covered under this specification section.

PART 2 - PRODUCTS

2.1 PIPE PRESSURE TESTING

A. Pipe Testing - General:
   1. Test piping systems as follows:
      a. Test exposed, non-insulated piping systems upon completion of system.
      b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
      c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
      d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
   2. Utilize pressures, media and pressure test durations as specified in Piping Specification Schedules.
   3. Isolate equipment which may be damaged by the specified pressure test conditions.
   4. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
      a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
      b. Notify the Engineer 24 HRS prior to each test.
   5. Completely assemble and test new piping systems prior to connection to existing pipe systems.
   6. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
   7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:
1. Testing medium: Unless otherwise specified in the Piping Specifications, utilize the following test media.

   a. Process and plant air systems:
      1) 2 IN and smaller, tested at 75 psi or less: Air or water.
      2) 2 IN and smaller, tested at greater than 75 psi or less: Water.
      3) Greater than 2 IN, tested at 3 psi or less: Air or water.
      4) Greater than 2 IN, tested at greater than 3 psi: Water.

   b. Natural gas systems: Cylinder nitrogen.

   c. Liquid systems:
      1) Up to and including 48 IN gravity systems, tested at 25 psig or less: Air or water.
      2) Above 48 IN gravity systems, tested at 25 psig or less: Water.
      3) All sizes of pumped systems, tested at 250 psig or less: Water.

2. Allowable leakage rates:

   a. Hazardous gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test.

   b. Hydrostatic exfiltration and infiltration for sanitary and stormwater sewers (groundwater level is below the top of pipe):
      1) Leakage rate: 200 GAL per inch diameter per mile of pipe per day at average head on test section of 3 FT.
      2) Average head is defined from groundwater elevation to average pipe crown.
      3) Acceptable test head leakage rate for heads greater than 3 FT: Acceptable leakage rate (gallons per inch diameter per mile per day) = 115 x (actual test head to the 1/2 power).

   c. Hydrostatic infiltration test for sanitary and stormwater sewers (groundwater level is above the top of pipe):
      1) Allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 6 FT.
      2) Leakage rate at heads greater than 6 FT: Allowable leakage rate (gallons per inch diameter per mile of pipe per day) = 82 x (actual head to the 1/2 power).

   d. Large diameter (above 48 IN) gravity plant piping systems shall have a maximum exfiltration of 25 gpd per inch-mile.

   e. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5 percent of the specified test pressure throughout the duration of the test.

   f. For low pressure (less than 25 psig) air testing, the acceptable time for loss of 1 psig of air pressure shall be:

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3. Hydrostatic pressure testing methodology:
   a. General:
      1) All joints, including welds, are to be left exposed for examination during
         the test.
      2) Provide additional temporary supports for piping systems designed for
         vapor or gas to support the weight of the test water.
      3) Provide temporary restraints for expansion joints for additional pressure
         load under test.
      4) Isolate equipment in piping system with rated pressure lower than pipe
         test pressure.
      5) Do not paint or insulate exposed piping until successful performance of
         pressure test.
   b. Soil, waste, drain and vent systems:
      1) Test at completion of installation of each stack or section of piping by
         filling system with water and checking joints and fittings for leaks.
      2) Eliminate leaks before proceeding with work or concealing piping.
      3) Minimum test heights shall be 10 FT above highest stack inlet.

4. Natural gas systems - testing methodology:
   a. Maintain specified test pressure until each joint has been thoroughly examined
      for leaks by means of soap suds and glycerine.
   b. Wipe joints clean after test.

5. Air testing methodology:
   a. General:
      1) Assure air is ambient temperature.
   b. Low pressure air testing:
      1) Place plugs in line and inflate to 25 psig.
      2) Check pneumatic plugs for proper sealing.
      3) Introduce low pressure air into sealed line segment until air pressure
         reaches 4 psig greater than ground water that may be over the pipe.
         a) Use test gage conforming to ASME B40.100 with 0 to 15 psi scale
            and accuracy of 1 percent of full range.
         4) Allow 2 minutes for air pressure to stabilize.
5) After stabilization period (3.5 psig minimum pressure in pipe) discontinue air supply to line segment.
6) Record pressure at beginning and end of test.

C. Dielectric Testing Methods and Criteria:

1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

2.2 CLEANING, DISINFECTION AND PURGING

A. Cleaning:

1. Clean interior of piping systems thoroughly before installing.
2. Maintain pipe in clean condition during installation.
3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
   a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
   b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
6. After erection of piping and tubing, but prior to installation of service outlet valves, blow natural gas systems clear of free moisture and foreign matter by means of air, nitrogen or carbon dioxide.
   a. Oxygen shall never be used.

B. Purging Natural Gas and Digester Gas:

1. Existing piping:
   a. Turn off gas supply.
   b. Vent line pressure outdoors.
   c. If section exceeds the following, then remaining gas shall be displaced with an inert gas.
      1) 50 FT for 2-1/2 IN pipe.
      2) 30 FT for 3 IN pipe.
      3) 15 FT for 4 IN pipe.
      4) 10 FT for 6 IN pipe.
      5) Any length for 8 IN or larger pipe.

2. New piping:
   a. Including but not limited to:
      1) All fuel gas piping.
      2) Digesters.
      3) Digester gas equipment.
4) Fuel gas trains.
b. Purge air filled system with fuel gas:
   1) Providing piping length is less than:
      a) 30 FT for 3 IN pipe.
      b) 15 FT for 4 IN pipe.
      c) 10 FT for 6 IN pipe.
      d) Any length for 8 IN and larger pipe.
   2) Providing a moderately rapid and continuous flow of fuel gas is introduced.
      a) Introduce fuel gas at one (1) end.
      b) Vent air at opposite end.
   3) Provided fuel gas flow is continuous without interruption until vented gas is free of air.
   4) The point of discharge shall not be left unattended during purging.
   
c. If the piping is 3 IN or larger and exceeds lengths stated above.
   1) Purge air with inert gas in accordance with NFPA 54 and NFPA 69.
   2) Purge inert gas with fuel gas.

3. Discharge of purged gases:
   a. Open end of piping shall not discharge into confined spaces or areas where there are sources of ignition.

2.3 PIPE PENETRATIONS

A. As specified in Section 01 73 20 - Openings and Penetrations in Construction.

2.4 RESTRAINED JOINTS

A. As specified in associated piping Sections.

2.5 COMPONENTS AND ACCESSORIES

A. Insulating Components:
   1. Dielectric flange kits:
      a. Flat faced.
      b. 1.8 IN thick dielectric gasket, phenolic, non-asbestos.
      c. Suitable for 175 psi, 210 Degrees F.
      d. 1/32 IN wall thickness bolt sleeves.
      e. 1/8 IN thick phenolic insulating washers.
   2. Dielectric unions:
      a. Screwed end connections.
      b. Rated at 175 psi, 210 DegF.
      c. Provide dielectric gaskets suitable for continuous operation at union rated temperature and pressure.
   3. Dirt Strainers:
      a. Y-type.
      b. Composition bronze.
      c. Rated for test pressure and temperature of system in which they are installed.
      d. 20 mesh Monel screen.
e. Threaded bronze plug in the blow-off outlet.
f. Threaded NPT end connections.

4. Strainers for Chemical Applications:
   a. Y-type.
   b. Strainers of same material, test pressure and temperature rating as system in which strainer is placed.

5. Reducers:
   a. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.
   b. Connection size requirements may change from those shown on Drawings depending on equipment furnished.

6. Underground Warning Tape:
   a. See Section 10 14 00 - Identification Devices.

7. Pressure Gauges:
   a. See Section 40 73 13 - Pressure and Differential Pressure Gauges.

8. Dry Disconnect Couplings:
   a. Adapters:
      1) Male adapters: Size shown on Drawings.
      2) Adapters:
         a) Female NPT end connection for sludge and flush applications.
         b) Male NPT end connection for chemical applications.
      3) Construct adapters for sludge applications from cast iron or steel.
      4) Construct adapters for chemical and PVC system applications 3 IN and below from polypropylene. Above 3 IN shall be stainless steel.
   b. Couplers:
      1) Built-in valve and spring-loaded poppet which close automatically when disconnected.
      2) Designed to remain with only one (1) arm locked in closed position.
      3) Construct couplers for sludge applications fabricated from material utilized for adapters.
      4) Construct couplers for chemical and PVC system applications 3 IN and less from polypropylene with stainless steel arms and pins. Above 3 IN shall be stainless steel or material compatible with chemical or PVC system.
   c. Dust caps: For all adapters.

9. Sacrificial Anode Cathodic Protection:
   a. 3 LBS magnesium sacrificial anodes, prepackaged in a cloth bag containing 75 percent hydrated gypsum, 20 percent bentonite, and 5 percent anhydrous sodium sulphate.
   b. TW 600 V or an HMWPE insulated copper lead attached to the anode.

2.6 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Section 09 96 00 - High Performance Coatings.

2.7 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
1. Provide shop inspection and testing of completed assemblies.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Drawings.

C. Inspect existing flanges for nonstandard bolt-hole configurations or design and verify that new pipe and flanges mate properly.

D. Verify that openings are ready to receive sleeves and firestopping.

E. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 IN from pipe ends.

F. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Cleaning: Thoroughly clean end connections before installation.

C. Close pipe and equipment openings with caps or plugs during installation.

D. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to ASME B31.3.

B. Coating: Finish piping appurtenances as specified in Section 09 96 00 - High Performance Industrial Coatings for service conditions.

C. Pipe Penetrations: Install pipe penetrations as specified in Section 01 73 20 – Openings and Penetrations in Construction.

D. Restrained Joints: As specified in associated piping Sections.
3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep equipment interior clean as installation progresses.

END OF SECTION 40 05 06
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SECTION 40 05 07 - PROCESS PIPE SUPPORT SYSTEMS

PART 1  GENERAL

1.1 SUMMARY

A. Section Includes: Pipe support and anchor systems for Process Piping.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 15 19 - Anchorage to Concrete.
   4. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
   2. ANVIL International (ANVIL).
   3. ASTM International (ASTM):
      e. A917, Standard Specification for Steel Sheet, Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface (General Requirements).
      a. D1.1, Structural Welding Code - Steel.
   5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. SP-69, Pipe Hangers and Supports - Selection and Application.

B. Responsibility:
   1. Contractor shall design support systems for 12 IN DIA piping and smaller, and for larger diameter piping where supports are not shown on the Drawings.
   2. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.
   3. General piping support details may be indicated on the Drawings in certain locations for pipe smaller than 12 IN DIA.
4. Contractor shall incorporate those details with requirements of this Specification Section to provide the piping support system.

C. Each type of pipe hanger or support shall be the product of one manufacturer.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
      d. Scaled Drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
      e. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
      f. Support systems for piping systems over 12 IN DIA, systems operating over 100 psig or systems operating over 200 DegF designed by the Contractor: Submit detail design calculations and scaled Drawings prepared and signed by a registered Professional Engineer in the state of Illinois.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 00.

2.2 MANUFACTURED UNITS

A. General:
   1. Galvanized components:
      a. Electro-galvanized components:
         1) Bar, forged or cast fabrications: ASTM B633, SC4.
         2) Rolled sheet fabrications: ASTM A917 and ASTM A918, 50N50NU.
      b. Hot-dipped galvanized components: See Specification Section 05 50 00.
   2. Dissimilar metals protection:
      a. Galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
      b. All other galvanized-to-dissimilar metal connections: Neoprene or nylon pads, shims, grommets, etc.

B. Hanger Rods:
   1. Material:
      a. Stainless Steel.
   2. Continuously threaded.
3. Load limit:

<table>
<thead>
<tr>
<th>NOMINAL ROD DIAMETER</th>
<th>MAXIMUM SAFE LOAD, (LBS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 IN DIA (min)</td>
<td>610</td>
</tr>
<tr>
<td>1/2 IN DIA</td>
<td>1,130</td>
</tr>
<tr>
<td>5/8 IN DIA</td>
<td>1,810</td>
</tr>
<tr>
<td>3/4 IN DIA</td>
<td>2,710</td>
</tr>
<tr>
<td>7/8 IN DIA</td>
<td>3,770</td>
</tr>
<tr>
<td>1 IN DIA</td>
<td>4,960</td>
</tr>
</tbody>
</table>

C. Hangers:
1. Hangers for use directly on copper pipe: Copper or cadmium plated.
2. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized.
3. Hanger type schedule:

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>PIPE SIZE</th>
<th>HANGER TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>All except noted</td>
<td>4 IN and less</td>
<td>ANVIL Figure 108 with Figure 114</td>
</tr>
<tr>
<td>All except noted</td>
<td>Over 4 IN</td>
<td>ANVIL Figure 590</td>
</tr>
<tr>
<td>Steam, condensate and hot water</td>
<td>All</td>
<td>ANVIL Figure 181, Figure 82</td>
</tr>
<tr>
<td>Service in chemical storage areas and as indicated on drawings for corrosion resistance</td>
<td>All</td>
<td>CorPro CP - Hanger or equal</td>
</tr>
</tbody>
</table>

D. Concrete Inserts for Hanger Rods:
1. Continuous slots: Unistrut #P1000.
2. Individual inserts: ANVIL Figure 281.
3. See Specification Section 03 15 19, mechanical anchors.

E. Beam Clamps for Hanger Rods:
1. Heavy duty.
2. ANVIL Figure 134.

F. Trapeze Hangers for Suspended Piping:
1. General:
   b. Angles, channels, or other structural shapes.
   c. Curved roller surfaces at support point corresponding with type of hanger required.
2. In chemical storage and feed areas and as indicated on the drawings:
   a. Materials: FRP.
   b. Unistrut fiberglass channel or equal.

G. Vertical Pipe Supports:
1. At base of riser.
2. Lateral movement:
   a. Clamps or brackets:
1) ANVIL Figure 261.

H. Expanding Pipe Supports:
   1. Spring hanger type.
   2. MSS SP-58.

I. Pipe Support Saddle:
   1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
   2. ANVIL Figure 264.

J. Pipe Support Risers:
   1. Schedule 40 pipe.
   2. Stainless Steel.
   3. Size: As recommended by saddle manufacturer.

K. Pipe Support Base Plate:
   1. 4 IN larger than support.
   2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
   3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
   4. Collar welded to floor plate.
   5. Edges ground smooth.

L. Pipe Covering Protection Saddle:
   1. For insulated pipe at point of support.
   2. ANVIL Figure 167, Type B.

M. Wall Brackets:
   1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
   2. ANVIL Figure 199.

N. Pipe Anchors:
   1. For locations shown on the Drawings.
   2. 1/4 IN steel plate construction.
   4. Designed to prevent movement of pipe at point of attachment.

O. Pipe Guides:
   1. For locations on both sides on each expansion joint or loop.
   2. To ensure proper alignment of expanding or contracting pipe.
   3. ANVIL Figure 256.

2.3 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.
   1. Provide 5 to 1 safety factor.
B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.3.
   2. MSS SP-58 and MSS SP-69.
   3. Except where modified by this Specification.

E. For steam and hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.1.
   2. MSS SP-58 and MSS SP-69.

F. Check all physical clearances between piping, support system and structure.
   1. Provide for vertical adjustment after erection.

G. Support vertical pipe runs in pipe chases at base of riser.
   1. Support pipes for lateral movement with clamps or brackets.

H. Place hangers are to be installed on outside of pipe insulation.
   1. Use a pipe covering protection saddle for insulated pipe at support point.
   2. Insulated piping 1-1/2 IN and less:
      a. Provide a 9 IN length of high density perlite or high density calcium silicate at saddle.
      b. See Specification Section 40 42 00.
   3. Insulated piping over 1-1/2 IN: Provide a 12 IN length of high density perlite or high density calcium silicate at saddle.

I. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.

J. Pipe Support Spacing:
   1. General:
      a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
      b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
      c. Provide at least one (1) support for each length of pipe at each change of direction and at each valve.
   2. Steel, stainless steel, cast-iron, ductile iron pipe support schedule:

<table>
<thead>
<tr>
<th>PIPE SIZES - IN</th>
<th>MAXIMUM SPAN - FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 and less</td>
<td>5</td>
</tr>
<tr>
<td>2 thru 4</td>
<td>10</td>
</tr>
</tbody>
</table>
### PIPE SIZES - IN
<table>
<thead>
<tr>
<th></th>
<th>MAXIMUM SPAN - FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 thru 8</td>
<td>15</td>
</tr>
<tr>
<td>10 and greater</td>
<td>20</td>
</tr>
</tbody>
</table>

3. Copper pipe support schedule:

<table>
<thead>
<tr>
<th>PIPE SIZES - IN</th>
<th>MAXIMUM SPAN - FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2 and less</td>
<td>5</td>
</tr>
<tr>
<td>3 thru 6</td>
<td>10</td>
</tr>
<tr>
<td>8 and greater</td>
<td>15</td>
</tr>
</tbody>
</table>

4. PVC pipe support schedule:

<table>
<thead>
<tr>
<th>PIPE SIZES - IN</th>
<th>MAXIMUM SPAN - FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/4 and less</td>
<td>3</td>
</tr>
<tr>
<td>1-1/2 thru 3</td>
<td>4</td>
</tr>
<tr>
<td>4 and greater</td>
<td>5</td>
</tr>
</tbody>
</table>

* Maximum fluid temperature of 120 DegF.

5. Support each length and every fitting:
   a. Bell and spigot piping:
      1) At least one (1) hanger.
      2) Applied at bell.
   b. Mechanical coupling joints:
      1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.

6. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.

7. Provide continuous support for nylon tubing.

8. For PVC, FRP and copper piping:
   a. Provide Unistruct Unicushion wrap of pipe at each support.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.
B. Weld Supports:
   1. AWS D1.1.
   2. Weld anchors to pipe in accordance with ASME B31.3.

C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

D. Inspect Hangers for:
   1. Design offset.
   2. Adequacy of clearance for piping and supports in the hot and cold positions.
   3. Guides to permit movement without binding.
   4. Adequacy of anchors.

E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

F. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
   1. Install concrete inserts as concrete forms are installed.

G. Welding:
   2. Integral attachments:
      a. Include welded-on ears, shoes, plates and angle clips.
      b. Ensure material for integral attachments is of good weldable quality.
   3. Preheating, welding and post-heat treating: ASME B31.3, Chapter V.

H. Field Painting: Comply with Specification Section 09 96 00.

END OF SECTION
SECTION 40 05 19 - DUCTILE IRON PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ductile iron pipe and fittings.
2. Accessories.

B. Related Requirements:

1. Section 09 96 00 - High-Performance Coatings.
2. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
3. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping.
4. Section 40 05 51 - Common Requirements for Process Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

2. ASME B31.3 - Process Piping Design.

B. ASTM International:


C. American Water Works Association:

1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
8. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.

D. The Society for Protective Coatings:

1. SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning.
1.3 COORDINATION
   A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
   B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
   B. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.
   C. Shop Drawings: Submit under provisions of Section 01 33 00 and include the following:
      1. Certified Dimensional Drawings of all valves, fittings and appurtenances.
      2. Certified Dimensional Drawings of joints showing the manufacturer’s allowable deflections.
      3. Copies of the manufacturer’s approved installation instructions for the types of joints being used.
      4. For pipe 42 IN DIA and larger, lay schedules that indicate the type of pipe, fitting, or special, and the location and the direction of each of these components in the completed line shall be provided. In addition, the lay schedule shall include: The pipe stationing at all changes in grade or horizontal alignment; all elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained joints, or of concrete encasement.

1.5 MAINTENANCE MATERIAL SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
   B. Tools: Furnish any special devices required for Owner to maintain fittings and appurtenances.

1.6 QUALITY ASSURANCE
   A. Perform Work according to manufacturer’s standards.
   B. Maintain a copy of each standard affecting the Work of this Section on-Site.
   C. Inspection: All pipe shall be subject to inspection at the place of manufacture, in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.
   D. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with requirements as applicable.
   E. Test Costs: Manufacturer shall perform said material tests at no additional cost to the Owner. Engineer shall have the right to witness all testing conducted by the Manufacturer.
F. Affidavits: Contractor shall submit affidavits of compliance from the Manufacturer for the following:
1. Ductile iron pipe is in accordance with the requirements of AWWA C151 and these specifications.
2. Cement–mortar lining of ductile iron pipe, appurtenances and fittings is in accordance with the requirements of AWWA C104 and these Specifications.
3. If specified, polyethylene encasement for ductile iron piping is in accordance with AWWA C105.
4. The grooved coupling manufacturer's factory trained representative shall provide on–site training for contractor’s field personnel in the use of grooving tools, application of groove, and installation of grooved joint products (A distributor’s representative is not considered qualified to conduct the training). The manufacturer’s representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
5. Rubber gasket joints for ductile iron pressure pipe and fittings is in accordance with the requirements of AWWA C111 and these Specifications.
6. Charpy impact testing of ductile iron used in the manufacture of pipe shall be performed in accordance with AWWA C151. The minimum corrected absorbed energy shall be 7 FT/LBS at 70 DegF +10 DegF.
7. Low–temperature impact tests shall be made from at least 10 percent of the test pipe to assure compliance. The minimum corrected absorbed energy shall be 3 FT/LBS at –40 DegF.
8. Affidavits of compliance shall be certified by a registered Professional Engineer.

1.7 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

1.9 EXISTING CONDITIONS
A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.
PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE AND FITTINGS

A. Manufacturers:
3. Clow Water Systems Co. – Coshocton, Ohio.
5. McWane Cast Iron Pipe Co. – Birmingham, Alabama.
8. Substitutions: Specified in Section 01 60 00 – Product Requirements.

B. Piping:
1. Diameter and Class: As indicated on Drawings.
2. Furnishing and installation of Ductile Iron Pipe and all appurtenances, complete in place, all in accordance with the requirements of the Contract Documents. Where standards, specifications or methods are cited without dates, the reference shall be construed to apply to the latest revision in effect at the time of contract.
3. Standards: Ductile iron pipe shall conform to AWWA C151, subject to the following supplemental requirements. The pipe shall be of the diameter and class shown on the plans, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all appurtenances and fittings shall be provided as required under the Contract Documents.
4. Laying Lengths: Pipe laying lengths shall be provided in 20 FT nominal lengths with allowable trim pipe lengths in accordance with AWWA C151 and special shorter lengths provided as required by the Drawings.
5. The class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer’s mark, country where cast, year in which the pipe was produced, and the letters “DI” or “Ductile” shall be stamped on the pipe.
6. Pipe Design Parameters: All ductile iron pipe shall be designed and manufactured in accordance with AWWA C150 and AWWA C151, respectively, for the following minimum operating conditions:
   a. The minimum internal design pressure shall be 150 psi with a 100 psi surge allowance, with a safety factor of 2.0 for a total internal design pressure of 500 psi. No reduction of safety factor for transient pressures shall be allowed.
   b. The thickness design of ductile iron pipe shall be in accordance with AWWA C150.
   c. The external loads design criteria shall be a minimum of 36 IN depth of cover at 120 pcf soil weight and live load based on one AASHTO H20 load.
   d. The horizontal deflection of cement: Mortar lined ductile iron pipe resulting from external load conditions shall not exceed 3 percent of the pipe diameter.
e. The pipe trench, per AWWA C150, for design purposes shall be:
   1) Laying condition Type 5 – Pipe bedded to its centerline in compacted granular material, 4 IN minimum under pipe. Compacted granular or select material to top of pipe (Approximately 90 percent Standard Proctor, AASHTO T99).

f. For purposes of restrained joint calculations per the Ductile Iron Pipe Research Association (DIPRA) method, the soil classification as described in “Thrust Restraint Design for Ductile Iron Pipe”, Current Edition, for both the native trench soil and also the backfill soil to surround the pipe shall be considered to be cohesive–granular.

7. Minimum Pipe Class: Ductile iron pipe shall conform to AWWA C151. All pipe shall have a minimum pressure rating as indicated below, or higher ratings as indicated in the Contract Documents:

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter (IN)</th>
<th>Pressure Class (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 12</td>
<td>350</td>
</tr>
<tr>
<td>14 to 20</td>
<td>250</td>
</tr>
<tr>
<td>24</td>
<td>200</td>
</tr>
<tr>
<td>30 to 64</td>
<td>150</td>
</tr>
</tbody>
</table>

C. Joints:

1. Pressure Rating: As indicated on Drawings.
2. General: Ductile Iron Pipe and fittings shall be furnished with:
   a. Below Grade: Push–on joints, push–on restrained joints, or mechanical joints.
   b. Above Grade: Flanged or grooved-end joints as indicated on Drawings.
3. Mechanical Joints:
   a. Acceptable Manufacturers:
      1) EBAA Iron, Inc. – Eastland, Texas – Series 1100 MEGALUG.
      2) Product substitutions allowed per Section 01 60 00 – Product Requirements.
   b. Design:
      1) Restraint devices for nominal pipe sizes 3 through 48 IN shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.
      2) Devices shall have a working pressure rating of 350–psi for 3 to 16 IN and 250 psi for 18 to 48 IN pipe. Ratings are for water pressure must include a minimum safety factor of 2.0 for all sizes.
   c. Material:
      1) Gland body, wedges and wedge actuating components shall be cast from grade 65–45–12 ductile iron material in accordance with ASTM A536.
      2) Ductile iron gripping wedges shall be heat treated within a range of 370 to 470 BHN.
      3) Three (3) test bars shall be incrementally poured per production shift as per Underwriter’s Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8.
4) Chemical and nodularity tests shall be performed as recommended by the Ductile Iron Society, on a per ladle basis.

d. Coating System:
1) All wedge assemblies and related parts shall be processed through a phosphate wash, rinse and drying operation prior to coating application. The coating shall consist of a minimum of two coats of a liquid fluoropolymer coating with heat cure to follow each coat.
2) All casting bodies shall be surface pretreated with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance.

e. Traceability:
1) An identification number consisting of year, day, plant and shift shall be cast into each gland body.
2) All physical and chemical test results shall be recorded such that they can be accessed via the identification number on the casting. These Material Traceability Records (MTR’s) are to be made available, in hard copy, to the purchaser that requests such documentation and submits his gland body identification number.

4. Push-on Joints:

a. Push–on joints shall conform to AWWA C111.
b. Gasket material shall be as shown on the plans and/or as designated GASKET MATERIAL SCHEDULE shown below.
c. The pressure rating for push–on joints shall be a minimum of 350 psi or the specified pressure rating of the pipe, whichever is less.
d. Standard allowable joint deflection for push–on type pipe shall be:

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter (IN)</th>
<th>Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 30</td>
<td>5°</td>
</tr>
<tr>
<td>36</td>
<td>4°</td>
</tr>
<tr>
<td>42 to 64</td>
<td>3°</td>
</tr>
</tbody>
</table>

5. Restrained Joints:

a. AWWA C111.
b. Restrained joints shall be boltless, push–on restrained devices and shall be provided by the same manufacturer supplying the pipe.
c. Gasket material shall be as shown on the plans and/or as designated GASKET MATERIAL SCHEDULE shown below.
d. Restrained joints and restrained joint pipe shall be rated for the minimum pressure shown in specified pressure rating of the pipe.
e. Manufacturer shall furnish test results showing that restrained joints in the sizes specified have been successfully tested to at least twice the specified pressure rating of the joint without leakage or failure.
   1) Tests shall be performed on pipe with nominal metal thickness less than or equal to that specified for the project

6. Flanged Joints:

   a. AWWA C110.
   b. Pipe for 4 to 54 IN flanged pipe thread–fabrication shall be Special Thickness Class 53 in accordance with AWWA C115.
   c. Threaded companion flanges for ductile iron pipe shall be ductile iron in accordance with AWWA C115. Bolt circle and bolt holes match those of ANSI B16.1 class 125 and ANSI B16.5 class 150 flanges.
   d. The flanges shall be rated for at least 250 psi working pressure.
   e. The threaded flanges shall be individually fitted and machine tightened on the pipe ends.
   f. Bolts, gaskets and installation shall be in accordance with AWWA C115 (Appendix A) requirements.
   g. Flanged gaskets shall be NSF 61 certified gaskets and shall be full face NSF 61 certified design for all service installations. Gaskets for flanged ductile iron pipe must not have the larger inside diameters provided by the requirements of ANSI B16.21.
   h. Flange facing shall be smooth or with shallow serrations per AWWA C115.

D. Fittings:

1. Fittings shall be ductile iron in accordance with AWWA C110, AWWA C153, or AWWA C606, latest revisions.
2. Cement-mortar lining, AWWA C104;
   a. Fittings shall have linings identical to the pipe to which they are connected.
3. Outside Coating:
   a. Buried Service: Asphaltic; 0.001 in thick.
   b. Exposed Service: As specified in Section 09 96 00 – High Performance Industrial Coatings.
4. Pressure Rating:
   a. Buried Service Fittings:
      1) Fittings, sizes 4 to 24 IN, with push–on, restrained push–on, or mechanical joints shall be rated for 350 psi working pressure.
      2) Fittings, sizes 30 to 64 IN, with push–on, restrained push–on, or mechanical joints shall be rated for 250 psi working pressure.
   b. Aboveground Service Fittings:
      1) Fittings, sizes 4 to 64 IN, with flanged joints shall be rated for 250 psi working pressure.
      2) Flanged joints for 12 IN and smaller sizes may be rated for 350 psi when used with NSF 61 certified gaskets.
5. Gray Iron Fittings:
   a. Cement-mortar lining; standard thickness.

6. Flanged Fittings:
   a. Flange fittings shall be ductile iron in accordance with AWWA C110 or AWWA C153.
   b. Bolt circle and bolt holes match those of ANSI B16.1 Class 125 and ANSI B16.5 Class 150 flanges.
   c. Flanges shall be rated for at least 250 psi working pressure.
   d. Bolts, gaskets and installation shall be in accordance with AWWA C110 or AWWA C115, Appendix A requirements.
   e. Flanged gaskets shall be NSF 61 certified and shall be full face NSF 61 certified design for all service installations. Gaskets for flanged ductile iron pipe must not have the larger inside diameters provided by the requirements of ANSI B16.21.

2.2 FINISHES

A. Cement-Mortar Lining:

1. Cement–Mortar Lining for Shop Application:
   a. Except for sanitary sewers that drain by gravity and as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings and appurtenances shall be cleaned and lined in the shop with a standard thickness cement–mortar lining applied in conformity with a Portland cement mortar meeting the requirements of AWWA C104.
   b. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be repaired or replaced with lining conforming to these Specifications.

2. Lining Thickness:
   a. The minimum lining thickness shall be as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter (IN)</th>
<th>Nominal Lining Thickness (IN)</th>
<th>Tolerance, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 10</td>
<td>3/16</td>
<td>-1/16, +1/8</td>
</tr>
<tr>
<td>12 to 20</td>
<td>1/4</td>
<td>-1/16, +1/8</td>
</tr>
<tr>
<td>24 to 64</td>
<td>5/16</td>
<td>-1/16, +3/16</td>
</tr>
</tbody>
</table>
3. Seal Coat Cement–Mortar Lining:

a. Ductile iron pipe shall be internally lined with cement–mortar lining in accordance with AWWA C104, by a high speed, centrifugal process. The quality system of the manufacturer shall be registered to an ISO 9000 quality standard by an accredited registrar. Grinding of linings shall not be allowed. The finished cement lining shall be uniformly smooth. In addition to complying with AWWA C104, the linings shall also comply with the following additional requirements:

1) Material: The cement used shall be a Portland cement. Sand shall consist of inert, hard, strong and durable silica grains. The water used in the cement mortar shall be potable, and free from injurious quantities of organic matter, alkali, salt or other impurities that might reduce the strength, durability or other desirable qualities of the lining. All material in contact with water shall be certified to meet the requirements of ANSI/NSF Standard 61. The cement mortar shall contain not less than one part of cement to two parts of sand, by volume.

2) Lining Thickness: Cement lining thicknesses shall be per AWWA C104 at the thicknesses shown in 2.7.B.1.

3) Surface Preparation: All surfaces to be mortar lined shall be cleaned as necessary to remove foreign matter that could interfere with the adherence of the cement mortar or protrude through the lining.

4) Lining Equipment and Process: Linings shall be manufactured using centrifugal pipe rotational equipment capable of sufficient rotation speed to sustain 60 G to 100 G of compaction force. Simultaneous controlled vibration shall be applied to the pipe during high–speed rotation to produce a lining of such high density and firm compaction that the laitance can be washed from the surface of the lining immediately after consolidation. Upon request, the Manufacturer shall submit an affidavit of compliance certified by a registered Professional Engineer that the linings have been applied according to these specifications. The mortar shall be mixed in batches. The amount of cement and sand entering into each batch shall be measured by weight. The quantity of mixing water entering into each batch shall be measured automatically by an adjustable device, or it shall be otherwise measured to ensure that the correct quantity of water is being added.

5) Washing and Finish: After the mortar has been distributed, the rotational speed and vibration shall be increased to produce a mortar lining with a uniformly smooth, firm surface. Immediately after lining, the surface of the lining shall be flushed with a large volume of water to remove excess laitance.

6) Curing: Cement–mortar linings shall be lined and stored in a building with controlled atmosphere for a minimum of 18 HRS. Linings shall be furnished standard with seal coat.

7) Repairs: All repairs of handling or other damage shall be made in accordance with the recommendations of the Manufacturer and shall be reasonably smooth and may not project into the waterway.
B. Ceramic Epoxy Lining for Gravity Sanitary Sewer Installations:

1. Ceramic Epoxy Lining:
   a. Condition of Ductile Iron Prior to Surface Preparation:
      1) All Ductile Iron pipe and fittings shall have a high build protective lining on
         the interior and a bituminous coating on the exterior except that the
         bituminous coating shall not be applied to the first 6 IN of the exterior of the
         spigot ends.
      2) All ductile pipe and fittings shall be delivered to the application facility
         without asphalt, cement lining or any other lining on the interior surface.

2. Lining Material:
   a. Lining material must be a high build multi–component Amine cured Novalac
      Epoxy lining. Any request for substitution must meet the following criteria and be
      accompanied by:
      1) The permeability rating when tested according to Method A of ASTM E96–66
         (Procedure A) with a test duration of 42 days as reported by an
         independent laboratory.
      2) A statement from the manufacturer of the submitted material attesting to the
         fact that a least 20 percent of the volume of the lining contains ceramic
         quartz pigment.
      3) A laboratory report containing test data for Immersion in Acids, Bases, and
         Deionized Water at elevated temperatures using ASTM D714–56 (1974) for
         the rating method. The report should also contain data on ASTM D2794
         Direct Impact and ASTM–G 53–77 Moisture and Ultraviolet Light
         Exposure.
      4) A statement concerning re-coatability and repair to the lining.

3. Application:
   a. Applicator: The lining shall be applied by a competent firm with a successful
      history of applying linings to the interior of Ductile Iron pipe and fittings.
   b. Surface Preparation: Prior to abrasive blasting, the entire area that will receive the
      protective compound shall be inspected for oil, grease, etc. Any areas where oil,
      grease, or any substance that can be removed by solvent is present shall be solvent
      cleaned using the guidelines outlined in SSPC–1 Solvent Cleaning. After the
      surface has been made free of grease, oil or other substances, all areas to receive
      the protective compounds shall be abrasive blasted using compressed air nozzles
      with sand or grit abrasive media. The entire surface to be lined shall be struck with
      the blast media so that all rust, loose oxides, etc., are removed from the surface.
      Only slight stains and tightly adhering annealing oxide may be left on the surface.
      Any area where rust reappears before coating must be re–blasted to remove all
      rust.
4. Lining:
   a. After the surface preparation and within 8 hours of surface preparation, the interior pipe shall receive 40 mils dry film thickness of the protective lining. No lining shall take place when the substrate or ambient temperature is below 40 DegF. The surface also must be dry and dust free. If flange fittings of pipe are included in the project, the linings must not be used on the face of the flange; however, full–face gaskets must be used to protect the ends of the pipe. All fittings shall be lined with 40 mils of the protective lining. The 40 mils system shall not be applied in the gasket grooves.

5. Coating of Gasket and Spigot Ends:
   a. Due to the tolerances involved, the gasket area and spigot end up to 6 IN back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum of the epoxy lining compound. This coating shall be applied by brush to ensure coverage. Care should be taken that the coating is smooth without excess buildup in the gasket groove or on the spigot end. All materials for the gasket groove and spigot end shall be applied after the application of the lining.

6. Number of Coats:
   a. The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The time between coats shall never exceed that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely re–coatable with itself without roughening of the surface.

7. Touch–Up/Repair:
   a. Lining material shall be capable of being used for field touch–up or repair. Procedures for touch–up or repair shall be in accordance with manufacturer's recommendations.

8. Inspection/Certification:
   a. All Ductile Iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC–PA–2 Film Thickness Rating.
   b. The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test.
   c. Each pipe joint and fitting shall be marked with the date of application of the lining system and with its numerical sequence of application on that date.
   d. The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this Specification, and that the material used was as specified, and that the material was applied as required by the specification.
C. Outside Coating:

1. Buried: The exterior of ductile iron pipe, special, and fittings shall be coated with a 1–mil asphaltic coating in accordance with AWWA C151, Section 51–9.
2. Exposed: As specified in Section 09 96 00 – High Performance Industrial Coatings.

2.3 ACCESSORIES

A. Jackets:

1. Polyethylene Encasement:

   a. All underground ductile iron pipe, fittings, valves and appurtenances shall be protected from corrosion with a polyethylene encasement installed in accordance with ANSI/AWWA C105/A21.5.
   b. Polyethylene wrap in tube form for piping encasement shall be manufactured from virgin polyethylene material conforming to the requirements of ASTM D1248. A linear low–density polyethylene film shall be used to encase the pipe.

   1) Film Thickness: 4 mils, minimum.

B. Gaskets:

1. Unless called out specifically on the plans, the following schedule shall be used for determining the various gasket compounds for push–on and mechanical joints.

   a. Potable Water, Non–Potable Water and Wastewater:

      1) Buried: Plain Rubber/Styrene Butadiene (SBR).
      2) Exposed: Neoprene/Polychloroprene (CR).

   b. Ketones, Dilute Acids and Alkalis, Vegetable Oil, Alcohols with Outdoor Exposure or Air:

      1) Ethylene Propylene (EPDM).

   c. Non–Aromatic Hydrocarbons, Petroleum Oil, Hydraulic Fluids, Fuel Oil, Fats, Oil and Grease:

      1) Buna–N/Nitrile.

   d. Aromatic Hydrocarbons, Gasoline, Refined Petroleum Products, most Chemicals and Solvents, High Temperature or Air:

      1) Flororelastomer/Fluorel/Viton (FKM).

C. Flange Adapters:

1. Acceptable Manufacturers:

   a. Only in locations indicated on the plans or approved by the Engineer, flange adapters are to be provided in accordance with the following specifications.

      1) EBAA Iron – Eastland, Texas – Series 1200 Flange.
      3) Substitutions allowed per Section 01 60 00 – Product Requirements.

2. Flange adapters are only permitted in locations shown on the plans or approved by the Engineer. The use of flange adapters in any other location is prohibited. Flange adapters found to be used in locations not shown on the plans or approved by the Engineer shall be replaced with flanged pipe at the Contractor’s expense.

   a. Contractor will be responsible for all costs associated with the removal of the unauthorized flange adapters, including Engineering labor and any other labor deemed necessary to address the situation.
b. No additional time extension will be granted for the replacement of the pipe.

3. Fabrication:
   a. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
   b. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
   c. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6 IN gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
   d. The flange adapter shall have a safety factor of 2:1 minimum.
   e. Wedges must be contoured to fit pipe and mechanically retained in pockets.
   f. Pressure Ratings (Minimum 2:1 safety factor in all sizes):
      1) 350 psi for 4 to 16 IN nominal sizes.
      2) 250 psi in 18 to 36 IN nominal sizes.
   g. Units must be UL listed and FM approved.

4. Coating:
   a. All wedge assemblies and related parts shall be processed through a phosphate wash, rinse and drying operation prior to coating application. The coating shall consist of a minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat.
   b. All casting bodies shall be surface pretreated with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance.
   c. The coating system shall be MEGA-BOND by EBAA Iron, Inc. or approved equal.

D. Dielectric Fittings: Provide between dissimilar metals.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Owner Inspection: Make completed materials available for inspection at manufacturer's factory prior to packaging for shipment. Owner inspections will be at the Owner's discretion, and will be paid for by the Owner and coordinated by the Contractor. Notify Owner at least seven days before inspection is allowed.

C. Owner Witnessing: Allow witnessing of factory inspections and test at manufacturer's test facility. Owner witnessing will be at the Owner’s discretion, and will be paid for by the Owner and coordinated by the Contractor. Notify Owner at least seven days before inspections and tests are scheduled.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Drawings.

C. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Thoroughly clean pipe and fittings before installation.

C. Surface Preparation:
   1. Touch up shop-primed surfaces with primer as specified in Section 09 96 00 – High Performance Industrial Coatings.
   2. Solvent-clean surfaces that are not shop primed.
   3. Clean surfaces to remove loose rust, mill scale, and other foreign substances as specified in Section 09 96 00 – High Performance Industrial Coatings; prime surface as specified in Section 09 96 00 – High Performance Industrial Coatings.

3.3 INSTALLATION

A. Buried Service:
   1. Install ductile iron pipe, fittings, valves and appurtenances specified herein and elsewhere in the project documents in complete conformance with Manufacturer’s installation instructions.
   3. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer’s written installation instructions. Grooved ends shall be clean and free from indentations and projections in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.
4. Split–Sleeve Couplings Joints – The Contractor shall inspect each coupling to insure that there are no damaged portions of the coupling. Particular attention should be paid to the sealing pad / sealing plate area. Before installation, each coupling shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times. Wrenches used shall be of a size and type recommended by the manufacturer. Bolts and studs shall be tightened so as to secure a uniform gasket compression between the coupling and the body of the pipe with all bolts or studs tightened approximately the same amount. Final tightening shall be done by hand (no air impact wrenches) and is complete when the coupling is in uniform contact around the circumference of the pipe.

   a. In no case shall the deflection in the joint between the pipe ends exceed the maximum deflection recommended by the manufacturer. No joint shall be misfit any amount that would be detrimental to the strength and water tightness of the finished joint.

5. Installation of Polyethylene Encasement:


B. Exposed Service:

1. Run piping straight along alignment indicated on Drawings with minimum number of joints.
2. Install according to ASME B31.3.
3. Fittings:
   a. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
   b. Install fittings according to manufacturer's instructions.
   c. All bolts to be treated with anti-sieze prior to installation.
   d. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer's recommendations.

4. Provide required upstream and downstream clearances from devices as indicated.

C. Make taps to ductile iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.

D. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

E. Support piping as specified in Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

F. Provide expansion joints as specified in Section 40 05 06 - Couplings, Adapters and Specials for Process Piping and pipe guides as specified in Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment to compensate for pipe expansion due to temperature differences.

G. Field Cuts: According to pipe manufacturer's recommendations.
H. Finish primed surfaces according to Section 09 96 00 – High Performance Industrial Coatings.
   1. All bolt threads are to be protected from paint.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.

B. Laying Tolerances: Install pipe to indicated elevation within tolerance of 5/8 IN.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by the Engineer. Repair damaged piping, or provide new undamaged pipe.

C. Repairing field-damaged areas of epoxy-lined pipe and fittings:
   1. Remove burrs caused by field cutting of ends or handling damage and smooth out the edge of the lining if rough.
   2. Remove all traces of oil, grease, asphalt, dust, dirt, etc.
   3. Remove any damaged lining caused by field cutting operations or handling and clean any exposed metal by sanding or scraping. Sandblasting or power tool cleaning roughening is also acceptable. It is recommended that any loose lining be removed by chiseling, cutting, or scraping into well adhered lined area before patching. Be sure to overlap at least 1” of lining in the area to be repaired.
   4. With the area to be sealed or repaired, absolutely clean and suitably roughened, apply a coat of epoxy lining using the following procedure:
      a. Mix the material that will be used to make the repair per the manufacturer’s instructions.
      b. Application of Material: After the material has been thoroughly mixed, it can be applied to the prepared surface by brush. Brushing is usually best, due to the fact that the areas are usually small.
      c. It is important to coat the entire freshly cut exposed metal surface of any cut pipe ends. To ensure proper sealing, overlap at least 1 IN of the lining with the repair material.

D. Pressure Testing:
   1. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping: Pipe Pressure Testing; Cleaning, Disinfection and Purging.
   2. Test Pressure: Not less than 125 psig.
   3. Conduct hydrostatic test for minimum 2 HRS.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements specifies requirements for cleaning.
B. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping: Cleaning, Disinfection and Purging.

C. Keep pipe interior clean as installation progresses.

D. Clean pipe interior of soil, grit, loose mortar, and other debris after pipe installation.

END OF SECTION 40 05 19
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SECTION 40 05 31 - THERMOPLASTIC PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe, valves, tube, and fittings.
2. Polyethylene (PE) pipe, tube, and fittings.
3. Accessories for plastic piping and fittings.
4. High Density Polyethylene Pipe Restraints.

B. Related Requirements:

1. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping.
3. Section 40 05 51 - Common Requirements for Process Valves.
4. Section 40 05 63 - Ball Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
4. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges.
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
7. ASME B31.3 - Process Piping Guide.

B. ASTM International:

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
5. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
15. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
27. ASTM F1290 - Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.

C. American National Standards Institute / National Sanitation Foundation:

D. American Water Works Association:
2. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
3. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 IN (100 mm) Through 63 IN (1,600 mm), for Water Distribution and Transmission.

1.3 COORDINATION
A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
   B. Coordinate Work of this Section with equipment installation.

1.4 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.
   C. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, and materials lists.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.7 QUALITY ASSURANCE
A. Maintain one copy of each standard affecting the Work of this Section on-Site.

1.8 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.
   B. Manufacturer: Company listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.
   C. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.
1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

1.10 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Temperature: Do not install pipe when temperature is below 40 DegF or above 90 DegF if pipe is exposed to direct sunlight.

C. Ultraviolet (UV) Protection: Provide pipe installed above ground or outside with UV protection.

1.11 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PVC PIPE, VALVES, TUBE, AND FITTINGS

A. PVC Pipe and Fittings:

1. Pipe: PVC, Type 1, Grade 1, Schedule 80 according to ASTM D1785; ASTM D2241, SDR-26 for 160-psig pressure rating, calculated according to ASTM D2837.

2. Fittings:
   a. Exposed service: Solvent welded socket type for service indicated on Drawings complying with ASTM D2467.
   b. Buried service: Solvent welded socket type for service indicated on Drawings complying with ASTM D2466.

3. Joints:
   a. Exposed service: Solvent welded for service indicated on Drawings with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
   b. Buried service: Solvent welded for service indicated on Drawings.

4. Materials: ASTM D1784, minimum cell classification 12545-C.

5. Coating:
   a. Exposed: Paint per Section 09 96 00 – High-Performance Coatings.
   b. Buried: None.
B. PVC Valves:

1. Furnish valves, appurtenances, and accessories as specified in Section 40 05 06 - Couplings, Adapters and Specials for Process Piping, as described in Section 40 05 63 – Ball Valves, and as specified by valve type in Division 40 - Process Integration.
   a. Furnish shutoff and drain valves at locations as indicated on Drawings, according to this Section.
   b. Install shutoff and isolation valves; isolate equipment, part of systems, or vertical risers as indicated on Drawings.
   c. Install valves for throttling, bypass, or manual flow-control services as indicated on Drawings.
   d. Install ball valves in all systems for shutoff service.
2. Seals shall be compatible with the chemical being pumped.

C. PVC Tube and Fittings:

1. Tube:
   a. Clear.
   b. Size and Wall Thickness: Size as indicated on Drawings, minimum 1/8 IN wall thickness.
   c. Pressure Rating: Minimum equal to that of associated feed system rating.

2. Fittings: Compression type; materials suitable for service indicated on Drawings.

2.2 PE PIPE AND FITTINGS

A. Polyethylene Pipe: ASTM D2513, SDR 11.5

B. Fittings: Socket fusion or butt fusion fittings complying with ASTM D2683 and ASTM D3261.

C. Joints:

1. Mechanical or Compression fit.
2. Fusion jointing system or as directed by local gas company.

2.3 ACCESSORIES

A. PVC Piping:

1. Solvent Cement: ASTM D2564; primers according to ASTM F656.

B. High Density PE Pipe Restraint

1. For use in restraining HDPE pipe to AWWA fittings, valves and similar appurtenances.
   a. Series 2000PV Mechanical Joint Restraint
      1) 2004 PV: Rated 160 psi.
      2) 2006 PV: Rated 160 psi.
2. Pipe must be manufactured in accordance with AWWA Standard ANSI/AWWA C906 with respect to size.

3. Operating pressure is limited to the pressure rating of the pipe, de-rated as appropriate for service temperature.

4. Pipe systems must be designed to compensate for thermal expansion/contraction.

5. Products are intended for use in underground service only.

6. MEGA-BOND Coating System.

7. Internal pipe stiffeners must be used. Stiffener length must be sufficient to fully encompass the area of the pipe being restrained.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Drawings.

C. Inspect existing flanges for nonstandard bolt-hole configurations or design, and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Ream pipe ends. Remove burrs.

C. Thoroughly clean pipe and fittings before installation.

D. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. Run piping straight along alignment indicated on Drawings with minimum number of joints.
B. Install piping and components according to ASME B31.3.

C. Fittings:
   1. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
   2. Install fittings according to manufacturer's instructions.
   3. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer's recommendations.

D. Provide required upstream and downstream clearances from devices as indicated.

E. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

F. Support exposed piping as specified in Section 40 05 07 – Process Pipe Support Systems.

G. Provide expansion joints as specified in Section 40 05 06 - Couplings, Adapters and Specials for Process Piping and pipe guides as specified in Section 40 05 07 – Process Pipe Support Systems to compensate for pipe expansion due to temperature differences.

H. Disinfection: Disinfect potable water piping as specified in Section 40 05 06 - Couplings, Adapters and Specials for Process Piping.

I. Field Cuts: According to pipe manufacturer's recommendations.

J. Joining:
   1. The systems will be installed with the fewest number of underground joints as possible.
   2. Perform heat joining according to ASTM D2657.
   3. Perform electrofusion joining according to ASTM F1290.
   5. PVC Solvent-Cemented Joints: ASTM D2855.

K. Underground Piping:
   1. Install sanitary sewer piping as specified in Section 33 31 00 – Sanitary Utility Sewerage Piping.
   2. Install sanitary sewer force main piping as specified in Section 33 34 00 – Sanitary Utility Sewerage Force Mains.
   3. Install natural gas piping in accordance with NFPA, local gas company regulations, codes and local ordinances, complete with necessary appurtenances.
      a. Install buried pipe at approximately 30 IN deep.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.

B. Laying Tolerances: As specified in Section 33 31 00 – Sanitary Utility Sewerage Piping and Section 33 34 00 – Sanitary Utility Sewerage Force Mains.
3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by the Engineer. Repair damaged piping, or provide new, undamaged pipe.

C. After installation, inspect for proper supports and interferences.

D. Pressure Testing:
   1. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping: Pipe Pressure Testing; Cleaning, Disinfection and Purging.
   2. Test Pressure: 125 psig.
   3. Conduct hydrostatic test for at least 2 HRS.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements specifies requirements for cleaning.

B. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping: Cleaning, Disinfection and Purging.

C. Keep pipe interior clean as installation progresses.

D. Clean pipe interior of soil, grit, shavings, and other debris after pipe installation.

END OF SECTION 40 05 31
SECTION 40 05 51 - COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valves.
2. Valve actuators.

B. Related Requirements:

1. Section 03 31 30 - Concrete, Materials and Proportioning.
2. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
4. Section 09 96 00 - High Performance Industrial Coatings.
5. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping.
7. Section 40 05 93 - Common Motor Requirements for Process Equipment.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
3. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International:

1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

C. Manufacturers Standardization Society:

1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges, and Unions.

D. National Electrical Manufacturers Association:

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

E. NFPA:

1. NFPA 70 - National Electrical Code (NEC).
F. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:
   1. Equipment Directory.

1.3 COORDINATION
   A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
   B. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Product Data:
      1. Manufacturer information for actuator with model number and size indicated.
      2. Valve cavitation limits.
      3. Acknowledgement that products submitted meet requirements of standards referenced.
      4. Manufacturer’s installation instructions.
      5. Valve pressure and temperature rating.
      7. Special linings.
      8. Valve dimensions, class and weight.
      10. Quantity of valves and operators.
      11. Indicator attachments.
      12. Wiring and control diagrams for electric or cylinder actuators.
      13. Test reports.

1.5 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.6 QUALITY ASSURANCE
   A. Maintain clearances as indicated on Drawings.
   B. Ensure that materials of construction of wetted parts are compatible with process liquid.
   C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.
D. Perform Work according to manufacturer’s standards.

E. Maintain a copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Licensed Professional: Professional Engineer experienced in design of specified Work and licensed in State of Illinois.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish manufacturer's standard warranty for valves and actuators.

PART 2 - PRODUCTS

2.1 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required. All valves of the same type shall be supplied by the same manufacturer.

B. Valve Ends:

1. Compatible with adjacent piping system. Refer to valve schedule.

2. Comply with the following standards:
   b. Flanged: ANSI B16.1 Class 125 unless otherwise noted or AWWA C207.
   c. Bell and spigot or mechanical (gland) type: AWWA C111.
e. Grooved: Rigid joints per Table 5 of AWWA C606.

C. Operation:

1. Open by turning counterclockwise; close by turning clockwise.
2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

D. Valve Marking and Labeling:

1. Marking: Comply with MSS SP-25.
2. Labeling: As specified in Section 10 14 00 - Identification Devices and valve schedule.
3. Provide buried valves with valve boxes, covers, and extensions:
   a. Extension kits shall be installed to raise the valve and valve box to grade.
   b. Valve box shall be Tyler 6850 Series – Screw Type or approved equal and have a valve box stabilizer installed, which shall be Valve Box Adaptor #2 Type A, as manufactured by Adaptor, Inc. or approved equal.
   c. Center and plumb valve box over valve. Set box cover flush with finished grade.

E. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
2. Bonnets:
   a. Screwed, or flanged to body and of same material and pressure rating as body.
   b. Furnish glands, packing nuts, or yokes as specified in valve Sections.
3. Stems and Stem Guides:
   a. Materials and Seals: As specified in valve Sections.
   c. Space stem guides: 10 FT OC.
   d. Submerged Stem Guides: Type 304 stainless steel.
4. Nuts and Bolts:
   a. Wetted or internal to be bronze or stainless steel. Exposed to be zinc or cadmium plated.

2.2 VALVE ACTUATORS

A. Provide actuators with position indicators for shutoff valves 6 IN and larger.

B. Comply with AWWA C542.

C. Provide chain actuators for shutoff valves mounted 5 FT above floor level.

D. Provide gear and power actuators with position indicators.
E. Counter clockwise opening as viewed from the top.

F. Gear-Assisted Manual Actuators:
   1. Provide totally enclosed gears.
   2. Maximum Operating Force: 60 LBS/FT.
   4. Packing: Accessible for adjustment without requiring removal of actuator from valve.

G. Chain Actuator:
   1. Description: Chain guides and hot-dip galvanized operating chain extending to 3 FT above floor level.
   2. Chain Wheels: Sprocket-rim type.
   3. Furnish chain storage if chains may interfere with pedestrian traffic.

H. Buried Actuators:
   1. Provide screw or slide type adjustable cast iron valve box, 5 IN minimum diameter, 3/16 IN minimum thickness and identifying cast iron cover.
   2. Box base to enclose buried valve gear box or bonnet.
   3. Provide 2 IN standard actuator nuts complying with Section 3.16 of AWWA C500.
   4. Provide at least two tee-handle keys for actuator nuts, with 5 FT extension between key and handle.
   5. Extension stem shall be provided for buried valves, extended to within 6 IN of finish grade.
   6. Provide concrete pad encasement of valve box as shown for all buried valves unless shown otherwise.

I. Exposed Manual Actuators:
   1. Provide for all exposed valves not having electric or cylinder actuators.
   2. Provide handwheels for gate and globe valves, sized for valves in accordance with AWWA C500.
   3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 IN and smaller.
      a. Lever actuators for butterfly valves shall have a minimum of 5 intermediate lock positions between full open and full close.
      b. Provide at least two levers for each type and size of valve furnished.
   4. Gear actuators required for plug valves, butterfly valves and ball valves 4 IN and larger.
   5. Provide gearing for gate valves 20 IN and larger in accordance with AWWA C500.
   6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
   7. Provide chain actuators for valves 6 FT or higher from finish floor to valve centerline.
      a. Cadmium-plated chain looped to within 3 FT of finish floor.
      b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without “gagging” the wheel.
   8. Provide cast iron floor stands where shown on Drawings. Stands to be furnished y valve manufacturer with actuator. Stand or actuator to include thrust bearings for valve operation and weight of accessories.

J. Submerged Actuators:
1. The valve actuator shall be mounted on top of an extension bonnet, 3 FT above any adjacent personnel access.
2. The valve and bonnet connection shall be flanged and watertight.
3. Provide a top brace support for the bonnet. Mount the brace 6 IN below the top of wall as shown on the Drawings.
4. Materials:
   a. Extension bonnet: Cast iron ASTM A126 or steel.
   b. Brace and anchor bolts: Type 304 stainless steel.

K. Valve Actuators in NEC Class I, Group D, Division 1 or 2 Hazardous Locations: UL approved.

L. Accessories:
   1. Handwheel:
      a. Furnish permanently attached handwheel for emergency manual operation.
      b. Rotation: None during powered operation.
      c. Permanently affix directional arrow and cast OPEN and CLOSE on handwheel to indicate appropriate direction to turn handwheel.
      d. Maximum Operating Force: 60 LBS/FT.
      e. Positive declutch mechanism to engage and disengage handwheel.
      f. Inoperable motor shall not prevent manual operation.

2.3 FINISHES

A. Valve Lining and Coating: Comply with AWWA C550.

B. ANSI/NSF 61 approved where noted in the Valve Schedule or as required.

C. Exposed Valves: As specified in Section 09 96 00 – High Performance Industrial Coatings.

D. Do not coat flange faces of valves unless otherwise specified.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

C. Owner Inspection:
   1. Make completed valves available for inspection at manufacturer's factory prior to packaging for shipment.
   2. Owner inspections will be at the Owner’s discretion, and will be paid for by the Owner and coordinated by the Contractor.
   3. Notify Owner at least seven days before inspection is allowed.
D. Owner Witnessing:

1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Owner witnessing will be at the Owner's discretion, and will be paid for by the Owner and coordinated by the Contractor.
3. Notify Owner at least seven days before inspections and tests are scheduled.

E. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for installation examination.

B. Verify that piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.

C. For grooved coupling valves, install rigid type couplings.

D. For threaded valves, provide union on one side within 2 FT of valve to allow valve removal.

E. Install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.

F. Coat studs, bolts and nuts with anti-seizing lubricant.

G. Clean field welds of slag and splatter to provide a smooth surface.

H. Install valves with stems upright or horizontal, not inverted.
I. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.

J. Install 3/4 IN ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.

K. Install valves with clearance for installation of insulation and to allow access.

L. Provide access where valves and fittings are not accessible.

M. Setting buried valves:
   1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
   2. Set valves and valve boxes plumb.
   3. Place valve boxes directly over valves with top of box being brought to surface of finished grade.
   4. Install in closed position.
   5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
   6. After installation, backfill up to top of box for a minimum distance of 4 FT on each side of box.

N. Pipe Hangers and Supports: As specified in Section 40 05 07 - Process Pipe Support Systems.

O. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.

P. Valve Applications:
   1. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.
   2. Install shutoff and isolation valves.
   3. Isolate equipment, part of systems, or vertical risers as indicated on Drawings.
   4. Install valves for throttling, bypass, or manual flow control services as indicated on Drawings.
   5. Install valves in sanitary systems for shutoff service.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Adjust valves, actuators and appurtenant equipment to comply with specifications. Operate valve, open and close at system pressures.

D. Valve Field Testing:
   1. Test for proper alignment.
2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.

3. Engineer will witness field testing.

END OF SECTION 40 05 51
SECTION 40 05 62.01 - PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Eccentric plug valves.

B. Related Requirement:

1. Section 40 05 51 - Common Requirements for Process Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.
4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International:

2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

C. American Water Works Association:

1. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

Product Data: Submit catalog information, indicating materials of construction and compliance with indicated standards.
PART 2 - PRODUCTS

2.1 ECCENTRIC PLUG VALVES

A. Manufacturers:

1. DeZurik Water Controls – Sartell, Minnesota.
2. Clow Valve Company – Oskaloosa, Iowa.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description:

1. Valves shall be of the tight closing, resilient faced, non–lubricating variety and shall be of eccentric design such that the valves pressure member (plug) rises off the body seat contact area immediately upon shaft rotation during movement.
2. Valves shall be drip–tight rated pressure (175 psi through 12 IN, 150 psi 14 IN and above) and shall be satisfactory for applications involving throttling service as well as frequent or infrequent on–off service. The valve–closing member should rotate approximately 90 degrees from the full open to full–close position and vice–versa.
3. Maximum Fluid Temperature: 125 DegF.
4. Ports: Rectangular; minimum port area 80 percent of nominal pipe area for valves 3 IN to 20 IN, 70 percent for valves larger than 20 IN.

C. Operation:

1. 6 IN and Smaller: Worm gear manual operators with handwheel, 2 IN square nuts, or chainwheels attached. Refer to valve schedule.
2. Greater than 6 IN: Worm gear manual operators with handwheel or chainwheel attached. Refer to valve schedule.
3. Extended bonnets and worm gears shall be provided on all buried valves. Bonnets shall be extended so that the associated handwheel is at an elevation of 42 IN above finished grade.
4. Furnish chainwheel operators for valves mounted at 5 FT or greater above floor.

D. Materials:

1. Body: AWWA C517, ASTM A126, Class B, cast iron (semi-steel), lined with elastomer as recommended by valve manufacturer for service conditions.
2. Body ends shall be as indicated in the Valve Schedule and shall conform to the following standards:
   a. Flanged with dimensions, facing, and drilling in full conformance with A–ANSI B16.1, Class 125. This includes flange thickness.
   b. Mechanical Joint to meet the requirements of AWWA C111/ANSI A21.11.
   c. Grooved ends to meet the requirements of AWWA C606.
3. Plug: AWWA C517, ASTM A126, Class B, cast iron (semi-steel). The plug shall have a cylindrical seating surface that is offset from the center of the plug shafts. The plug shafts shall be integral. The plug shall be coated with Buna-N, Chloroprene elastomer in all valve sizes. The Rubber to metal bond must withstand 75 LBS. Pull under test procedure ASTM D429 Method B.

4. Seats: Valve seat surface shall be welded-in overlay, cylindrically shaped of not less than 90 percent pure nickel. Seat area shall be a minimum of 0.125 IN thick and 0.500 IN wide.

5. Stem: Type 316 stainless steel.

6. Stem Bearings: Upper and lower, shall be sleeve type metal bearings, sintered, oil impregnated, and permanently lubricated type 316 stainless steel conforming to ASTM A743 Grade CF–8M. Thrust bearings shall be Nylatron or PTFE.

7. Plug valve shaft seals shall be on the multiple V–ring type (Chevron) and shall be adjustable. All packing shall be replaceable without removing the bonnet or actuator and while the valve is in service. Shaft seals shall be made of Buna N.

8. Connecting Hardware: Areas listed as wet or corrosive shall utilize Type 316 stainless steel hardware. All other areas shall utilize carbon steel hardware unless noted otherwise.

E. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Performance Testing: Operate each valve and actuator from fully CLOSED to fully OPEN to fully CLOSED under no-flow conditions.

C. Leakage Testing: Test at indicated working pressure to ensure valves are drip-tight. Test with pressure in both directions for five minutes each way.

D. Hydrostatic Testing: Test for at least one minute to ensure no leakage. Test at twice the rated working pressure. Certified copies of individual tests shall be submitted when requested. Certified copies of proof–of–design tests shall be submitted upon request.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Verify that field dimensions are as indicated on Drawings.

C. Inspect existing flanges for nonstandard bolt-hole configurations or design, and verify that new valve and flange mate properly.
3.2 PREPARATION
A. Section 01 70 00 - Execution and Closeout Requirements.
B. Thoroughly clean valves before installation.
C. Surface Preparation:
   1. Touch up shop-primed surfaces with primer as specified in Section 09 96 00 – High Performance Industrial Coatings.
   2. Solvent-clean surfaces that are not shop primed.
   3. Clean surfaces to remove loose rust, mill scale, and other foreign substances as specified in Section 09 96 00 – High Performance Industrial Coatings.
   4. Prime surfaces as specified in Section 09 96 00 – High Performance Industrial Coatings.

3.3 INSTALLATION
A. Install valves according to AWWA C517 and as recommended by manufacturer.
B. Install plug valves in horizontal piping with stem horizontal; install plug valves in vertical piping with plug at top when closed.
C. Install such that plugs are on top when OPEN and on pressure side when CLOSED.

3.4 FIELD QUALITY CONTROL
A. Section 01 70 00 - Execution and Closeout Requirements.
B. Inspection:
   1. Inspect for damage to valve lining or coating and for other defects that may be detrimental as determined by Engineer.
   2. Repair damaged valve or provide new, undamaged valve.
   3. After installation, inspect for proper supports and interferences.
C. Pressure test valves with piping.

3.5 CLEANING
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
B. Keep valve interior clean as installation progresses.
C. After installation, clean valve interior of soil, grit, loose mortar, and other debris.

END OF SECTION 40 05 62
SECTION 40 05 63 - BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ball valves.
   2. Plastic ball valves.

B. Related Requirements:
   1. Section 40 05 51 - Common Requirements for Process Valves

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
   2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.
   3. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
   5. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International:

C. American Water Works Association:
   1. AWWA C507 - Ball Valves, 6 In. Through 60 In. (150 mm Through 1,500 mm).

D. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit catalog information, indicating materials of construction and compliance with indicated standards.

PART 2 - PRODUCTS

2.1 BALL VALVES

A. Smaller than 4 inches:

2. Operator: Hand lever, AISI 304 with plastic insulator.
4. Stem Packing: PTFE.
5. Thrust Washer: PTFE.
7. Body: ASTM A351 gr. CF8M.
8. Reinforced PTFE seats.
9. Ball: ASTM A351 gr. CF8M.
10. Adaptor: ASTM A351 gr. CF8M.
12. Body Seal: PTFE.

2.2 PLASTIC BALL VALVES

A. Manufacturers:

1. Asahi.
2. Substitutions: Section 01 60 00 - Product Requirements.

B. Description:

1. Working Pressure: 100 psig.
2. Maximum Fluid Temperature: 120 degrees F.
3. Full-size ports.
   a. Less than 6” – True union.
   b. 6” and greater – Flanged.
5. All ball valves in sodium hypochlorite service shall be vented.

C. Operator: Hand lever.

D. Materials:

1. Seats: PTFE.
2. Body: PVC.
4. Carrier: PVC.
5. Connector: PVC.
6. Union Nut: PVC.
8. Handle: ABS.
9. Stem: PVC.
10. Face O-Ring: Viton.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test ball valves according to AWWA C507.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support valves in plastic piping to prevent undue stresses on piping.

END OF SECTION 40 05 63
SECTION 40 05 65.23 - SWING CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Swing check valves 3 IN and larger.

B. Related Requirements:

1. Section 09 96 00 - High Performance Industrial Coatings.
2. Section 40 05 51 - Common Requirements for Process Valves.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.

B. ASME International:

2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.

C. ASTM International:

3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

D. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

E. SSPC - The Society for Protective Coatings:

1. SSPC-SP 6 - Commercial Blast Cleaning.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and as indicated on Drawings.

1.4 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Product Data: Submit catalog information, indicating materials of construction and compliance with indicated standards.

1.5 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.6 QUALITY ASSURANCE
   A. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

1.7 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

1.9 EXISTING CONDITIONS
   A. Field Measurements:
      1. Verify field measurements prior to fabrication.
      2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SWING CHECK VALVES
   A. Manufacturers:
      2. G. A. Industries – Cranberry Township, Pennsylvania – Model Figure 220DS.
5. Substitutions: As specified in Section 01 60 00 - Product Requirements.

B. Description:
1. Type: Swing, resilient seated, with outside lever and adjustable weight.
2. Size: 3 IN and larger.
3. Comply with AWWA C508.
4. Maximum Fluid Temperature: 125 DegF.
5. Flow Area: Full open, equal to connecting nominal pipe diameter.
6. Provide check valves 12 IN and larger with adjustable air cushion chambers.
7. Mounting: As indicated on Project Drawings.

C. Materials:
1. Body and Cover: Cast iron, ASTM A126 Class B.
   a. Integral flanges, faced and drilled per ANSI B16.1 Class 250, suitable for horizontal or vertical installation.
   b. The valve body shall be the full waterway type, designed to provide a net flow area not less than the nominal inlet pipe size when swung open no more than 25 degrees.
2. Disc: Ductile iron, ASTM A536 or steel.
   a. The disc arm shall be suspended from and keyed to an austenitic stainless steel shaft which is completely above the waterway and supported at each end by heavy bronze bushings. The shaft shall rotate freely without the need for external lubrication. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable packing. Simple O–ring shaft seals are not acceptable.
3. Seat: Field replaceable, Type 304 stainless steel.
   a. The valve shall have a replaceable stainless steel body seat, a cast iron disc faced with a renewable resilient seat ring of rubber or other suitable material and held in place by stainless steel screws.
5. Seals: Stuffing box and adjustable packing.
6. Rubber Components: Buna-N.
7. Connecting Hardware: Areas listed as wet or corrosive shall utilize Type 316 stainless steel hardware. All other areas shall utilize carbon steel hardware unless noted otherwise.

D. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:
1. Hydrostatically test check valves at twice rated pressure according to AWWA C508.
2. Permitted Leakage at Indicated Working Pressure: None.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that field dimensions are as indicated on Drawings.
C. Inspect existing flanges for nonstandard bolt-hole configurations or design, and verify that new valve and flange mate properly.

3.2 PREPARATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Thoroughly clean valves before installation.
C. Surface Preparation:
   1. Touch up shop-primed surfaces with primer as specified in Section 09 96 00 – High Performance Industrial Coatings.
   2. Solvent-clean surfaces that are not shop primed.
   3. Clean surfaces to remove loose rust, mill scale, and other foreign substances as specified in Section 09 96 00 – High Performance Industrial Coatings.
   4. Prime surfaces as specified in Section 09 96 00 – High Performance Industrial Coatings.

3.3 INSTALLATION
A. According to AWWA C508 and manufacturer instructions.
B. Dielectric Fittings: Provide between dissimilar metals.

3.4 FIELD QUALITY CONTROL
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Inspection:
   1. Inspect for damage to valve lining or coating and for other defects that may be detrimental as determined by Engineer.
   2. Repair damaged valve or provide new, undamaged valve.
   3. After installation, inspect for proper supports and interferences.
C. Pressure test valves with piping.
3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep valve interior clean as installation progresses.

C. After installation, clean valve interior of soil, grit, loose mortar, and other debris.

END OF SECTION 40 05 65.23
SECTION 40 05 93 - COMMON MOTOR REQUIREMENTS PROCESS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Single- and three-phase motors for application on equipment provided under other Sections.

B. Related Requirements:
   1. Section 10 14 00 - Identification Devices.
   2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   3. Section 26 09 16 - Control Equipment Accessories.

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, physical dimensions, weights, mechanical performance data, and support points.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years’ documented experience.
B. Testing Agency: Company Member of International Electrical Testing Association and specializing in testing products specified in this Section with minimum three years' documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT
A. Furnish materials according to manufacturer’s standards.
B. Motors 3/4 HP and Larger: Three-phase motor as specified below.
C. Motors Smaller than 3/4 HP: Single-phase motor as specified below, except motors less than 250 watts or 1/4 HP may be equipment manufacturer's standard.
D. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor with windings to accomplish starting methods and number of speeds, as indicated in individual equipment Specifications.
   1. Voltage: As indicated on Drawings and individual equipment Specifications.
   2. Service Factor: 1.15.
   3. Enclosure: Meet conditions of installation.
   4. Design for continuous operation in 40 DegC environment, with temperature rise according to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   5. Insulation System: NEMA Class F.
   6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
   7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy-encapsulated solid state-control relay with wiring to terminal box.
   8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum, V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

E. Single-Phase Motors:
   1. Permanent split-capacitor type where available; otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
   2. Voltage: As indicated on Drawings and individual equipment Specifications.
F. Motors with Variable Frequency Type Adjustable Speed Drives:
   1. Induction motors that are in compliance with NEMA MG 1, Part 31.
   2. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
   3. Insulated drive end bearings on all motors.
   4. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 100 HP and larger.
   5. An insulated bearing carrier on the non-drive end for vertical shaft motors 100 HP and larger.
   6. Shaft grounding ring on all motors:
      a. Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
      b. Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.

G. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
   B. Testing: Test motors according to NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.1 PREPARATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
   B. Disconnect and remove abandoned motors.
   C. Clean and repair existing motors to remain or those to be reinstalled.

3.2 INSTALLATION
   A. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.
   B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
   C. Install engraved plastic nameplates according to Section 10 14 00 - Identification Devices.
   D. Ground and bond motors according to Section 26 05 26 - Grounding and Bonding Electrical Systems.
3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspect and test according to NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 40 05 93
SECTION 40 63 43 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1  GENERAL

1.1 SUMMARY

A. Section Includes: Programmable controllers and accessories.

B. Related Requirements:
   1. Section 10 14 00 - Identification Devices.
   2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   3. Section 26 09 16 - Control Equipment Accessories.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
   1. NEMA IA 2.2 - Programmable Controllers - Equipment Requirements and Tests.
   2. NEMA IA 2.3 - Programmable Controllers - Programming Languages.
   3. NEMA ICS 3 - Industrial Control and Systems: Factory Built Assemblies.
   4. NEMA ICS 6 - Industrial Control and Systems: Enclosures.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit catalog data for each component specified showing electrical characteristics and connection requirements.

C. Shop Drawings:
   1. Indicate electrical characteristics and connection requirements, including layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements.
   2. Instrumentation Subcontractor shall include control loop descriptions for each loop in system with submittals. Ensure that tag numbers cross reference with loop diagrams and tag numbers shown on instrument specification forms. Where tag numbers are not assigned, the control integrator shall assign tag numbers. Describe each element and include appropriate tag number in parenthesis. When additional elements are necessary, use and assign tag number not in conflict with others and in accordance with ISA procedures.
   3. The Instrumentation Subcontractor shall coordinate required interface screens with Engineer, Operations Staff, and Equipment Manufacturers to provide desired functionality.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Spare Parts: Furnish one spare circuit card for each unique circuit card type installed.
1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience, and with service facilities within 100 miles of Project.

B. Supplier/Integrator:
1. Concentric Integration, 8430 West Bryn Mawr Avenue, Suite 400, Chicago, IL 60631. Contact is Mike Klien, 815-444-3240, mklein@goconcentric.com.
2. For the purpose of standardization and responsibility, all instrumentation specified shall be provided by one system Integrator.
3. The system Integrator shall have extensive experience with the specified software.

1.7 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Conform to specified service conditions during and after installation of programmable controllers.

C. Maintain area free of dirt and dust during and after installation of products.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Configuration: Networked programmable controllers.

B. Sequence of Operation:
1. See 3.6 Attachments for Control Loop Descriptions.
2. The control loop descriptions provide the functional requirements of the control loops represented in the Contract Documents. Descriptions are provided as follows:
   a. Control system overview and general description.
   b. Major equipment to be controlled.
   c. Major Field mounted instruments (does not include local gauges).
   d. Manual control functions.
   e. Automatic control functions/interlocks.
   f. Major indications provided at local control panels and motor starters/VFD's.
   g. Remote indications and alarms.
3. The control loop descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the drawings and other specification sections. The control loop descriptions shall not be considered equal to a bill of materials.
4. Provide instrumentation hardware and software as necessary to perform control functions specified herein and shown on drawings.

2.2 PROGRAMMABLE CONTROLLER

A. Manufacturers:
1. New Processors: Allen-Bradley Compact Logix 1769-L16ER.
2. New HMIs: The units shall be manufactured by Allen-Bradley, PanelView Plus 7 Performance screen display. Equivalent HMI’s from other manufacturers will be considered subject to approval. Minimum 7” screen, 8Gb RAM, Intel Core i5 or better, with 4-year pro support next business day onsite service.

B. The Instrumentation Subcontractor shall be responsible for adding control of the new systems and integrating with City SCADA.

C. Instrumentation Subcontractor shall furnish and install any required expansion boards, racks, analog or discrete input or output modules required.

D. The Instrumentation Subcontractor shall be responsible for thoroughly checking the control system to identify and correct conflicts and verify functionality.

E. Description: Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points.

F. Service Conditions: Subcontractor shall provide necessary heating, cooling, and ventilation as required for trouble free operation. Conform to NEMA ICS 3 and the following:
   1. Temperature: 50 - 95 DegF.
   2. Humidity: 90 percent.
   3. Altitude: 720 FT AMSL.

G. Programming Language: Rockwell Factory Talk. Conform to NEMA IA 2.3.

H. Programming Software: Furnish one license for program for use with general purpose PanelView Plus and Microsoft Windows 10 operating system.

I. Networking Connections: Ethernet.

J. Spare Input/Output Capacity: 20 percent.

K. Input Voltage: 120 volts, 60 Hz.

L. Enclosure: See Division 13 Specifications.

M. Surge Protection: See Division 13 Specifications.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test programmable controller according to NEMA IA 2.2.

PART 3 EXECUTION

3.1 PREPARATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Disconnect and remove abandoned programmable controller components.

C. Extend existing programmable controller installations using materials and methods compatible with existing installations, or as specified.

D. Clean, reprogram, and repair existing programmable controllers to remain or to be reinstalled.

3.2 INSTALLATION

A. Do not install products until major construction is complete and site is prepared for traffic box installation.

B. Connect input and output devices as indicated on the Drawings.

C. Install engraved plastic nameplates according to Section 10 14 00 - Identification Devices.

D. Ground and bond programmable controllers according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Perform operational testing on control systems to verify proper operation and field wiring connections.

D. Manufacturer's Field Services: Prepare and start up programmable controller.

3.4 DEMONSTRATION AND TRAINING

A. Furnish 8 HRS of instruction for five persons, to be conducted at Project Site with manufacturer's representative.

3.5 MAINTENANCE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

B. Furnish service and maintenance of programmable controllers for one year from date of Substantial Completion.
3.6 ATTACHMENTS – I/O LIST AND CONTROL LOOP DESCRIPTIONS

A. New PLC:
   1. General Information:
      a. See Section 13 44 30 for information on Control Loop Descriptions.
   2. This PLC interacts with and controls the following systems and equipment:
      a. Raw Sewage Pump P-1
      b. Raw Sewage Pump P-2
      c. Submersible Level Transducer LE-101
      d. Float Switch LS-1, Low Level Alarm
      e. Float Switch LS-2, High Level Alarm
      f. Float Switch LS-3, Lead Start
      g. Float Switch LS-4, Lag Start
      h. Float Switch LS-5, All Stop
      i. Raw Sewage Flow Meter FE/FIT-1
      j. Power Monitor for P-1 Motor Starter
      k. Power Monitor for P-2 Motor Starter
      l. Automatic Transfer Switch and Generator
   3. New PLC-1 I/O:
      a. Device Tag: Raw Sewage Pump P-1:
         1) Signal: Discrete Output – Start.
         2) Signal: Discrete Input – Running.
         3) Signal: Discrete Input – Fault.
         4) Signal: Discrete Input – Local/Auto.
         5) Signal: Discrete Input – High Temperature.
         6) Signal: Discrete Input – Seal Failure.
      b. Device Tag: Raw Sewage Pump P-2:
         1) Signal: Discrete Output – Start.
         2) Signal: Discrete Input – Running.
         3) Signal: Discrete Input – Fault.
         4) Signal: Discrete Input – Local/Auto.
         5) Signal: Discrete Input – High Temperature.
         6) Signal: Discrete Input – Seal Failure.
      c. Device Tag: Submersible Level Transducer LE-1:
         1) Signal: Analog Output – Wet Well Level.
      d. Device Tag: Float Switch LS-1:
         1) Signal: Discrete Input – Low Level Alarm.
      e. Device Tag: Float Switch LS-2:
         1) Signal: Discrete Input – High Level Alarm.
      f. Device Tag: Float Switch LS-3:
         1) Signal: Discrete Input – Lead Start.
      g. Device Tag: Float Switch LS-4:
         1) Signal: Discrete Input – Lag Start.
      h. Device Tag: Float Switch LS-5:
         1) Signal: Discrete Input – All Stop.
      i. Device Tag: Raw Sewage Flow Meter FE/FIT-1:
         1) Signal: Analog Input – Flow Rate, gpm.
      j. Device Tag: Power Monitor for P-1 Motor Starter:
         1) Signal: Analog Input – Power Usage, Watts, via Ethernet.
      k. Device Tag: Power Monitor for P-2 Motor Starter:
1) Signal: Analog Input – Power Usage, Watts, via Ethernet.

I. Device Tag: Automatic Transfer Switch and Generator:
   1) Signal: Discrete Input – Generator Running.
   2) Signal: Discrete Input – Generator Fault.
   3) Signal: Discrete Input – Power Failure.

END OF SECTION 40 63 43
SECTION 40 73 13 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Pressure gauges.

B. Related Requirements:
   1. Section 43 05 20 - Common Work Results for Liquid Handling Equipment.

1.2 REFERENCE STANDARDS

A. ASME International:
   1. ASME B40.100 - Pressure Gauges and Gauge Attachments.

B. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with piping work and pump installation.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation requirements and other details.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.7 QUALITY ASSURANCE
   A. Ensure that materials of construction of wetted parts are compatible with process liquid.
   B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.
   C. Maintain one copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

1.10 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
   B. Furnish manufacturer's standard warranty for pressure gauges.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES
   A. Manufacturers:
      1. Ashcroft, Inc. – Type 1279.
      2. Substitutions: As specified in Section 01 60 00 - Product Requirements.
   B. Type: Differential.
   C. Dials:
      1. Nominal Diameter: 4-1/2 IN.
      2. Face: White, laminated plastic dials with black graduations.
      3. Scale: Extend over arc not less than 270 degrees.
4. Ranges and Graduation Units: As required by individual piping and pumping systems.

D. Cases:
   1. Liquid filled.
   3. Type: Blowout protected.
   5. Provide removable polycarbonate rear plate.
   6. Windows:
      b. Thickness: 1/8 IN.
      c. Provide gasket.

E. Connection:
   1. Location: Bottom.
   2. Socket:
      a. 1/2 IN NPT male thread.
      b. Material: Brass forging.
      c. Extend minimum 1-1/4 inches below gauge cases.
      d. Provide wrench flats.

F. Measuring Element:
   1. Bourdon Tubes:
      b. Provide welded, stress-relieved joints.
   2. Movement:
      a. Rotary adjustable.
      b. Material: Stainless steel.
   3. Accuracy:
      a. Comply with ASME B40.100.
      b. Plus and minus 0.5 percent of full-scale range.

G. Adjustment:
   1. Provide for zero-reading adjustment.
   2. Adjusting Screws: Accessible from rear of case without need for disassembly.
H. Accessories:

1. Pressure Snubber:
   a. Material: Type 316 stainless steel.
   b. Provide isolation valve.

2. Shutoff Cocks: Furnished by gauge manufacturer.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

3.2 INSTALLATION

A. According to manufacturer instructions.

B. Coordinate location and orientation of gauges and seal assemblies with final piping and equipment installations. Ensure that gauges are located to be easily read during operation and easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

END OF SECTION 40 73 13
DIVISION 43

PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT
SECTION 43 05 20 - COMMON WORK RESULTS FOR LIQUID HANDLING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lubrication.
2. Pump piping, fittings, and valves.
3. Piping connections.
4. Shaft coupling guards.
5. Accessories.

B. Related Requirements:

1. Section 03 31 30 - Concrete, Materials and Proportioning.
2. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
4. Section 09 96 00 - High Performance Industrial Coatings.
5. Section 10 14 00 - Identification Devices.
6. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping.
7. Section 40 05 19 - Ductile Iron Process Pipe.
8. Section 40 05 31 - Thermoplastic Process Pipe.
9. Section 40 05 51 - Common Requirements for Process Valves.
10. Section 40 05 63 - Ball Valves.
11. Section 40 05 62 - Plug Valves.
12. Section 40 05 65.23 - Swing Check Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

C. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910 - Occupational Safety and Health Standards.
1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with location and placement of utilities and piping.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:
   1. Submit manufacturer information for:
      a. Drive assemblies, pumps, tanks, mixers, panels, and other major components.
      b. Schematics, diagrams, panel layouts, ladder diagrams, and sequence of operation.
      c. Electric motors and variable-frequency drives.

C. Shop Drawings:
   1. Indicate assembly, foundation, and installation with location including critical dimensions, sizes, and support locations.
   2. Characteristic Pump Curves: Plot against flow rate and indicate total dynamic head, pump efficiency, brake horsepower, net positive suction head, power input to motor, and overall efficiency.
   3. For variable-frequency-driven pumps, indicate characteristic curves for range of speeds in 5 Hz increments.
   4. Submit pump name, identification tag number, and Specification Section number.
   5. Submit elevation of local control panel, indicating panel-mounted devices, power single-line diagram, and input/output list.
   6. Submit electrical schematic diagram and wiring diagram of field connections.

D. Manufacturer's Certificate:
   1. Certify that pumping systems meet or exceed specified requirements.
   2. Pumping Systems Rated Greater than 3 hp:
      a. Certify that pumping system has been installed satisfactorily and is ready for operation.
      b. Indicate date of field tests and furnish test data.

E. Test and Evaluation Reports:
   1. Performance Data Curves:
      a. Indicate head, flow rate, power demand, net positive suction head (NPSH) required, and pump efficiency over entire operating range of pump.
      b. Indicate head, power demand, overall efficiency at design, and maximum and minimum flow rates.
c. For variable-frequency-driven pumps, indicate performance at intervals of 100 rpm from minimum to maximum speed.

2. NPSH:
   a. Indicate test results of NPSH required, as required by specific pump Section.
   b. Otherwise, submit manufacturer's NPSH calculation.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:
   1. Submit qualifications for manufacturer.
   2. Submit manufacturer's approval of installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:
   1. Furnish one set of manufacturer's recommended spare parts.

C. Tools: Furnish special tools and other devices required for Owner to maintain and calibrate pumping systems.

1.6 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

B. Perform Work according to manufacturer’s standards.

C. Maintain a copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer.
1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish manufacturer's standard warranty for pumping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide pumping systems designed and constructed for continuous service within specified range of operation, without overheating, cavitation, or excessive vibration.

2.2 LUBRICATION

A. Water-Lubricated Pumps: Provide flow meter and differential pressure switch to de-energize pumping unit in low-water-flow conditions.

B. Ball Bearings and Roller Bearing: Lubricate materials as recommended by pump manufacturer.

C. Lubrication Equipment: Provide pumps, piping, tankage, and filters as required to supply lubrication to pumping units.
2.3 PUMP PIPING, FITTINGS, AND VALVES

A. For piping, fittings, and valves furnished with pumps, comply with relevant Section referenced in this Section under "Related Requirements" Paragraph.

B. Drainage Piping:
   1. Exposed Galvanized Steel Piping:
      a. Support as required.
      b. Provide cleanout plugs.
      c. Coated as specified in Section 09 96 00 - High Performance Industrial Coatings.
   2. Buried or Concealed: Cast iron pipe with cleanouts.
   3. Route drainage piping to nearest sink or floor drain.

2.4 PIPING CONNECTIONS

A. Flanges:
   1. Comply with ASME B16.5.

B. Fasteners:
   1. As specified in Section 05 50 00 - Metal Fabrications.

C. Screwed Fittings: Comply with ASME B1.20.1.

2.5 SHAFT COUPLING GUARDS

A. Comply with OSHA requirements.

2.6 FINISHES

A. As specified in Section 09 96 00 – High Performance Industrial Coatings.

2.7 ACCESSORIES

A. Nameplates:
   1. As specified in Section 10 14 00 - Identification Devices.
   2. Identify individual pumps with a stainless-steel nameplate, indicating assigned equipment number, serial number, rated head and flow rate, impeller size, speed, and manufacturer's name and model number.
2.8 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Performance Testing (Non-positive-displacement Pumps):

1. Test over entire operating range of pump; obtain measurements of head, flow rate, power demand, NPSH required, and pump efficiency.
2. Obtain measurements of head, maximum and minimum flow rates, power demand, and overall efficiency at design.
3. For variable-frequency-driven pumps, test pumps at intervals of 100 rpm from minimum to maximum speed.
4. Demonstrate that pump is free from overheating, cavitation, and excessive vibration over flow rate range.
5. For centrifugal pumps, demonstrate no contact between impeller ring and casing ring over flow rate range.

C. Drive Units:

1. Perform tests using complete pump system to be furnished, including Project motor and variable-frequency drive, if specified.
2. For pumps with motors rated less than 100 hp, manufacturer's certified test motor is acceptable.

D. NPSH:

1. Perform test of NPSH required as required by specific pump Section.

E. Do not ship equipment until test data have been accepted by Architect/Engineer.

F. Owner Inspection:

1. Make completed pumping system available for inspection at manufacturer's factory prior to packaging for shipment.
2. Owner inspection will be at the Owner’s discretion, and will be paid for by the Owner and coordinated by the Contractor.
3. Notify Owner at least seven days before inspection is allowed.

G. Owner Witnessing:

1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Owner witnessing will be at the Owner’s discretion, and will be paid for by the Owner and coordinated by the Contractor.
3. Notify Owner at least seven days before inspections and tests are scheduled.

H. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that designated areas, clearances, structural requirements, piping, utility connections, and electronic signals are ready to receive equipment.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Disconnect electrical systems scheduled for removal.

C. Provide temporary wiring and connections to maintain existing systems in service during construction.

D. Remove, relocate, and extend existing installations as necessary to accommodate new construction.

3.3 INSTALLATION

A. According to manufacturer instructions.

B. Ensure that equipment is secure in position.

C. Equipment Bases and Supports:

   1. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 4 inches beyond supported equipment base plate, as indicated on Drawings.
   2. Install anchor bolts and accessories for mounting and anchoring equipment.
   3. Supports:
      a. Construct supports of steel members.
      b. Brace and fasten with flanges bolted to equipment structure.
      c. Provide flexible connections as required to isolate equipment from piping.

D. Provide rigid anchors for pipes after vibration isolation components are installed.

E. Gages:

   1. Except for sample pumps and sump pumps, provide pressure gages at pump discharge piping and compound gages on pump suction piping.
   2. If subject to shock or vibrations, wall-mount gages or attach gages to galvanized channel floor stands and connect with flexible connectors.
F. Lubricants: Provide necessary oil and grease for initial operation.

G. Coat materials and equipment as specified in Section 09 96 00 – High Performance Industrial Coatings.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Testing:

1. Test for proper alignment and freedom from binding, scraping, shaft runout, or other defects.
2. Where specified by individual Specification Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
3. Engineer will witness field testing.
4. Start control system by energizing system equipment and testing operation of hardware and process control logic under supervision of manufacturer's representative and in presence of Engineer.
5. Field-test each pump system after installation in order to demonstrate:
   a. Satisfactory operation without excessive noise and vibration over flow rate range; if pump driven by variable-frequency drive, test at 100-rpm increments.
   b. Required head, flow rate, and efficiency at design point.
6. Certify in writing that pump system has been satisfactorily tested.

D. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 8 hours on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.

E. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

F. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
B. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 05 20
SECTION 43 25 13.27 - SUBMERSIBLE PUMPING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Submersible raw sewage pumps.

B. Related Requirements:

1. Division 13 – Special Construction.
2. Section 26 09 16 - Control Equipment Accessories.
3. Section 40 05 06 - Couplings, Adapters and Specials for Process Piping.
4. Section 40 05 51 - Common Requirements for Process Valves.
5. Section 40 05 93 - Common Motor Requirements for Process Equipment.
6. Section 40 63 43 - Programmable Logic Controllers.
7. Section 43 05 20 - Common Work Results for Liquid Handling Equipment.

1.2 REFERENCE STANDARDS

A. ASTM International:


B. National Electrical Manufacturers Association:

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

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

1. Coordinate Work of this Section with installation of process piping.

1.4 SCHEDULING

A. Section 01 32 16 - Construction Progress Schedule: Requirements for scheduling.

B. Schedule Work of this Section prior to connecting piping work.

1.5 SEQUENCING

A. Section 01 10 00 - Summary: Requirements for sequencing.
B. Sequence Work of this Section to prevent interference with plant operations.

1.6 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.

C. Shop Drawings:
   1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
   2. Include manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   1. Certify installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

I. Qualifications Statement: Submit qualifications for manufacturer.

1.7 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience. Manufacturer shall have a complete in-house factory service facility with complete field service capabilities and complete spare parts available within a 75-mile radius of the project site.
1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish manufacturer's standard warranty for pumps and components.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE INTERNAL RECYCLE PUMPS

A. Manufacturers:

1. ABS/Sulzer, XFP100E-CB1.5.
2. Flygt, 1315S-3X.
3. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Submersible non-clog pumps, each equipped with submersible electric motor. The heavy duty submersible wastewater pump(s) shall be capable of handling raw unscreened sewage, storm water, and other similar solids-laden fluids without clogging. The pump shall be driven by a Premium Efficiency motor, providing the highest levels of operational reliability and energy efficiency.

C. Guide Rail Base Assembly:

1. There shall be no need for personnel to enter the wet well to remove or reinstall the pump(s). In a wet pit installation, the discharge base & elbow assembly shall be permanently installed in the wet well and connected to the discharge piping. In order to prevent binding or separation of the pump from the guide rail system, the pump(s) shall connect to the guide rail base automatically and firmly, guided by one 2-inch guide pipe extending from the base elbow to the top of the station. Systems using guide cable in lieu of rigid guide bars or pipes shall not be considered acceptable. The sliding guide bracket shall be a separate part of the pumping unit, capable of being attached to standard 4-inch ANSI class 125 or metric DN100 pump flanges, so that the pump mounting is non-proprietary, and any pump with a standard discharge flange can be mounted on the base assembly. Base or bracket assemblies with proprietary or non-standard flange dimensions shall not be considered acceptable.

2. A field replaceable Nitrile (Buna-N) rubber profile gasket or o-ring shall accomplish positive sealing of the pump flange/guide rail bracket to the discharge elbow. Base assemblies which rely solely on metal to metal contact between the pump flange and discharge base elbow as a means of sealing are inherently leak prone and shall not be considered equal. No portion of the pump shall bear directly on the floor of the sump. The guide rail system shall be available in an optional non-sparking version, approved by Factory Mutual for use in NEC Class 1, Division 1, Group C&D hazardous locations.

D. Pump Construction:
1. Major pump components shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be stainless steel 1.4401 (AISI type 316) construction. All metal surfaces coming into contact with the pumped media (other than the stainless steel components) shall be protected by a factory applied spray coating of zinc phosphate primer followed by a high solids two part epoxy paint finish on the exterior of the pump. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings, or for hooking from the wet well surface. The hoop shall be stainless steel 1.4401 (AISI 316), and shall be rated to lift a minimum of four times the pump weight.

2. Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings. Sealing will be the result of controlled compression of rubber O-rings in two planes of the sealing interface. Housing interfaces shall meet with metal to metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

E. Impeller:

1. The ABS ContraBlock Plus impeller shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The impeller shall be of the semi-open, non-clogging, single vane design, meeting the Ten State Standards requirement for minimum solids passage size of 3 inches. The impeller shall be capable of passing a minimum of 3.1 inch diameter spherical solids as are commonly found in waste water.

2. The impeller shall have a slip fit onto the motor shaft and drive key and shall be securely fastened to the shaft by a stainless steel bolt which is mechanically prevented from loosening by a positively engaged ratcheting washer assembly. The head of the impeller bolt shall be effectively recessed within the impeller bore to prevent disruption of the flow stream and loss of hydraulic efficiency.

3. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation. Impeller designs which do not meet the Ten State Standards requirement for 3 inch solids passage size, those that rely on retractable impeller designs to pass 3 inch solids, or those that rely on fins or pins protruding into the suction path to assist in the handling of fibrous material shall not be considered equal.

F. Self-Cleaning Wear Plate:

1. The ABS ContraBlock Plus wear plate shall be constructed from gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The wear plate shall be designed with an inlet incorporating strategically placed cutting grooves and an outward spiral V-shaped groove on the side facing the impeller, to shred and force stringy solids outward from the impeller and through the pump discharge. The wear plate shall be mounted to the volute with three stainless steel securing screws and three stainless steel adjusting screws to permit close tolerance adjustment between the wear plate and impeller for maximum pump efficiency. The wear plate shall be factory mounted to the volute in a fixed position with metal to metal contact on machined surfaces to insure optimal clearance and efficiency at startup.
2. Future adjustments shall be easily accomplished by removing three securing screws and rotating the plate 45 degrees to the adjustment position. Adjustment to allow for wear and restore peak pumping performance shall then be accomplished using standard tools, and without requiring disassembly of the pump. The use of fixed or non-adjustable wear plates or rings, or systems that require disassembly of the pump or shimming of the impeller to facilitate adjustment shall not be considered equal. The suction flange shall be integrated into the wear plate and its bolt holes shall be drilled and threaded to accept standard 4 inch ANSI class 125 flanged fittings.

G. Pump Volute:

1. The pump volute shall be single piece gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. Discharge size shall be as specified on the pump performance curve. The discharge flange design shall permit attachment to standard ANSI or metric flanges/appurtenances. The discharge flange shall be slotted to accept both 4 inch ANSI class 125 and metric DN100 (PN 10) metric flanged fittings. Proprietary or non-standard flange dimensions shall not be considered acceptable. The minimum working pressure of the volute and pump assembly shall be 10 bar (145 psi).

H. Shaft:

1. The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation. Each shaft shall be stainless steel 1.4021 (AISI 420) material, and shall have a polished finish with accurately machined shoulders to accommodate bearings, seals and impeller. Carbon steel, chrome plated, or multi piece welded shafts shall not be considered adequate or equal.

I. Bearings:

1. Each pump shaft shall rotate on high quality permanently lubricated, greased bearings. The upper bearing shall be a deep grooved ball bearing and the lower bearings shall be a heavy duty double row angular contact ball bearing. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. L-10 bearing life shall be a minimum of 50,000 hours at flows ranging from ½ of BEP flow to 1½ times BEP flow (BEP is best efficiency point). The bearings shall be manufactured by a major internationally known manufacturer of high quality bearings, and shall be stamped with the manufacturer’s name and size designation on the race. Generic or unbranded bearings from other than major bearing manufacturers shall not be considered acceptable.

J. Pump Motor:

1. The Premium Efficiency motor shall meet efficiency standards in accordance with IEC 60034-30, level IE3 and NEMA Premium. Motor rating tests shall be conducted in accordance with IEC 60034-2-1 requirements and shall be certified accurate and correct by a third party certifying agency. A certificate shall be available upon request.
2. The Premium Efficiency motor shall be housed in a water tight gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) enclosure capable of continuous submerged operation underwater to a depth of 20 meters (65 feet), and shall have an IP68 protection rating. The motor shall be of the squirrel-cage induction design, NEMA type B, Premium Efficiency. The copper stator windings shall be insulated with moisture resistant Class H insulation materials, rated for 180°C (356°F). The stator shall be press fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is unacceptable. The rotor bars and short circuit rings shall be made of cast aluminum.

3. The motor shall be designed for continuous duty. The maximum continuous temperature of the pumped liquid shall be 40°C (104°F), and intermittently up to 50°C (122°F). The motor shall be capable of handling up to 15 evenly spaced starts per hour without overheating. The service factor (as defined by the NEMA MG1 standard) shall be 1.3 in wet pit service and 1.15 in dry pit service. The motor shall have a voltage tolerance of +/-10% from nominal, and a phase to phase voltage imbalance tolerance of 1%. The motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The surface temperature rating shall be T3C. The motor shall meet the requirements of NEMA MG1 Part 30 and 31 for operation on PWM type Variable Frequency Drives.

4. The motor shall be capable of operating, completely submerged, partially submerged, or unsubmerged. For submerged (wet pit) applications, the motor shall be self-cooling via the process fluid surrounding the motor. For unsubmerged (dry pit) applications, an integrated oil cooling system shall be utilized to enhance heat transfer and allow the motor to operate at full rated power continuously without the need for de-rating or reduced duty cycle. No external coolant supply or external cooling jacket shall be required for dry pit applications. The motor shall have a NEMA Class A temperature rise for submerged service, and class B rise for dry pit service, providing cool operation under all operating conditions.

5. Thermal Protection:
   a. Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 140°C +/- 5°C (284°F). They shall be connected to the control panel, and used in conjunction with, and supplemental to, external motor overload protection.

6. Electrical Characteristics:
   a. 7.5 hp.
   b. Voltage: 230 V, three phase, 60 Hz.

7. K. Mechanical Seals:
   1. Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate.
2. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary industrial duty silicon-carbide seal ring and one rotating industrial duty silicon-carbide seal ring. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron EN-GJL-250 (ASTM A-48, Class 35B). The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate.

3. The upper, secondary seal unit, located between the lubricant chamber and motor housing, shall contain one stationary industrial duty silicon-carbide seal ring, and one rotating industrial duty silicon-carbide seal ring. Each seal interface shall be held in contact by its own spring system.

4. The seals shall not require routine maintenance, or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal, and shall be easily accessible from the outside of the pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe non-toxic material.

5. The following seal types shall not be considered equal: Seals of proprietary design, or seals manufactured by other than major independent seal manufacturing companies. Seals requiring set screws, pins, or other mechanical locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, any system requiring a pressure differential to seat the seal and ensure sealing.

L. Mechanical Seal Protection System:

1. The primary mechanical seal shall be protected from interference by particles in the waste water, including fibrous materials, by an active Seal Protection System integrated into the impeller. The back side of the impeller shall be equipped with a sinusoidal cutting ring, forming a close clearance cutting system with the lower submersible motor housing or seal plate. This sinusoidal cutting ring shall spin with the pump impeller providing a minimum of 75 shearing actions per pump revolution. Large particles or fibrous material which attempt to lodge behind the impeller or wrap around the mechanical seal shall be effectively sheared by the active cutting system into particles small enough the prevent interference with the mechanical seal. The Seal Protection System shall operate whenever the pump operates and shall not require adjustment or maintenance in order to function. Submersible pump designs which do not incorporate an active cutting system to protect the primary mechanical seal shall not be considered acceptable for wastewater service.

M. Seal Failure Early Warning System:

1. The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned between the primary and secondary mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be filled with environmentally safe non-toxic oil.
2. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the primary mechanical seal, the probe shall sense the increase in conductivity and signal the solid-state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage, thereby preventing damage to the submersible pump, and allowing scheduled rather than emergency maintenance.

3. Systems utilizing float switches or any other monitoring devices located in the stator housing rather than in a sensing chamber between the mechanical seals are not considered to be early warning systems and shall not be considered equal.

N. Power Cable:

1. The power cables shall be sized according to NEC and CSA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil and water resistant, and shall be capable of continuous submerged operation underwater to a depth of 65 feet.

O. Cable Entry System:

1. The cable entry system shall consist of submersible plug assembly which allows the cable to be easily disconnected from the pump for service or replacement. Cable sealing shall be accomplished by a Nitrile compression grommet with both cylindrical and conical sealing surfaces, flanked by a stainless steel washer and an integrated strain relief. A brass (C3604) compression nut shall be threaded into to the cast iron EN-GJL-250 (ASTM A-48, Class 35B) cable plug housing, compressing the grommet ID to the cable while the grommet OD seals against the bore of the cable entry housing. Cable conductors shall be terminated in copper pin connectors which are separated and retained by a circular pin retainer fabricated from high dielectric strength Polyamid (30% GF). Each pin shall pass through its own hole in the pin retainer, maintaining perfect alignment with the mating pins in the motor body. The corresponding motor body pin assembly shall be manufactured from high dielectric strength Polyamid (30% GF), with copper connector pins. The pin assembly shall be sealed with an O-ring to prevent water entry into the motor and retained in the motor housing bore via a retaining ring. Attachment of the plug assembly to the motor shall engage the corresponding copper pins, creating a complete circuit between the motor and cable. The plug assembly shall be fastened with stainless steel fasteners, and shall be sealed by an O-ring.

2. The cable plug and sealed entry system as part of the motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The system shall be anti-wicking by design, and shall prevent any water that enters the cable through damage to the jacket from entering the motor. Cable entry designs which utilize potting compounds to provide a water tight seal, or those which do not allow the cable to be easily changed in the field shall not be considered equal.

P. Access Doors and Frames:

1. Access doors and frames to be Per Section 08 31 00 – Access Doors.
2. Contractor to ensure clearance for submersible pumping equipment will be provided by specified access door sizing indicated in Section 08 31 00 – Access Doors

Q. Accessories:

1. Upper guide holders.
2. Level sensor cable holders.
3. Sliding nut rails to attach accessories.
4. Lifting Chain:
   b. Material: Stainless steel.
   c. Strength: Sufficient to permit raising and lowering of pump.

R. Performance and Design Criteria:

1. Design Flow Rate: 300 GPM.
2. Design Flow Total Dynamic Head: 42 FT.
3. Minimum Efficiency at Design Flow Rate: 60 percent.
4. Net Positive Suction Head Available: 34 FT.
5. Service Liquid: Raw Sewage
7. Temperature: 25 DegC.
8. Maximum Speed: 1,760 RPM.
9. Control Panel:
   c. Single-point power connection and grounding lug.
10. Controls:
    a. Mount double electrode in seal chamber to actuate remote alarm when water is detected in seal chamber.
11. Disconnect Switch: As indicated on Drawings.
12. Operation Sequences: See Section 40 63 43 - Programmable Logic Controllers and Section 13 44 30 - Control Loop Descriptions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of pumps, access doors, accessories, and piping connections.
3.2 INSTALLATION

A. Install pumps and accessories where indicated on Drawings and according to manufacturer's instructions.

B. Provide and connect piping, accessories, and power and control conduit and wiring to make system operational, ready for startup.

C. Flush piping with clean water.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Pre-operational Checks:
   1. Check pump and motor alignment.
   2. Check for proper motor rotation.
   3. Check pump and drive units for proper lubrication.

C. Startup and Performance Testing:
   1. Operate pump using clean water at design point for continuous period of 2 HRS, under supervision of manufacturer's representative and in presence of Architect/Engineer.

D. Verify pump performance by performing time-drawdown test or time-fill test.

E. Check pump and motor for high bearing temperature and excessive vibration.

F. Check for motor overload by taking ampere readings.

G. Equipment Acceptance:
   1. Adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.
   3. Document adjustments, repairs, and replacements in manufacturer's field services certification.

H. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

I. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.
3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

3.5 SCHEDULE

A. Submersible Pump Schedule:

1. P-1 and P-2:
   a. Location: 7th & Division Lift Station Wet Well.
   b. Type of Fluid: Raw Sewage.
   c. Capacity: 300 GPM.
   d. Discharge Head (TDH): 38 FT.
   e. Maximum Speed: 1,760 RPM.
   f. Motor:
      1) Maximum Power: 7.5 hp.
      2) Voltage/Phase: 230 V / 3ph.
   g. Manufacturer and Model:
      1) ABS/Sulzer, XFP100E-CB1.5.

END OF SECTION 43 25 13.27
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DIVISION 44

POLLUTION AND WASTE CONTROL EQUIPMENT
SECTION 44 31 19 - PACKAGED ODOR CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes: Furnishing, delivery and installation of an inverted vent valve.
B. Related Requirements:
   1. Section 09 96 00 - High Performance Industrial Coatings.
   2. Section 10 14 00 - Identification Devices.

1.2 DEFINITIONS
A. FRP: Fiberglass-reinforced plastic.
B. SS: Stainless Steel.
C. HDPE: High-density polyethylene.

1.3 COORDINATION
A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with Work of other Sections.

1.4 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer information for system materials and component equipment.
C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation and anchoring requirements, fasteners, and other details.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
F. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

G. Qualifications Statements:
1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.7 QUALITY ASSURANCE
A. Perform Work according to manufacturer’s standards.

1.8 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
B. Installer: Company with minimum five years experience specializing in wastewater collection system and lift station work and familiar with hazard classifications.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
C. Store materials according to manufacturer instructions.
D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.
1.10 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
   B. All mechanical components shall be warranted free of manufacturing defects for a period of 12 months from substantial completion of the Contract.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Manufacturers:
   1. Wager 1800 Vent Scrubber 4-1800FAPC, by Wager Company, Rural Hall, NC.
   2. Substitutions: Section 01 60 00 - Product Requirements.

2.2 INVERTED VENT VALVE

A. The 4-1800FAPC consists of dry-scrubbing media contained in a 356-T6 powder coated, grass green aluminum casting with a 4” inlet.
   B. The 4-1800FAPC shall contain 12 lbs. of dry-scrubbing media that is engineered for the removal of H2S gas.
   C. The airflow shall be designed for passive applications. The configuration shall be arranged so that the contaminated air shall flow into the top inlet flange and be forced downwards through the media bed. Treated air shall discharge out the bottom of the unit through ventilated openings.
   D. Components:
      1. 356-T6 aluminum casting, powder coated.
      2. 12 lbs. of odor controlling media engineered in pellet form.
      3. Polycarbonate canister measuring 7.2”-diameter and 12” in height.
      4. 4” flanged connection.
      5. Tamper proof, lockable, 316 stainless steel hooks and security latches.
      6. Disposable media polycarbonate insert.
   E. Media:
1. Media must be Non-Hazardous before and after it is spent.
2. Moisture Content: 35% Max.
3. Crush Strength: 35%-70% Max.
4. Abrasion: 4.5% Max.
5. Pellet Diameter: 1/16”.
6. Only UL certified media will be accepted in Wager’s vent scrubber. If other media is used in this unit, it must be designed to be 25% larger with a minimum of 25% additional media.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all systems in accordance with Manufacturer’s written instructions and recommendations.

B. Media installation procedures must comply with Manufacturer's instructions and recommendations.

3.2 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspect for proper operation.

3.3 MANUFACTURER SERVICES

A. Media Sampling and Analysis:
1. The manufacturer, after start up, shall analyze media samples to predict the remaining service life of system media. Such service will be provided as needed at the manufacturer's expense over the life of the unit.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 44 31 19