ADDENDUM No. 5

Date: November 18, 2016
Requisition No. 38269
Due Date: November 29, 2016
Time: 2:00 P.M.

TO: Bidders for: 2016 Operations Resurfacing – Bagley Road

FROM: Cuyahoga County
Office of Procurement & Diversity

The following are changes/corrections to the above referenced specification package:

a) Pump Station Specifications – OEPA Submittal is attached (136 pages)

b) Note: The standby emergency generator shall be a 128 KW/160 KVA 192 FLA, 480/277V outdoor pad mounted, natural gas generator with output breaker and all weather sound attenuating enclosure. Either one manufactured by Cummins-Onan or Kohler or approved equal by the sanitary engineering staff. The automatic transfer switch shall be supplied by the manufacturer of the standby generator.

All remaining terms and conditions of the specification package remain in effect and this addendum therefore becomes part of the specification.

Respectfully submitted,
CUYAHOGA COUNTY

Richard E. Opre
Purchasing Manager

cc: file
Cuyahoga County
Department of Public Works

West Bagley Road West of Stearns Pump Station Improvements

Technical Specifications

December 7, 2015
CTI Project No. E15019-2
SECTION 01 32 00

SCHEDULES AND REPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. General. This section specifies administrative and procedural requirements for schedules and reports required for proper performance of the work.

B. Coordination. Each prime Contractor shall closely coordinate scheduling and reporting with the scheduling and reporting of other prime Contractors.

C. Schedules required include:
   1. Preliminary Construction Schedule, including Submittals Tabulation.
   2. Contractor's Construction Schedule.
   4. Schedule of Values.

D. Reports required include:
   1. Daily Construction Reports.
   2. Material Location Reports.
   3. Field Correction Reports.
   4. Spare Parts Inventory Reports.
   5. Equipment Start-up Report and Certifications.

E. Project meeting minutes are included in Section 01 3119, Project Meetings.

F. Inspection and test reports are included in Section 01 4000, Quality Control Services.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and other Division 1 specification sections, apply to this section.

1.3 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar Chart Schedule. Submit a preliminary horizontal bar chart type construction schedule within seven days of the date established for commencement of the work.

B. Bar Chart Schedule. The Contractor for General Construction shall submit a preliminary horizontal bar chart type construction schedule, with a copy to each prime Contractor, within seven days of the date established for commencement of the work. Within five working days of this submittal, each other prime Contractor shall submit a matching preliminary horizontal bar chart schedule showing their construction operations sequenced and coordinated with general construction.
1. Provide a separate time bar for each significant construction activity. Coordinate each element on the schedule with other construction activities. Schedule each construction activity in proper sequence. Provide a continuous vertical line to identify the first working day of each week.

2. Indicate completion of the work in advance of the date established for substantial completion.

3. If adjustments are necessary for sequencing and coordination of the work, the Contractor for general construction shall arrange a meeting with the other prime Contractors at the earliest possible date. At this meeting each prime Contractor shall negotiate reasonable adjustments to their schedules.

C. Submittal Tabulation. With the submittal of the preliminary construction schedule, include a tabulation by date of submittals required during the first 90 days of construction. List those submittals required to maintain orderly progress of the work, and those required early because of long lead time for manufacture or fabrication.

1. At the Contractor's option, submittal dates may be shown on the schedule, in lieu of being tabulated separately.

1.4 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Bar Chart Schedule. Prepare a comprehensive, fully developed, horizontal bar chart type Contractor's construction schedule based on the preliminary construction schedule and on whatever updating and feedback was received since the start of the project.

B. Bar Chart Schedule. The Contractor for general construction shall secure time commitments for performing critical construction activities from each of the other prime Contractors and shall prepare a combined construction schedule for the entire project. The Schedule shall be a comprehensive, multi-sheet, integrated, fully developed horizontal bar chart type schedule based on the preliminary construction schedules and reflecting updating and feedback received since the start of the project.

1. Submit the schedule within 30 calendar days of the date established for commencement of the work, unless a longer time has been requested and approved.

2. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week.

a. If practical, use the same breakdown of units of the work as indicated in the "Schedule of Values."

3. For significant construction activities that require 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within the time bar. As work progresses, place a contrasting mark in each bar to indicate actual completion percentage.
4. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data clearly for the entire construction period.
   a. Show the activities of each prime contract on a separate sheet.
   b. Prepare a simplified summary sheet indicating the combined construction activities of the prime contracts.

5. Secure time commitments for performing critical elements of the work from parties involved. Coordinate each element on the schedule with other portions of the work; include minor elements involved in the overall sequence of the work. Show each construction activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the work. Show critical path activities or elements.

6. Coordinate the Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests and other required schedules and reports.

7. Indicate completion of the work in advance of the date established for substantial completion. Indicate substantial completion on the schedule to allow ample time for the Engineer's administrative procedures necessary for certification of substantial completion.

C. Work Stages. Use crosshatched bars to indicate important stages of construction for each major portion of the work.

D. Such stages include, but are not necessarily limited to:
   1. Subcontract awards.
   2. Purchases.
   3. Mockups.
   4. Fabrication.
   5. Sample testing.
   6. Deliveries.
   7. Installation.
   8. Testing.
  10. Curing.
  11. Start-up and placement into final use and operation.

E. Distribution. Following the Engineer's response to initial submittal of the Contractor's construction schedule, print and distribute copies to the Engineer, Owner, separate contractors, subcontractors, suppliers, fabricators, and other parties required to comply with scheduled dates.
   1. Post copies of the schedule in the project meeting room and temporary field office.
2. When revisions are made, distribute the updated schedule to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the work and are no longer involved in performance of construction activities.

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

1.5 SUBMITTAL SCHEDULE

A. Prepare a complete submittal schedule concurrent with the development of the Contractor's construction schedule. Submit the schedule within 30 calendar days of the date established for commencement of the work, unless a longer period has been requested and approved.

1. Coordinate submittal schedule with the list of subcontracts, Schedule of Values, and the list of products specified in Section 01 6000, Materials and Equipment, as well as the Contractor's construction schedule.

2. Prepare the schedule in chronological order; include submittals listed on the tabulation of submittals required during the first 90 days of construction. Provide the following information on the schedule:

   a. Schedule date for the first submittal.
   b. Related section number.
   c. Submittal category.
   d. Name of subcontractor.
   e. Description of the part of the work covered.
   f. Scheduled date of the Engineer's final release or approval.

3. Scheduled submittal dates shall be staggered.

4. Items of a critical nature shall be prioritized and so noted.

5. Scheduled final release or approval dates shall be coordinated with construction schedule.

B. Distribution. Following the Engineer's response to initial submittal, print and distribute the schedule to the Engineer, Owner, separate Contractors, subcontractors, suppliers, fabricators, and other parties required to comply with submittal dates indicated.

1. Post copies in the project meeting room and temporary field office.

2. When revisions are made, distribute the updated schedule to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned part of the work and are no longer involved in the performance of construction activities.
C. Schedule Updating. Revise the schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue the updated schedule concurrently with report of each meeting.
1.6 SCHEDULE OF VALUES

A. Prepare and submit a schedule of values established in the Agreement within 15 days of the date established for commencement of the work.

1. Refer to Section 01 2200, Measurement and Payment, for a listing of categories of work where unit prices are required.

2. Refer to individual specification sections for portions of the work where the establishment of unit prices is required. Methods of measurement and pricing are specified in these sections.

B. Prepare the schedule in tabular form, including the following items:

1. Name of the part of the work.
2. Related specification section.
3. Name of subcontractor assigned.
4. Unit of measurement.
5. Price per unit.

C. Distribution. Distribute to the Owner, Engineer, and each party involved in performance of the portion of the work, where established unit prices could come into force and effect.

D. Following review by the Owner and Engineer, revise the schedule of values to correct any elements which the Owner and Engineer find unacceptable. After revision, the schedule of values shall be submitted for further review.

1.7 REPORTS

A. Daily Construction Reports. Prepare a daily construction report, recording the following information concerning events at the site; and submit duplicate copies to the Engineer at weekly intervals:

1. List of subcontractors at the site.
2. List of separate contractors at the site.
3. Approximate count of personnel at the site.
4. High and low temperature, general weather conditions.
5. Accidents (refer to accident reports).
6. Meetings and significant decisions.
7. Unusual events (refer to special reports).
8. Stoppages, delays, shortages, losses.
9. Meter readings and similar recordings.
10. Emergency procedures.
11. Orders and requests of governing authorities.
12. Change Orders received, implemented.
13. Services connected, disconnected.
14. Equipment or system tests and start-ups.
15. Partial completions, occupancies.
16. Substantial completions authorized.
B. Material Location Reports. At monthly intervals prepare a comprehensive list of materials delivered to and stored at the site. The list shall be cumulative, showing materials previously reported plus items recently delivered. Include with the list a statement of progress on and delivery dates for all materials or items of equipment being fabricated or stored away from the building site. Submit copies of the list to the Engineer at monthly intervals.

C. Field Correction Report. When the need to take corrective action that requires a departure from the Contract Documents arises, prepare a detailed report including a statement describing the problem and recommended changes. Indicate reasons the Contract Documents cannot be followed. Submit a copy to the Engineer immediately.

D. Spare Parts Inventory Report. Document in writing on forms provided by the Engineer delivery to the Owner of specified spare parts. Include the manufacturer's name, part name, number, and quantity delivered. Reports shall be signed by representatives of the Contractor, Owner, and Engineer. Reports are due prior to substantial completion.

1.8 LOGS

A. RFI Log. Maintain a tabular log of all Requests for Information (RFI). Number RFIs in a sequential manner. Note date of request and date of response for each. Update the RFI log monthly and distribute at the monthly progress meeting.

B. Shop Drawing and Product Data Submittal Log. Maintain a tabular log of all shop drawing and product data submittals. Number submittals in a sequential manner. Note dates of initial submittal, first return, resubmittal, second or final return along with Engineer’s action noted for each submittal. Update the shop drawing submittal log monthly and distribute at the monthly progress meeting.

C. Change Order Request/Proposal Log. Maintain a tabular log of all change order requests/proposals. Number change order requests/proposals in a sequential manner. Note date of submittal, brief description of covered work, proposed price, requested number of days (if applicable), and status (denied/approved/pending). For those that are approved, indicate in which change order they are included. Update the log monthly and distribute at the monthly progress meeting.

D. O & M Manual Log. Maintain a tabular log of all O & M Manual submittals. Number submittals in a sequential manner. Note dates of initial submittal, first return, resubmittal, second or final return along with Engineer’s action noted for each submittal. Update the O & M Manual submittal log monthly and distribute at the monthly progress meeting.

1.9 EQUIPMENT START-UP REPORT AND CERTIFICATION

A. An experienced, authorized service representative (not a sales representative) of the manufacturer of each item of equipment shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment manufacturer’s representative shall be present when the equipment is placed in operation and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of the Engineer.
B. Each equipment manufacturer's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and (4) has been operated under full load conditions and that it operated satisfactorily. Work will not be accepted as substantially complete until executed Equipment Start-up Report and certification forms have been submitted in accordance with the requirements of this section.

C. Properly coordinate the visits by the manufacturer's representatives, particularly where the operation of an item of equipment is dependent on the operation of other equipment. Prior to calling the manufacturer's representative, ensure that all necessary related equipment, structures, piping, and electrical work is complete. Pay for any revisits to the site by the manufacturer's representative made necessary due to the Contractor's failure to properly coordinate the visits.

D. Secure the services of the manufacturer's representative at the site of the work for as long as is necessary to check the installation and place the equipment in satisfactory operation.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PAYMENT

A. No requests for payment for work under this Contract will be processed until the Contractor's Preliminary Construction Schedule, Submittals Tabulation, and Schedule of Values are submitted and found acceptable by the Owner and Engineer in conformance with the requirements of this section.

B. No further requests for payment will be processed after the due date of the Contractor's Construction Schedule and Submittal Schedule until both schedules are submitted in conformance with the requirements of this section.

C. If payment is being requested for stored materials, the material location report must be included with the request for payment.

END OF SECTION
SECTION 01 33 23
SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies administrative and procedural requirements for submittal of shop drawings, product data, and samples to verify that products, materials, and systems proposed for use comply with provisions of the Contract Documents.

B. Shop drawings are required for all materials, products, and equipment furnished on this project, unless otherwise specified.

C. Standard information prepared without specific reference to the project is not considered to be shop drawings.

D. Coordination drawings are a special type of shop drawing that show the relationship and integration of different construction elements that require close and careful coordination during fabrication or during installation to fit in the restricted space provided or to function as intended.

E. Product data include, but are not limited to, the following:

1. Manufacturer's product specifications.
2. Manufacturer's installation instructions.
4. Catalog cuts.
5. Roughing-in diagrams and templates.
7. Printed performance curves.
8. Operational range diagrams.
10. Standard product operating and maintenance manuals.

F. Samples include, but are not limited to, the following:

1. Partial sections of manufactured or fabricated components.
2. Small cuts or containers of materials.
3. Complete units of repetitively used materials.
4. Swatches showing color, texture, and pattern.
5. Color range sets.
6. Components used for independent inspection and testing.

G. Administrative Submittals. Refer to other Division 1 sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to:

1. Permits.
2. Applications for payment.
3. Performance and payment bonds.
4. Insurance certificates.
5. Listing of subcontractors.

H. Project Photographs. Submittal of project photographs is included under Section 01 3233, Construction Photographs.

I. Inspection and Test Reports. Submittal of inspection and test reports is included under Section 01 4000, Quality Control Services.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and other Division 1 specification sections, apply to this section.

1.3 CONTRACTOR'S RESPONSIBILITY

A. It is the duty of the Contractor to check all drawings, data, and samples prepared by or for him before submitting them to the Engineer for review. Each and every copy of the Drawings and data shall bear Contractor's stamp showing that they have been so checked. Shop drawings submitted to the Engineer without the Contractor's stamp will be returned to the Contractor for conformance with this requirement. Shop drawings shall indicate any deviations in the submittal from requirements of the Contract Documents.

B. The Contractor shall determine and verify:

1. Field measurements.
2. Field construction criteria.
3. Catalog numbers and similar data.
4. Conformance with Specifications.

C. Do not begin any of the work covered by a drawing, data, or a sample returned for correction until a revision or correction thereof has been reviewed and accepted by the Engineer.

D. Submit to the Engineer all drawings and schedules sufficiently in advance of construction requirements to provide no less than 21 calendar days for checking and appropriate action from the time the Engineer receives them.

E. Stagger shop drawing submittals and indicate priority for critical delivery items on the shop drawing submittal schedule.

F. Submit four copies for the Engineer plus the number of copies the Contractor requires of descriptive or product data submittals to complement shop drawings (up to a maximum of eight copies). The Engineer will retain four sets. All blueprint shop drawings shall be submitted with one set of reproducibles and only four sets of prints. The Engineer will review the blueprints and return to the Contractor the set of marked-up prints with appropriate review comments.
Contractor shall be responsible for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of the work prior to the review by Engineer of the necessary shop drawings.

1.4 ENGINEER’S REVIEW OF SHOP DRAWINGS

A. The Engineer’s review of drawings, data, and samples submitted by the Contractor is for general conformance with the design concept of the project and for general compliance with the information given in the Contract Documents. The Engineer's review and exception, if any, will not constitute an approval of dimensions, quantities, and details of the material, equipment, device, or item shown.

B. The review of drawings and schedules shall not be construed:

1. As permitting any departure from the Contract requirements;

2. As relieving the Contractor of responsibility for any errors, including details, dimensions, and materials;

3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.

C. If the drawings or schedules as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in contract price or time for performance, the Engineer may return the reviewed drawings without noting an exception.

D. When reviewed by the Engineer, each of the shop drawings will be identified as having received such review, being so stamped and dated. Shop drawings stamped "REVISE AND RESUBMIT" and with required corrections shown will be returned to the Contractor for correction and resubmittal.

E. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall direct specific attention, in writing or on resubmitted shop drawings, to revisions other than the corrections requested by the Engineer on previous submissions. Make any corrections required by the Engineer.

F. If the Contractor considers any correction indicated on the Drawings to constitute a change to the Contract Drawings or Specifications, the Contractor shall give written notice thereof to the Engineer.

G. The Engineer will review a submittal/resubmittal a maximum of 3 times, after which the cost of review will be borne by the Contractor. The cost of engineering will be equal to the Engineer's charges to the Owner under the terms of the Engineer's agreement with the Owner.

H. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.
I. No partial submittals will be reviewed. Submittals not complete will be returned to the Contractor, and will be considered "Rejected" until resubmitted.

1.5 SUBMITTAL PROCEDURES

A. Coordination. Coordinate preparation and processing of submittals with performance of the work. Transmit each submittal to the Engineer sufficiently in advance of scheduled performance of related construction activities to avoid delay.

1. Coordinate each submittal with other submittals and related activities that require sequential activity including:
   a. Testing.
   b. Purchasing.
   c. Fabrication.
   d. Delivery.

2. Coordinate transmittal of different types of submittals for the same element of the work and different elements of related parts of the work so that processing will not be delayed by the Engineer's need to review submittals concurrently for coordination.
   a. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are forthcoming.
   b. No extension of time will be authorized because of the Contractor's failure to transmit submittals to the Engineer sufficiently in advance of the work to permit processing.

B. Submittal Preparation. Prepare and submit shop drawings in accordance with the following:

1. Attach a submittal cover sheet to each copy of a shop drawing. The submittal cover sheet shall contain the following information:
   a. Project name and Owner's name.
   b. Contractor's name and address.
   c. Engineer's name and address.
   d. Specification section and title.
   e. Drawing reference number.
   f. Submittal number.
   g. Space to indicate the results of the Contractor's review.
   h. Space to indicate any deviations from the Contract Documents or comments by the Contractor.
   i. Space approximately 8 inches wide and 4 inches high for the Engineer to indicate the results of his review and any comments.

2. Each shop drawing submittal shall be assigned a sequential number, beginning with the number 1. Resubmittals shall be identified by a letter suffix (i.e., 1A, 1B, etc.).
C. Submittal Transmittal. Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer, and to other destinations, as indicated, by use of a transmittal form. Submittals received from sources other than the Contractor will be returned to the sender without action. A separate transmittal shall be used for each shop drawing submittal.

1.6 SHOP DRAWINGS

A. The term “shop drawings,” when used in the Contract Documents, shall be considered to mean Contractor’s plans for material and equipment which become an integral part of the Project. These drawings shall be complete and detailed. Shop drawings shall consist of fabrication, erection and setting drawings and schedule drawings, manufacturer's scale drawings, and wiring and control diagrams. Cuts, catalogs, pamphlets, descriptive literature, and performance and test data, shall be considered only as support to required shop drawings as defined above.

B. Drawings and schedules shall be checked and coordinated with the work of all trades involved before they are submitted for review by the Engineer. Contractor shall indicate whether the shop drawing complies with or deviates from the requirement of the Contract Documents.

C. If drawings show deviations from Contract requirements because of standard shop practice or for other reasons, the Contractor shall clearly mark and describe such deviation in his letter of transmittal. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility for executing the Work in accordance with the Contract, even though such drawings have been reviewed.

D. Data on materials and equipment include, without limitation, materials and equipment lists, catalog data sheets, cuts, performance curves, diagrams, materials of construction and similar descriptive material. Materials and equipment lists shall give, for each item thereon, the name and location of the supplier or manufacturer, trade name, catalog reference, size, finish and all other pertinent data.

E. Installation List. When requested by the Engineer, manufacturers or equipment suppliers who propose to furnish equipment or products shall submit an installation list to the Engineer along with the required shop drawings. The installation list shall include at least five installations where identical equipment has been installed and has been in operation for a period of at least 1 year.

F. Color. Only the Engineer will utilize the color "red" in marking shop drawing submittals.

G. Before final payment is made, the Contractor shall furnish to Engineer five sets of record drawings, all clearly revised, complete and up-to-date showing the permanent construction as actually made for all reinforcing and structural steel, miscellaneous metals, process and mechanical equipment, yard piping, electrical system and instrument system.

1.7 SAMPLES
A. Furnish, for the approval of the Engineer, samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed. The Contractor shall prepay all shipping charges on samples. Materials or equipment for which samples are required shall not be used in work until approved by the Engineer.

1.8 SPECIFIC SUBMITTAL REQUIREMENTS

A. Submit coordination drawings where required for integration of different construction elements. Show construction sequences and relationships of separate components where necessary to avoid conflicts in utilization of the space available.

B. Highlight, encircle, or otherwise indicate deviations from the Contract Documents on the shop drawings.

C. Do not permit shop drawing copies without an appropriate final stamp or other marking indicating the action taken by the Engineer to be used in connection with construction.

D. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit shop drawings on sheets at least 8½ by 11 inches but no larger than 30 by 40 inches.

1.9 PRODUCT DATA

A. Collect product data into a single submittal for each element of construction or system. Mark each copy to show which choices and options are applicable to the Project.

B. Where product data have been printed to include information on several similar products, some of which are not required for use on the project, or are not included in this submittal, mark copies to clearly indicate which information is applicable.

C. Where product data must be specially prepared for required products, materials, or systems, because standard printed data are not suitable for use, submit as "shop drawings," not "product data."

D. Include the following information in product data:

1. Manufacturer’s printed recommendations.
2. Compliance with recognized trade association standards.
3. Compliance with recognized testing agency standards.
4. Application of testing agency labels and seals.
5. Notation of dimensions verified by field measurement.
6. Notation of coordination requirements.

E. Submittals. Submit two copies of each required product data submittal; submit two additional copies where copies are required for maintenance manuals. The Engineer will retain one copy, and will return the other marked with the action taken and corrections or modifications required.
F. Distribution. Furnish copies of final product data submittal to manufacturers, subcontractors, suppliers, fabricators, installers, governing authorities and others as required for performance of the construction activities. Show distribution on transmittal forms.

1. Do not proceed with installation of materials, products and systems until a copy of product data applicable to the installation is in the installer’s possession.

2. Do not permit use of unmarked copies of project data in connection with construction.

1.10 ENGINEER’S ACTION

A. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:

1. Final Unrestricted Release: Where submittals are marked "NO EXCEPTIONS," that part of the work covered by the submittal may proceed, provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.

2. Final-But-Restricted Release: When submittals are marked "EXCEPTIONS AS NOTED," that part of the work covered by the submittal may proceed, provided it complies with both the Engineer’s notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.

3. Returned for Resubmittal: When submittal is marked "REVISE AND RESUBMIT," do not proceed with that part of the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the Engineer's notations; resubmit without delay. Repeat if necessary to obtain a different action mark.

   a. Do not permit submittals marked "REVISE AND RESUBMIT" to be used at the project site, or elsewhere where construction is in progress.

4. Rejected: When submittal is marked "REJECTED," the materials, equipment, and/or methods identified in the submittal do not comply with the Contract requirements and shall not be incorporated into the work. No resubmittal of the same materials, equipment, and/or methods shall be made.

5. Other Action: Where a submittal is primarily for information or record purposes, for special processing or other Contractor activity, the submittal will be returned, marked "Action Not Required."

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION (Not Applicable)

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SECTION 01 65 00

TRANSPORTATION AND HANDLING

PART 1 - GENERAL

1.1 SCOPE

A. Provide transportation of all equipment, materials, and products furnished under these Contract Documents to the site of the work. In addition, provide preparation for shipment and storage, unloading, handling and rehandling, short-term storage, extended storage, storage facilities, maintenance and protection during storage, preparation for installation, and all other work and incidental items necessary or convenient to the Contractor for the satisfactory prosecution and completion of the work.

1.2 TRANSPORTATION

A. Suitably box, crate, or otherwise protect all equipment during transportation.

B. Ship and deliver all equipment in the largest assembled sections practical or permitted by carrier regulations to minimize the number of field connections.

C. Ensure that the equipment is assembled and transported in such a manner so as to clear buildings, power lines, bridges, and similar structures encountered during shipment or delivery to the site of the work.

D. Ensure that the weights of the assembled sections do not exceed the capacity of the cranes or hoisting equipment where equipment will be installed using existing cranes or hoisting equipment.

E. Small items and appurtenances such as gauges, valves, switches, instruments, and probes which could be damaged during shipment shall be removed from the equipment prior to shipment and packaged and shipped separately. All openings shall be plugged or sealed to prevent the entrance of water or dirt.

F. Paint temporary shipping braces and supports orange or yellow for easy identification.

1.3 HANDLING

A. Carefully handle all equipment, materials, and products to prevent damage or excessive deflections during unloading or transportation. All equipment, materials, and products damaged during transportation or handling shall be repaired or replaced by the Contractor at no additional cost to the Owner prior to being incorporated into the work.

B. Strictly follow lifting and handling drawings and instructions furnished by the manufacturer or supplier. Eyebolts or lifting lugs furnished on the equipment shall be used in handling the equipment. Shafts and operating mechanisms shall not be used as lifting points. Spreader bars or lifting beams shall be used when the distance between lifting points exceeds that permitted by standard industry practice. Slings and chains shall be padded as required to prevent damage to protective coatings and finishes.

C. Under no circumstances shall equipment or products such as pipe, structural steel, casting, reinforcement, lumber, piles, poles, etc., be thrown or rolled off of trucks onto the ground.
D. Handle items such as nonmetallic pipe, nonmetallic conduit, flagpoles, and lighting poles using nonmetallic slings or straps.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. Equipment shall be received, inspected, unloaded, handled, stored, maintained, and protected by the Contractor in a suitable location on or off site, if necessary, until such time as installation is required.

B. Storage and protection of Contractor-furnished equipment shall be in strict conformance with the requirements of the applicable provisions of the General Conditions and Supplemental General Conditions or General Provisions of these Specifications.

1.2 STORAGE

A. Provide satisfactory storage facilities which are acceptable to the Engineer. In the event that satisfactory facilities cannot be provided on site, satisfactory warehouse, acceptable to the Engineer, will be provided by the Contractor for such time until the equipment, materials, and products can be accommodated at the site.

B. Equipment, materials, and products which are stored in a satisfactory warehouse acceptable to the Engineer will be eligible for progress payments as though they had been delivered to the job site.

C. Maintain and protect all equipment, materials, and products placed in storage and bear all costs of storage, preparation for transportation, transportation, re-handling, and preparation for installation.

D. Equipment and products stored outdoors shall be supported above the ground on suitable wooden blocks or braces arranged to prevent excessive deflection or bending between supports. Items such as pipe, structural steel, and sheet construction products shall be stored with one end elevated to facilitate drainage.

E. Building products and materials such as cement, grout, plaster, gypsum-board, particleboard, resilient flooring, acoustical tile, paneling, finish lumber, insulation, wiring, etc., shall be stored indoors in a dry location, unless otherwise permitted in writing by the Engineer. Building products such as rough lumber, plywood, concrete block, and structural tile may be stored outdoors under a properly secured waterproof covering.

F. Tarps and other coverings shall be supported above the stored equipment or materials on wooden strips to provide ventilation under the cover and minimize condensation. Tarps and covers shall be arranged to prevent ponding of water.

1.3 EXTENDED STORAGE
A. In the event that certain items of major equipment such as air compressors, pumps, and mechanical aerators have to be stored for an extended period of time, the Contractor shall provide satisfactory long-term storage facilities which are acceptable to the Engineer. The Contractor shall provide all special packaging, protective coverings, protective coatings, power, nitrogen purge, desiccants, lubricants, and exercising necessary or recommended by the manufacturer to properly maintain and protect the equipment during the period of extended storage.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies administrative and procedural requirements for operating and maintenance manuals including the following:

1. Preparation and submittal of operating and maintenance manuals for building operating systems or equipment.

2. Preparation and submittal of instruction manuals covering the care, preservation, and maintenance of architectural products and finishes.

3. Instruction of the Owner's operating personnel in operation and maintenance of building systems and equipment.

B. Special operating and maintenance data requirements for specific pieces of equipment or building operating systems are included in the appropriate sections of Divisions 2 through 49.

C. Preparation of shop drawings and product data are included in Section 01 33 23, Shop Drawings, Product Data and Samples.

D. General closeout requirements are included in Section 01 7800, Project Closeout.

E. General requirements for submittal of project record documents are included in Section 01 7839, Project Record Documents.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and other Division 1 specification sections, apply to this section.

1.3 QUALITY ASSURANCE

A. Operation and Maintenance Manual Preparation. In preparation of operation and maintenance manuals, use personnel thoroughly trained and experienced in operation and maintenance of the equipment or system involved.

1. Where written instructions are required, use personnel skilled in technical writing to the extent necessary for communication of essential data.

2. Where Drawings or diagrams are required, use drafters capable of preparing Drawings clearly in an understandable format.

B. Instructions for the Owner's Personnel. For instruction of the Owner's operating and maintenance personnel, use experienced instructors thoroughly trained and
experienced in the operation and maintenance of the building equipment or system involved.

1.4 SUBMITTALS

A. Submittal Schedule. Comply with the following schedule for submittal of operating and maintenance manuals.

1. Prior to the 80 percent completion point on the work, submit two draft copies of each manual to the Engineer for review. Include a complete index or table of contents of each manual.

2. Prior to substantial completion, make corrections or modifications to comply with the Engineer's comments and submit the specified number of copies of each approved manual to the Engineer.

3. Number: Four final copies of each manual.

B. Form of Submittal. Prepare operating and maintenance manuals in the form of an instructional manual for use by the Owner's operating personnel. Organize into suitable sets of manageable size. Where possible, assemble instructions for similar equipment into a single binder.

1. Binders: For each manual, provide heavy-duty, commercial quality, 3-ring, vinyl-covered loose-leaf binders, in thickness necessary to accommodate contents, sized to receive 8½- by 11-inch paper. Provide a clear plastic sleeve on the spine to hold labels describing the contents. Provide pockets in the covers to receive folded sheets.

   a. Where two or more binders are necessary to accommodate data, correlate data in each binder into related groupings in accordance with the project manual Table of Contents. Cross-reference other binders where necessary to provide essential information for proper operation or maintenance of the piece of equipment or system.

   b. Identify each binder on the front and spine, with the typed or printed title "OPERATION AND MAINTENANCE MANUAL," project title or name, and subject matter covered. Indicate the volume number for multiple-volume sets of manuals.

2. Dividers: Provide heavy paper dividers with celluloid-covered tabs for each separate section. Mark each tab to indicate contents. Provide a typed description of the product and major parts of equipment included in the section on each divider.


4. Text Material: Where written material is required as part of the manual, use the manufacturer's standard printed material, or if it is not available, specially prepared data, neatly typewritten, on 8½- by 11-inch, 20-pound white bond paper.
5. Drawings: Where drawings or diagrams are required as part of the manual, provide reinforced, punched binder tabs on the drawings and bind in with the text.

a. Where oversized drawings are necessary, fold the drawings to the same size as the text pages and use as a fold-out.

b. If drawings are too large to be used practically as a fold-out, place the drawing, neatly folded, in the front or rear pocket of the binder. Insert a typewritten page indicating the drawing title, description of contents, and drawing location at the appropriate location in the manual.

1.5 MANUAL CONTENT

A. In each manual include information specified in the individual specification section, and the following information for each major component of building equipment and its controls:

1. General system or equipment description.
2. Design factors and assumptions.
3. Copies of applicable shop drawings and product data.
4. System or equipment identification, including:
   a. Name of manufacturer.
   b. Model number.
   c. Serial number of each component.
5. Operating instructions.
7. Wiring diagrams.
8. Inspection and test procedures.
9. Maintenance procedures and schedules.
10. Precautions against improper use and maintenance.
12. Repair instructions including spare parts listing.
13. Sources of required maintenance materials and related services.

B. Organize each manual into separate sections for each piece of related equipment. As a minimum, each manual shall contain a title page, a table of contents, copies of product data supplemented by drawings and written text, and copies of each warranty, bond, and service contract issued.

1. Title Page: Provide a title page in a transparent plastic envelope as the first sheet of each manual. Provide the following information:

a. Subject matter covered by the manual.
b. Name and address of the project.
c. Date of submittal.
d. Name, address, and telephone number of the Contractor.
e. Name and address of the Engineer.
f. Cross reference to related systems in other operating and maintenance manuals.

2. Table of Contents: After the Title Page, include a typewritten table of contents for each volume, arranged systematically according to the project manual format. Include a list of each product included, identified by product name or other appropriate identifying symbol and indexed to the content of the volume.

a. Where more than one volume is required to accommodate data for a particular system, provide a comprehensive table of contents for all volumes in each volume of the set.

3. General Information: Provide a general information section immediately following the Table of Contents, listing each product included in the manual, identified by product name. Under each product, list the name, address, and telephone number of the subcontractor or installer, and the maintenance contractor. Clearly delineate the extent of responsibility of each of these entities. In addition, list a local source for replacement parts and equipment.

4. Product Data: Where manufacturer's standard printed data is included in the manuals, include only sheets that are pertinent to the part or product installed. Mark each sheet to identify each part or product included in the installation. Where more than one item in a tabular format is included, identify each item, using appropriate references from the Contract Documents. Identify data applicable to the installation and delete references to information that is not applicable.

5. Written Text: Where manufacturer's standard printed data is not available, and information is necessary for proper operation and maintenance of equipment or systems, or it is necessary to provide additional information to supplement data included in the manual, prepare written text to provide necessary information. Organize the text in a consistent format under separate headings for different procedures. Where necessary, provide a logical sequence of instruction for each operating or maintenance procedure.

6. Drawings: Provide specially prepared drawings where necessary to supplement manufacturer's printed data to illustrate the relationship of component parts of equipment or systems, or to provide control or flow diagrams. Coordinate these drawings with information contained in project record drawings to ensure correct illustration of the completed installation.

7. Do not use original record documents as part of the operating and Maintenance Manuals.

8. Warranties, Bonds, and Service Contracts: Provide a copy of each warranty, bond, or service contract in the appropriate manual for the information of the Owner's operating personnel. Provide written data outlining procedures to be followed in the event of product failure. List circumstances and conditions that would affect validity of the warranty or bond.

1.6 MATERIAL AND FINISHES MAINTENANCE MANUAL
A. Unless otherwise specified, submit three copies of each manual on material and finishes, in final form, to the Engineer for distribution. Provide one section for architectural products, including applied materials and finishes, and a second for products designed for moisture-protection and products exposed to the weather.

1. Refer to individual specification sections for additional requirements on care and maintenance of materials and finishes.

B. Architectural Products: Provide manufacturer’s data and instructions on care and maintenance of architectural products, including applied materials and finishes.

1. Manufacturer’s Data: Provide complete information on architectural products, including the following, as applicable:
   a. Manufacturer’s catalog number.
   b. Size.
   c. Material composition.
   d. Color.
   e. Texture.
   f. Reordering information for specially manufactured products.

2. Care and Maintenance Instructions: Provide information on care and maintenance, including manufacturer’s recommendations for types of cleaning agents to be used and methods of cleaning. Provide information regarding cleaning agents and methods that could prove detrimental to the product. Include manufacturer’s recommended schedule for cleaning and maintenance.

C. Moisture-Protection and Weather-Exposed Products: Provide complete manufacturer’s data with instructions on inspection, maintenance, and repair of products exposed to the weather or designed for moisture-protection purposes.

1. Manufacturer’s Data: Provide manufacturer’s data giving detailed information, including the following, as applicable:
   a. Applicable standards.
   b. Chemical composition.
   c. Installation details.
   d. Inspection procedures.
   e. Maintenance information.
   f. Repair procedures.

1.7 EQUIPMENT AND SYSTEMS OPERATION AND MAINTENANCE MANUAL

A. Unless otherwise noted, submit six copies of each completed manual on equipment and systems, in final form, to the Engineer for distribution. Provide separate manuals for each unit of equipment, each operating system, and each electric and electronic system.

1. Refer to specification sections for additional requirements on operating and maintenance of the various pieces of equipment and operating systems.

B. Equipment and Systems. Provide the following information for each piece of equipment, each building operating system, and each electric or electronic system.
1. **Description:** Provide a complete description of each unit and related component parts, including the following:

   a. Equipment or system function.
   b. Operating characteristics.
   c. Limiting conditions.
   d. Performance curves.
   e. Engineering data and tests.
   f. Complete nomenclature and number of replacement parts.

2. **Manufacturer's Information:** For each manufacturer of a component part or piece of equipment, provide the following:

   a. Printed operating and maintenance instructions.
   b. Assembly drawings and diagrams required for maintenance.
   c. List of items recommended to be stocked as spare parts.

3. **Maintenance Procedures:** Provide information detailing essential maintenance procedures, including the following:

   a. Routine operations.
   b. Trouble-shooting guide.
   c. Disassembly, repair, and reassembly
   d. Alignment, adjusting, and checking.

4. **Operating Procedures:** Provide information on equipment and system operating procedures, including the following:

   a. Start-up procedures.
   b. Equipment or system break-in.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Instructions on stopping.
   f. Shut-down and emergency instructions.
   g. Summer and winter operating instructions.
   h. Required sequences for electric or electronic systems.
   i. Special operating instructions.

5. **Servicing Schedule:** Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.

6. **Controls:** Provide a description of the sequence of operation and as-installed control diagrams by the control manufacturer for systems requiring controls.

7. **Coordination Drawings:** Provide each contractor's coordination drawings.

   a. Provide as-installed, color-coded piping diagrams, where required for identification.

8. **Valve Tags:** Provide charts of valve tag numbers, with the location and function of each valve.
9. Circuit Directories: For electric and electronic systems, provide complete circuit directories of panelboards, including the following:
   a. Electric service.
   b. Controls.
   c. Communication.

1.8 INSTRUCTION OF THE OWNER’S PERSONNEL

A. Prior to substantial completion, instruct the Owner’s personnel in operation, adjustment, and maintenance of products, equipment, and systems. Provide instruction at mutually agreed upon times.

1. For equipment that requires seasonal operation, provide similar instruction during other seasons.

2. Use operation and maintenance manuals as the basis of instruction for each piece of equipment or system. Review contents in detail to explain all aspects of operation and maintenance.

B. Training shall be conducted by an experienced, authorized service representative of the manufacturer (not a sales representative).

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION
SECTION 01 78 36

WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.

1. General closeout requirements are included in Section 01 7800, Project Closeout.

2. Specific requirements for warranties for the work and products and installations that are specified to be warranted, are included in the individual sections of Divisions 2 through 49.

B. Disclaimers and Limitations. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

C. Separate Prime Contracts: Each Prime Contractor is responsible for warranties related to its own contract.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and other Division 1 specification sections, apply to this section.

1.3 DEFINITIONS

A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.4 WARRANTY REQUIREMENTS

A. Standard Warranty: Warrant all equipment, materials, products, and workmanship provided under these Contract Documents for a period of 12 months after the date of substantial completion established by the Engineer.

B. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.

C. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty.
D. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. Complete warranty work as soon as possible after receipt of notice from the Owner for a warranty claim. The Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether the Owner has benefitted from use of the work through a portion of its anticipated useful service life.

E. Owner’s Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

2. If the required repairs or replacements have not been completed or if positive and good faith efforts have not been made to complete the repairs or replacements within 30 consecutive calendar days after receipt of notice from the Owner of the warranty claim, the Owner shall be authorized to proceed with the repairs or replacements and the cost thereof shall be assessed against the Contractor’s Performance Bond. Evidence of positive and good faith efforts shall include, as a minimum, joint visits by the Contractor and affected equipment vendors and manufacturers, and certified copies of purchase orders or invoices.

F. The Owner reserves the right to refuse to accept work for the project where a special warranty, certification, or similar commitment is required on such work or part of the work, until evidence is presented that entities required to countersign such commitments are willing to do so.

G. Multiple Equipment Failures. In the event of multiple equipment failures of major consequence prior to the expiration of the one-year warranty described above, disassemble, inspect, and modify or replace the affected equipment as necessary to prevent further occurrences. As used herein, "multiple equipment failures" shall be interpreted to mean two or more successive failures of the same kind in the same item of equipment or failures of the same kind in two or more items of similar equipment. Major equipment failures may include, but are not limited to, cracked or broken housings, piping, or vessels, excessive deflections, bent or broken shafts or structural members, broken or chipped gear teeth, overheating, premature bearing failure, excessive wear, or excessive leakage around seals. Should multiple equipment failures occur in a given item or type of equipment, disassemble, inspect, modify or replace, as necessary, all equipment of the same size and type, and rewarant for 12 months.

1.5 SUBMITTALS

A. Submit written warranties to the Engineer prior to the date certified for substantial completion. If the Engineer’s Certificate of Substantial Completion designates a commencement date for warranties other than the date of substantial completion for the work, or a designated portion of the work, submit written warranties upon request of the Engineer.

1. When a designated portion of the work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the work.
B. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier, or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.

1. Refer to individual sections of Divisions 2 through 49 for specific content requirements, and particular requirements for submittal of special warranties.

C. Form of Submittal. At final completion, compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Contract Documents.

1. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (NOT APPLICABLE).

PART 3 - EXECUTION (NOT APPLICABLE).

END OF SECTION
PART 1 - GENERAL

PART 1.1 SCOPE

A. This section specifies cast-in-place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

PART 1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and Section 100 specification sections, apply to this section.

PART 1.3 SUBMITTALS

A. General. Submit the following in accordance with conditions of contract and Division 1 specification sections.

B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterproofes, joint systems, curing compounds, and others as requested by Engineer.

C. Shop drawings for reinforcement, describing the fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures. Splices, clearances, and tolerances shall comply with ACI 318 requirements.

D. Shop drawings for formwork, prepared by a registered professional engineer, for fabrication and erection of forms for suspended slabs, beams, and other elevated concrete elements.

1. Engineer's review is for general design compliance only. Design of formwork for structural stability and efficiency is Contractor's responsibility.

E. Laboratory test reports for concrete materials and mix design test.

F. Materials certificates for the items listed below. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification for admixture manufacturers that chloride content complies with specification requirements.

1. Aggregates.
2. Cement.
3. Admixtures.
4. Reinforcement (including welds).
5. Curing compounds.
6. Waterstops.
7. Bonding compounds.

PART 1.4 QUALITY ASSURANCE

A. Codes and Standards. Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI 318, “Building Code Requirements for Reinforced Concrete.”

2. Concrete Reinforcing Steel Institute (CRSI), ”Manual of Standard Practice.”

B. Concrete Testing. The Owner will engage an independent testing laboratory to conduct testing of materials and concrete to ensure compliance with this Specification.

C. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting, of rejected materials or installed work which fails its initial testing, shall be done at Contractor’s expense.

PART 2 - PRODUCTS

PART 2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete. Plywood, metal, metal-framed plywood-faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.

1. Use overlaid plywood complying with U.S. Product Standard PS-1 “A-C or B-B High Density Overlaid Concrete Form,” Class 1.

2. Plywood complying with U.S. Product Standard PS-1 “B-B (Concrete Form) Plywood,” Class 1, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete. Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns and Supports. Metal, fiberglass-reinforced plastic, or paper or fiber tubes. Provide paper or fiber tubes of laminated plies with water-resistant adhesive and wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

D. Form Coatings. Provide commercial formulation form-coating compounds with a maximum VOC of 350 g/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

E. Form Ties. Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal.
Provide units that will leave no metal closer than 1½ inches to exposed surface. Provide ties that, when removed, will leave holes not larger than 1 inch diameter in concrete surface. Tie holes shall be filled with non-shrink grout.

PART 2.2 REINFORCING MATERIALS

A. Reinforcing Bars. ASTM A 615, Grade 60, deformed.

B. Epoxy-Coated Reinforcing Bars. ASTM A 775.

C. Steel Wire. ASTM A 82, plain, cold-drawn steel.


E. Welded Deformed Steel Wire Fabric. ASTM A 497.


1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

PART 2.3 CONCRETE MATERIALS

A. Portland Cement. ASTM C 150, Type I. Use one brand of cement throughout project unless otherwise acceptable to Engineer.

B. Fly Ash. ASTM C 618, Type C or Type F.

C. Normal Weight Coarse Aggregate. ASTM C 33, Class Designation 3S, Grading Size No. 67, and as herein specified. Provide coarse aggregate from a single source for all exposed concrete.

D. Normal Weight Fine Aggregate. Natural siliceous river sand, consisting of hard, clean, sharp, strong, durable, and uncoated particles, conforming to the requirements of ASTM C 33.

Fine aggregate shall have a fineness modulus of 2.40 minimum and 3.00 maximum and the material passing the No. 200 sieve shall not exceed 3.0 percent by weight of the total sample. Coal and lignite shall not exceed 0.5 percent by weight of the total sample for all concrete. The fineness modulus of fine aggregate incorporated in the work shall not vary more than 0.10 plus or minus from the fineness modulus of the fine aggregate in the appropriate preliminary mix design approved by the Engineer.

F. Water: Drinkable.

G. Admixtures, General. Provide admixtures for concrete that contain not more than 0.1 percent chloride ions.

1. Available Manufacturers: Provide admixtures from single source manufacturer for air entrainment and water reducing admixtures. Manufacturers of admixtures shall include but not be limited to the following provided single source availability requirements are met:
   a. Master Builders, Inc.
   c. Euclid Chemical Company.

2. Air-Entraining Admixture. ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

3. Water-Reducing Admixture: ASTM C 494, Type A.

4. High-Range Water-Reducing Admixture (Super Plasticizer). ASTM C 494, Type F or Type G.

5. Water-Reducing, Accelerating Admixture. ASTM C 494, Type E. Accelerating admixtures must be nonchloride type and are for use only when specifically authorized by the Engineer. Submittal of separate mix design using accelerating admixture will be required.

6. Water-Reducing, Retarding Admixture. ASTM C 494, Type D. Retarding admixtures must be nonchloride type and are for use only when specifically authorized by the Engineer. Submittal of separate mix design using retarding admixture will be required.

H. Fibrous Reinforcement: Engineered polypropylene fibers designed for secondary reinforcement of concrete slabs. (Use only where specially called for on the Drawings.)

1. Available Manufacturers: Subject to compliance with requirements, manufacturers whose products may be incorporated in the work include, but are not limited to, the following:
   b. Synthetic Industries.

PART 2.4 RELATED MATERIALS

A. Waterstops. Provide waterstops at construction joints and other joints as indicated on the Drawings.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
   1) The Burke Company.
   2) Greenstreak Plastic Products Company.
   3) W. R. Meadows, Inc.
   4) Progress Unlimited.
   5) Schlegel Corp.
   6) Vinylex Corp.

2. Bentonite Clay Waterstops. Specially formulated joint sealant, manufactured in coils with a rectangular cross section, which swells upon contact with water. Adhesive supplied by the water stop manufacturer shall be used to secure the waterstop to existing concrete prior to placing adjoining concrete.

   a. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, "Waterstop-RX," American Colloid Company.

B. Granular Base. Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.

C. Sand Cushion. Clean, manufactured or natural sand.

D. Vapor Retarder. Provide polyethylene sheet vapor retarder cover not less than 8 mils thick over prepared base material where indicated below slabs on grade. Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154.

E. Vapor Barrier. Multi-ply lamination of polyethylene film and glass scrim reinforced paper to form a moisture, scuff, and puncture-resistant membrane. Moisture permeance shall not exceed 0.10 perms in accordance with ASTM E 96, Procedure A.

   1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

F. Liquid Membrane-Forming Curing Compound. Liquid-type membrane-forming curing compound with fugitive dye complying with ASTM C 309, Type I-D, Class A. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers whose products may be incorporated in the work include, but are not limited to, the following:
      a. Dayton Superior Corp.
      b. Euclid Chemical.
      c. Sonneborn Rexnord.
G. Epoxy Bonding Agent. ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
   a. "Burke Epoxy M.V.,” The Burke Company.
   b. "Euco Epoxy System #452 or #620,” Euclid Chemical Co.

H. Chemical Hardener. U.S. Army Corps of Engineers Specification 204, liquid hardener composed of magnesium and zinc fluorosilicates combined with an anionic surfactant to improve wetting penetration. Hardener to be colorless, nontoxic, nonflammable, and compatible with and providing good adhesion for subsequent topping and/or coatings. Install hardener in accordance with manufacturer’s recommendations on interior concrete floors of shops, garages, vehicle service areas, and elsewhere as indicated on the Drawings.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

I. Joint Filler. At joints in slabs and elsewhere as indicated on the Drawings, use preformed strips of asphalt saturated fiberboard (½-inch nominal thickness) complying with ASTM D 1751.

PART 2.5 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

1. Fly ash may be substituted for cement in amounts not to exceed 20 percent of the specified cement content by weight providing that the mix conforms with all other requirements.

B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of concrete placement. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.

C. Design mixes to provide normal weight concrete with the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Concrete Class</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>28-day Compressive Strength:</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Average of Three Consecutive Specimens</td>
<td>4,000 psi</td>
<td>2,500 psi</td>
</tr>
<tr>
<td>Minimum Any One Specimen</td>
<td>3,200 psi</td>
<td>2,000 psi</td>
</tr>
</tbody>
</table>
### Concrete Class

<table>
<thead>
<tr>
<th>Property</th>
<th>Concrete Class A</th>
<th>Concrete Class B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Cement Content (sacks/cubic yard)</td>
<td>6.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>
| Maximum Water-to-Cement Ratio:  
  By Weight (pound/pound) | 0.49 | 0.54 |
|  
  By Sack (gallon/sack) | 5.5 | 6.0 |
| Air Content (percent by volume):  
  Minimum | 4.5 | 4.5 |
|  
  Maximum | 5.5 | 5.5 |
| Ratio of Coarse to Fine Aggregate (by weight):  
  Minimum | 1.0 | 1.0 |
|  
  Maximum | 2.0 | 2.5 |
|  
  Stone Gradation | #67 | #67 |

Class "A" concrete shall be used for all concrete work unless Class "B" is specifically called for on the Drawings.

D. Adjustment to Concrete Mixes. Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

**PART 2.6 ADMIXTURES**

A. Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in all concrete.

B. Use nonchloride accelerating admixture in concrete placed at ambient temperatures below 50°F (10°C) when authorized by the Engineer.

C. Use high-range water reducing admixture (HRWR) in pumped concrete.

D. Admixtures. Use admixtures for water reduction and set control in strict compliance with manufacturer's directions.

E. Slump Limits. Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
2. Walls: 2½ to 4 inches.
3. Floors and slabs: 2 to 3 inches.
4. Beams: 2 to 3 inches.
5. Blocks and Footings: 2 to 4 inches.
Concrete having a slump greater than 1 inch over the specified maximum shall be rejected.

In pumped concrete, the maximum slump of the concrete at the suction of the pump may be increased above the maximum specified slump by the amount of slump loss in the pumping system up to a maximum of 1 inch.

PART 2.7 CONCRETE MIXING

A. Job-Site Mixing. Only allowed when specifically authorized by the Engineer.

B. Ready-Mix Concrete. Comply with requirements of ASTM C 94, and as specified.

1. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce mixing and delivery time from 1½ hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes.

PART 2.8 EPOXY ANCHORS AND DOWELS

A. Anchors. Unless shown otherwise, dowels or anchors placed in existing or hardened concrete shall be stainless steel Type 304 or 316 ASTM F 593 and ASTM F 594, threaded rod with hex nuts.

B. Epoxy adhesive shall be as follows:

1. Two component, 100% solid (containing no solvents), non-sag paste, insensitive to moisture, grey in color.

2. Conform to NSF Standard 61 for use in conjunction with drinking water systems.

3. Conform to ASTM C 881-90; Type IV; Grade 3; Class A, B, and C with the exception of gel time.

4. Maximum shrinkage during cure per ASTM D 2566 of 0.00051 in./in.

5. Compressive strength, ASTM D 695: 10,300 psi minimum.

6. Shelf life: 3 years minimum.

7. Water solubility: None.


9. Epoxy adhesive shall be Epcon C-6, manufactured by ITW Ramset.
A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

PART 3.2 FORMS

A. General. Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

D. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges at ¾ inch unless indicated otherwise on the Drawings, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for Other Trades. Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and Tightening. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

PART 3.3 VAPOR RETARDER/BARRIER INSTALLATION

A. General. Following leveling and tamping of granular base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.

B. Lap joints 6 inches and seal vapor barrier joints with manufacturers' recommended mastic and pressure-sensitive tape.
C. After placement of vapor retarder/barrier, cover with sand cushion and compact to depth as shown on Drawings.

PART 3.4 PLACING REINFORCEMENT

A. General. Comply with ACI 318 and the CRSI's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as herein specified.

1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.

2. Field bending of reinforcement using heat and/or welding of reinforcement is NOT permitted.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Engineer.

D. Place reinforcement to obtain at least minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

PART 3.5 JOINTS

A. Construction and Control Joints. Locate and install construction and control joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer.

1. Provide keyways at least 1½ inches deep with a width of approximately one-half the thickness of the thinnest section being joined at construction and control joints in walls, slabs, between walls and slabs, and between walls and footings unless otherwise indicated. Acceptable bulkheads designed for this purpose may be used for slabs.

2. Place construction and control joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated. Do not continue reinforcement through sides of strip placements or at control joints.

3. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete at construction joints.
B. Waterstops. Provide waterstops in construction and control joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer’s printed instructions.

C. Isolation Joints in Slabs-on-Ground for Floors of Buildings, Sidewalks, and Driveways. Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated. Construct isolation joints using preformed joint filler board.

D. Contraction Joints in Slabs-on-Ground for Floors of Buildings, Sidewalks, and Driveways. Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 1/6 inch wide by 1/4 of slab depth or inserts 1/4 inch wide by 1/4 of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

2. Begin saw cutting of contraction joints in floor slabs as soon as possible after slab finishing as may be safely done without dislodging aggregate. Saw cutting must be completed within 8 hours following slab placement.

3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and locate to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

PART 3.6 INSTALLATION OF EMBEDDED ITEMS

A. General. Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.

B. Forms for Slabs. Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

PART 3.7 PREPARATION OF FORM SURFACES

A. General. Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before reinforcement is placed.

B. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

C. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.
PART 3.8 CONCRETE PLACEMENT

A. Inspection. Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.

B. General. Comply with ACI 304, “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete,” and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.

D. Placing Concrete in Forms. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

2. One operable, back-up, mechanical vibrator shall be on site prior to beginning concrete placement.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

E. Placing Concrete Slabs. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.


F. Cold-Weather Placing. If permitted by the Engineer, comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C) and not more than 80°F (27°C) at point of placement.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless authorized by the Engineer.

4. Provide adequate means for maintaining the temperature of the air surrounding the concrete at 70°F for three days, or 50°F for five days, or for as long as is necessary to ensure proper curing of the concrete. Rapid cooling of the concrete shall be prevented. Housing, covering, or other protection used in connection with heating shall remain in place and intact at least 24 hours after the artificial heat is discontinued.

G. Hot-Weather Placing. When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 85°F. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor’s option.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.

4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, when acceptable to Engineer.

PART 3.9 FINISH OF FORMED SURFACES

A. Coordinate finish requirements with surface preparation requirements for concrete to be coated in accordance with Section 09910, Painting.

B. Provide rough form finish for formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material, with tie holes and defective areas repaired and patched and fins and other projections exceeding ¼-inch in height rubbed down or chipped off.

C. Provide smooth form finish for formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with
selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

D. Grout-Cleaned Finish. Provide grout-cleaned finish as follows to concrete surfaces that have received smooth form finish treatment not to be coated with paint, waterproofing, dampproofing, or other similar system.

1. Combine one part portland cement to 1½ parts fine sand by volume, and a 50:50 mixture of acrylic-based bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.

2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

PART 3.10 MONOLITHIC SLAB FINISHES

A. Coordinate finish requirements with surface preparation requirements for concrete to be coated in accordance with Section 09910, Painting.

B. Float Finish. Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and as otherwise indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance of plus or minus ¼-inch as measured from a 10-foot straight edge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish. Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.

D. Trowel and Fine Broom Finish. Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
E. Non-slip Broom Finish. Apply non-slip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

PART 3.11 CONCRETE CURING AND PROTECTION

A. General. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

B. Initial Curing. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.

C. Curing Methods. Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified. Select curing method appropriate for subsequent coating and finishing requirements. Coordinate curing methods with Section 09910, Painting, for concrete to be painted.

1. Provide moisture curing by either of the following methods or combination thereof, maintaining concrete surface moisture for seven days:
   a. Keep concrete surface continuously wet by covering with water.
   b. Use continuous water-fog spray.
   c. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.

2. Moisture-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Maintain concrete surface moisture for seven days.

3. Curing and sealing compound, when utilized, shall be applied as follows:
   a. Flatwork: Apply curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within two hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
b. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

c. Formed Surfaces: Apply curing and sealing compound upon removal of formwork.

4. **Curing Formed Surfaces:** Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

5. **Curing Unformed Surfaces:** Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

   a. Cure concrete surfaces to receive liquid floor hardener or other finish by use of moisture-retaining cover, unless otherwise directed.

**PART 3.12  REMOVAL OF FORMS**

A. **General.** Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 72 hours after placing concrete, provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beams, soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

**PART 3.13  REUSE OF FORMS**

A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces except as acceptable to Engineer.

**PART 3.14  MISCELLANEOUS CONCRETE ITEMS**

A. **Filling In.** Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place.
Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

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

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

D. Reinforced Masonry. Provide concrete grout for reinforced masonry lintels and bond beams where indicated on Drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

E. Concrete Embedment and Encasement of Pipe. Install concrete for embedment and encasement where indicated on the Drawings and at such locations where installation conditions require such pipe support as determined by the Engineer. Embedment and encasement of pipe shall be preceded by the following preliminary steps:

1. Remove all loose material from the trench prior to placing concrete. All concrete shall have a continuous contact with undisturbed soil on sides and bottom of trench.

2. Accurately place a base course of concrete to such grade and elevation that the pipe will be at specified grade when pipe bells are supported on, and in contact with, the top surface of the base course.

3. Restrain each length of pipe to maintain alignment and prevent floatation in a manner acceptable to the Engineer.

PART 3.15  CONCRETE SURFACE REPAIRS

A. Patching Defective Areas. Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Engineer.

1. Cut out honeycomb, rock pockets, voids over ¼-inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.

2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

B. Repair of Formed Surfaces. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects, as such, include
color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

C. Repair of Unformed Surfaces. Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.

1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.

2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete.

4. Repair defective areas, except random cracks and single holes not exceeding 1-inch-diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least ¾-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

D. Repair isolated random cracks and single holes not over 1-inch-diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2½ parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack before bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

E. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar.

F. Repair methods not specified above may be used, subject to acceptance of Engineer.
PART 3.16  QUALITY CONTROL TESTING DURING CONSTRUCTION

A. General. The Owner will employ a testing laboratory to perform tests and to submit test reports.

B. Field Sampling and Testing. During concreting operations, the Engineer will periodically require additional field inspection, sampling, and testing of cement, aggregate, and/or concrete by an independent testing laboratory in order to determine if the requirements of this specification section are being satisfied.

1. Field sampling and testing of cement, aggregate, and concrete will be performed according to the following ASTM standards at a frequency determined by the Engineer:

   a. Aggregate
      1) Sampling  ASTM D 75
      2) Testing    Any test specified in ASTM C 33

   b. Cement
      1) Sampling  ASTM C 183
      2) Testing    Any test specified in ASTM C 150

   c. Concrete
      1) Sampling  ASTM C 172
      2) Slump Test ASTM C 143
      3) Air Content Test ASTM C 231
      4) Making and Curing Test Cylinders ASTM C 31
      5) Compression Strength Tests ASTM C 39

2. Compressive strength testing will consist of making, curing, and testing cylinders of concrete. A total of six test cylinders will be prepared from each sample of concrete to be tested. Two test cylinders will be broken at an age of 7 days, three test cylinders will be broken at an age of 28 days, and the remaining test cylinders will be held in reserve. The minimum number of samples and test cylinders to be taken is as follows:

<table>
<thead>
<tr>
<th>Total Size of Pour (CY)</th>
<th>Number of Samples</th>
<th>Number of Cylinders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 100</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>101 - 200</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>201 - 300</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Over 300</td>
<td>1/100 CY</td>
<td>6/100 Cy</td>
</tr>
</tbody>
</table>

3. Test cylinders will normally be laboratory-cured. However, the Engineer may require tests on field-cured specimens to check the adequacy of curing operations.

4. A slump test and an air content test will be performed on each sample of concrete tested for compressive strength.
5. Cement and aggregate will be subject to inspection, sampling, and field testing at the batching plant. Concrete will be subject to inspection, sampling, and field testing at the place of concrete placement.

6. All field sampling, field testing, making and curing of field test cylinders, and laboratory testing performed during concreting operations for the purpose of determining if the requirements of this specification section are being satisfied shall be conducted by an independent testing laboratory selected by the Owner and paid for directly by the Owner and not as a part of this Contract.

7. Furnish the testing laboratory representative satisfactory samples of cement, aggregate, and concrete for inspection and testing purposes. The Contractor shall furnish any barrows, shovels, mixing boards, shaded area for preparing test cylinders, and similar equipment required by the testing laboratory representative for securing samples, making test cylinders, and conducting field tests.

C. Test results will be reported in writing to Engineer, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

D. Nondestructive Testing. Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

E. Additional Tests. The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for any and all such tests.

PART 3.17 LOADS APPLIED TO NEW CONCRETE

A. Loads including, but not limited to, earth loads, loads exerted from bracing or shoring, wind loads, hydrostatic or hydraulic loads, equipment or vehicle loads, or loads exerted by stacked materials, shall not be applied to fresh concrete until the concrete has reached its specified 28-day strength.

B. Concrete which has cracked due to overloading, loading before required strength has developed, or otherwise damaged shall be repaired or replaced as determined by the Engineer.

PART 3.18 INSTALLATION OF EPOXY ANCHORS AND DOWELS

A. Verify number, size, depth, and location of anchors or dowels to be installed.

B. Drill holes in concrete to the depth specified on the Drawings using methods as instructed by the epoxy manufacturer. The diameter of holes shall be as instructed by
the epoxy manufacturer for the anchor or dowel being installed. Clean holes as instructed by the epoxy manufacturer.

C. Install epoxy in strict accordance with the manufacturer's instructions using guns with self-mixing nozzles provided by the manufacturer. Verify epoxy is mixed prior to placement into the hole using methods per manufacturer's instructions. Insert dowel or anchor into the hole and hold steady as instructed by the manufacturer.

END OF SECTION
PART 1 - GENERAL

PART 1.1 DESCRIPTION

A. Under this section furnish all materials, equipment, and labor to accomplish all painting necessary or convenient to the Contractor for the satisfactory completion of the work included under these Contract Documents. The words "paint" and "painting" used in this specification apply to and also describe the use and application of protective coatings.

B. In general, the work included under this section shall include the surface preparation, shop priming, field priming, and/or field painting of all surfaces identified in Part 3.5, Protective Coating Schedule, of this section. These surfaces include, but are not limited to, the following:

1. Wood
2. Ferrous metals (except stainless steel or pre-finished surfaces)
3. Galvanized metal
4. Concrete and masonry
5. Gypsum wallboard and plaster
6. Piping and pipe insulation, including:
   a. Aluminum
   b. Cast or ductile iron
   c. Copper
   d. Fiberglass
   e. PVC
   f. Stainless steel
   g. Steel pipe

C. Aluminum, bronze, copper, stainless steel, and/or other corrosion-resistant metal surfaces (excluding piping) shall not be painted unless specifically called for on the Drawings or in these Contract Documents.

PART 1.2 QUALITY ASSURANCE

A. Submit to the Engineer for his review the following information concerning the materials the Contractor proposes to use in work covered by this item:

1. A list of all components (paints or other materials) to be used in each painting system required herein.

2. A complete descriptive specification of each component.
Only those systems and components which are judged acceptable by the Engineer shall be utilized in the work covered by this item. No materials shall be delivered to the job site until the Engineer has evaluated their acceptability.

B. All products submitted shall be lead- and chromate-free formulations and comply to current VOC emission regulations. Manufacturers technical data sheets must contain the following information:

1. Manufacturer's name
2. Type of paint or other generic identification
3. Manufacturer's stock number
4. Color (if any)
5. Type of gloss
6. Minimum flash point
7. Percent solids by volume
8. Recommended dry film thickness per coat
9. Theoretical coverage rates
10. Instructions for mixing, thinning, or reducing (as applicable)
11. Manufacturer's application recommendations
12. Safety and storage information
13. Viscosity at ambient temperature
14. Average dry times (dry to touch, dry to recoat) at ambient temperature.
15. Recommended thinners and maximum thinning permissible to meet current VOC regulations.
16. Recommended primer if applicable
17. Application method (brush, roll, conventional or airless spray)
18. VOC level of coating
19. Instructions for mixing multiple component materials

C. Obtain the Engineer's review of the first finished room, space, area, item, or portion of work of each surface type and color specified. The first room, space, area, item, or portion of work which is acceptable to the Engineer shall serve as the project standard for all surfaces of similar type and color. Where spray application is utilized, the area to be reviewed shall not be smaller than 100 square feet.

D. An authorized representative of the coatings manufacturer shall be present at the start-up and periodically during painting operations. Such representative shall instruct and observe the Contractor's workmanship and shall, at the completion of the work, certify in writing to the Engineer that the manufacturer's application recommendations were followed.

E. Contractor Qualification. Contractor must provide documentation that he has previously performed this type of work and provide job references as required by the Engineer. Provide a written guarantee against defective materials and workmanship in accordance with these Specifications.
PART 1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver all paint, primers, varnishes, and sealers to the job site in their original, unopened containers not exceeding 5-gallon capacity each, unless otherwise specified herein. With the permission of the Engineer, the manufacturer may use and ship in agitator barrels. Paint containers shall not be opened until they have been inspected and approved by the Engineer.

B. Store paint and related materials and equipment in a suitable location on the project site away from work areas and other storage areas. Strictly adhere to all applicable health, safety, and fire regulations controlling the storage of paint and related materials. Store and handle all materials in accordance with the manufacturer's recommendations.

C. Each container shall be marked with the manufacturer's name, product number, and batch number. The labels shall also show mixing and thinning instructions, and recommended dry film thickness of each product. Use thinner recommended by the manufacturer. The use of accelerators must be approved by the Engineer. Any substitutions of generic thinners must be approved by the Engineer.

PART 1.4 JOB CONDITIONS

A. Strictly follow the manufacturer's recommendations concerning environmental conditions under which a material can be applied. No finishes shall be applied in areas where dust is being generated.

B. Cover or otherwise protect the finished work of other trades, surfaces not being painted concurrently, and/or surfaces which are not to be painted. Any injury or damage to such surfaces shall be remedied at Contractor's expense to the satisfaction of the Engineer before final acceptance, and no separate payment therefor will be made.

PART 1.5 TESTING EQUIPMENT

A. Furnish and make available to the Engineer the following items of testing equipment for use in determining if the requirements of this Specification section are being satisfied. The specified items of equipment shall be available for the Engineer's use at all times when field painting or surface preparation is in progress.

1. Wet film gauge
2. Surface thermometer
3. Spring micrometer with surface profile tape
4. Set of Steel Structures Painting Council Visual Standards (SSPC-VIS 1-89)
5. Holiday (pin hole) detector (low voltage)
6. Sling-psychrometer and psychrometric tables
7. Magnetic dry film gauge (Type 1 or Type 2) with appropriate calibration shims or plates.

PART 2 - PRODUCTS

PART 2.1 ACCEPTABLE MANUFACTURERS

A. The specific products and manufacturers listed for each general product classification in Part 2.2, Materials List, of this section are given only to identify the generic type, quality, and general composition required for each product. Furnish similar products of other manufacturers subject to the review of the Engineer in accordance with the provisions of Part 1.2, Quality Assurance, of this section. The utilization of named products as given in Part 2.2, Material List, of this section does not excuse the Contractor from complying with the provisions of Part 1.2.

B. All materials used in successive field coats shall be produced by the same manufacturer. Material used in the first field coat over shop painted or previously painted surfaces shall cause no wrinkling, lifting, or other damage to underlying paint.

PART 2.2 MATERIAL LIST

Primers and Finishes. Subject to compliance with requirements, provide one of the following:

**TYPE**

A. Fillers, Sealers, and Surfacers

FS-1  Concrete/Steel

"63-1500 Filler and Surfacer," TNEMEC

FS-2  Masonry

"54-660 Masonry Filler," TNEMEC
"Sanitile 250 W.B. Block Filler," Carboline

FS-3  Concrete

"Series 434 Perma-Shield H2S," Tnemec
"Steel-Seam FT910," Sherwin-Williams

FS-4  Drywall Sealer

"51-792 PVA Sealer," TNEMEC
B. Primers

**TYPE**

**P-1** Alkyd
"Series 36 Undercoater," TNEMEC

**P-2** Waterborne Acrylic
"Carboline Multi-Bond 120," Carboline

**P-3** Latex
"79-W-1 Latex Primer," Valspar

**P-4** Interior Wood Stain
"Ultra-Hide Oil Base Stain No. 280," Glidden
"Interior Wood Stain," Sherwin-Williams

**P-5** High Temperature - Zinc Rich
"Series 90E92 Tneme-Zinc," TNEMEC
"MZ-7 Inorganic Zinc Rich 13-F-12," Valspar

**P-6** High levels of Hydrogen Sulfide - Vinyl Ester
"Series 120-5002 Beige Vinester Primer," TNEMEC

**P-7** High levels of Hydrogen Sulfide - Modified Phenolic
"Phenoline 300 Primer," Carboline

**P-9** Non-immersion (Exterior)
"Series 68 Poxiprime II," TNEMEC
"13-R-62 Epoxy Primer," Valspar
"Carboline 893 Primer," Carboline

**P-10** Concrete Floors - Epoxy
"Series 201 Epoxoprime," TNEMEC
"Carboline 890 Epoxy (thinned 12%)," Carboline

C. Finishes

**F-1** Acrylic
"Series 6/7-Color Tneme-Cryl"," TNEMEC
"Carboline 3359 Acrylic," Carboline

* Series 6 - Matte Finish; 7 - Semi-Gloss Finish.

**F-2** Latex
"79 Series Latex," Valspar
TYPE

F-3 Interior Wood Varnish
"Spred Urethane Varnish No. 10," Glidden
"Marrethane Satin Varnish," Sherwin-Williams

F-4 Immersion (Potable water - NSF Approved)
"Series 140 Pota-Pox Plus," TNEMEC
"NSF V78PR Series Hi-Build Epoxy," Valspar
"Super Hi-Gard 891," Carboline

F-5 Immersion (Non-potable water)
"Series 69 Hi-Build Epoxoline II," TNEMEC
"V78PR Series Hi-Build Epoxy," Valspar
"Carboline 890 Epoxy," Carboline

F-6 High levels of Hydrogen Sulfide
"Series 435 Perma-Glaze," Tnemec
"Cor-Cote SC Sewer-Cote," Sherwin-Williams

F-7 High levels of Hydrogen Sulfide - Modified Phenolic
"Phenoline 302 Finish," Carboline

F-8 Non-immersion (Exterior/Interior)
"Series 66 Hi-Build Epoxoline," TNEMEC
"V89 Series Hi-Build Epoxy," Valspar
"Carboline 890 Epoxy," Carboline

F-9 Exterior - Urethane
"Series 74/75-Color Endura-Shield," TNEMEC
"V40 Series Urethane Enamel," Valspar
"Carbothane 134 HS," Carboline

F-10 Below Grade - Coal Tar Epoxy
"46H-413 Hi-Build Tneme-Tar," TNEMEC
"Bitumastic 300M," Carboline

F-11 Exterior Concrete - Modified Epoxy
"52-Color Tneme-Crete," TNEMEC

F-12 Below Grade - Modified Polyurethane
"Series 262 Elasto-Shield," TNEMEC
TYPE

F-13 Concrete Floors - Epoxy
"Series 67 Tneme-Tread," TNEMEC
"Carboline 890 Epoxy," Carboline

F-14 Concrete Floors - Aggregate Filled Epoxy
"Series 221 Lami-Tread," TNEMEC

F-15 Concrete Floors - Ceramic Filled Epoxy
"Series 222 Deco-Tread," TNEMEC

F-16 Concrete Floors - Color Epoxy Finish
"Series 280 Tneme-Glaze," TNEMEC

F-17 Concrete Floors - Clear Epoxy Finish
"Series 284 Deco-Clear," TNEMEC

F-18 Concrete - Acrylic Emulsion
"Series 180/181 W.B. Tneme-Crete," TNEMEC

F-19 High Temperature - Silicone
"39-1061 Silicone Aluminum," TNEMEC

F-20 Polyurethane
"Series 70 and 71 Endura Shield," TNEMEC

PART 2.3 COLORS

A. Color Cards. Submit color cards for all paints, stains, or other materials to the Engineer for review and color selection. Only those colors which have been reviewed and accepted by the Engineer shall be utilized in work covered by this section.

PART 2.4 PIPE AND EQUIPMENT IDENTIFICATION

A. Pipe Color Code

1. Pipe: Color code all pipes, including insulated pipe, in accordance with the schedule given below. Where applicable, colors shall comply with the specifications described in Section 3, "Color Definitions," of ANSI Z53.1. Other colors shall be selected by the Engineer in accordance with Part 2.3, Colors, of this section.
2. Stripes where required shall consist of 6-inch-wide bands completely around the pipe located 36 inches on centers. On pipe runs less than 36 inches in length, one color band shall be located at the center of the run.

3. Color Schedule

<table>
<thead>
<tr>
<th>Material</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hazardous</strong></td>
<td></td>
</tr>
<tr>
<td>Acid</td>
<td>Yellow with Black Stripes</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Yellow</td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td>Yellow with Red Stripes</td>
</tr>
<tr>
<td>Hydraulic Fluid Piping</td>
<td>Yellow with Blue Stripes</td>
</tr>
<tr>
<td>Lime Slurry</td>
<td>Yellow with Green Stripes</td>
</tr>
<tr>
<td><strong>Air Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Instrument Air</td>
<td>Green with White Stripes</td>
</tr>
<tr>
<td>Process Air</td>
<td>Green</td>
</tr>
<tr>
<td>Vacuum</td>
<td>Green with Red Stripes</td>
</tr>
<tr>
<td><strong>Flammable</strong></td>
<td></td>
</tr>
<tr>
<td>Digester Gas</td>
<td>Orange</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>Orange with Blue Stripes</td>
</tr>
<tr>
<td><strong>Process Water</strong></td>
<td></td>
</tr>
<tr>
<td>Plant Water</td>
<td>Red with Black Stripes</td>
</tr>
<tr>
<td>Seal Water</td>
<td>Red</td>
</tr>
<tr>
<td>Wash Water (High Pressure)</td>
<td>Red with Yellow Stripes</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>Red with White Stripes</td>
</tr>
<tr>
<td><strong>Sludge</strong></td>
<td></td>
</tr>
<tr>
<td>Blended Sludge</td>
<td>Tan with Blue Stripes</td>
</tr>
<tr>
<td>Digested Sludge</td>
<td>Tan with Green Stripes</td>
</tr>
<tr>
<td>Primary Sludge</td>
<td>Tan with Orange Stripes</td>
</tr>
<tr>
<td>Return or Recirculated Sludge</td>
<td>Tan</td>
</tr>
<tr>
<td>Transfer Piping</td>
<td>Tan with Red Stripes</td>
</tr>
<tr>
<td>Waste Activated Sludge</td>
<td>Tan with Black Stripes</td>
</tr>
<tr>
<td><strong>Vents</strong></td>
<td></td>
</tr>
<tr>
<td>Digester Gas Vents</td>
<td>Aluminum with Orange Stripes</td>
</tr>
<tr>
<td>Fuel Oil Vents</td>
<td>Aluminum with Blue Stripes</td>
</tr>
<tr>
<td>Sanitary Vents</td>
<td>Aluminum with Black Stripes</td>
</tr>
<tr>
<td>Other Vents</td>
<td>Aluminum with Green Stripes</td>
</tr>
</tbody>
</table>
### Material

<table>
<thead>
<tr>
<th>Process Piping</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating and Heat Recovery</td>
<td>Gray with Red Stripes</td>
</tr>
<tr>
<td>Piping (Steam)</td>
<td></td>
</tr>
<tr>
<td>Supernatant, Decant, or Filtrate</td>
<td>Gray</td>
</tr>
<tr>
<td>Overflow</td>
<td>Black</td>
</tr>
<tr>
<td>Raw Sewage (Sanitary)</td>
<td>Black</td>
</tr>
</tbody>
</table>

### Miscellaneous

<table>
<thead>
<tr>
<th>Electrical Conduit</th>
<th>Aluminum*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>White</td>
</tr>
<tr>
<td>Potable Water</td>
<td>Blue</td>
</tr>
<tr>
<td>Roof Drains</td>
<td>Gray with Blue Stripes</td>
</tr>
</tbody>
</table>

*Where electrical conduit is exposed in a finished room or area, the conduit shall be painted to match room finish.

### B. Pipe Labels

1. **Legends:** After other painting of pipe work has been completed as provided for above, label all pipe work with stenciled legends. Legends shall be descriptive of the function of the pipe, such as "ACID." Provide two legends, one legend on each side of the pipe, at a suitable location along each pipe run. For long runs of pipe, provide legends at intervals not exceeding 20 feet. Locate the legend on the pipe so that it will be in direct line of vision. Legend may be omitted from one side if view is obstructed from that side. Where the flow in a pipe shall be at all times in one direction only, then a flow arrow shall be placed in front of each legend on the pipe. The lettering and arrows shall be cut neatly into stencils, the arrows being the same height as the letters. The size of lettering shall be as follows:

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe or Covering</th>
<th>Size of Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; to 1-1/4&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>1-1/2&quot; to 2&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>2-1/2&quot; to 6&quot;</td>
<td>1-1/4&quot;</td>
</tr>
<tr>
<td>8&quot; to 10&quot;</td>
<td>2-1/2&quot;</td>
</tr>
<tr>
<td>Over 10&quot;</td>
<td>3-1/2&quot;</td>
</tr>
</tbody>
</table>

2. **Tag:** For pipes smaller than 3/4 inch in outside diameter, use a laminated plastic or aluminum tag with the lettering etched or stamped and filled in with black or contrasting enamel.
3. Legends and Flow Arrows: The legends and flow arrows shall be stenciled with approved black or contrasting stencil paint. The above outline of intent designates the general extent of the identification work and is not exclusive of other similar work such as identification of pumps and other equipment as may be directed by the Engineer. Following the completion of the work under this item, deliver to the Owner two sets of all stencils used.

4. Equipment Labels: Where specified in these Contract Documents or directed by the Engineer, paint stencil legends, in the same manner as a pipe of appropriate size on the individual units of equipment such as blowers, pumps, collector drives, compressors, silencers etc. All push buttons, starters, switches, etc., when remote from the equipment controlled and/or power packs, shall have labels of the engraved plastic type affixed to or adjacent to the remote switch, push button, starter, etc.

PART 2.5 MIXING AND TINTING

A. All paints and other materials shall be mixed and tinted by the paint manufacturer prior to delivery to the job site, when possible.

B. Strictly adhere to the manufacturer's recommendations when job site mixing and/or tinting is required. The Contractor shall be solely responsible for the proper conduct of all on-site mixing and/or tinting.

PART 3 - EXECUTION

PART 3.1 CONTRACTOR'S INSPECTION

A. Examine all surfaces scheduled to receive paint or other finishes for conditions that will adversely affect execution, permanence, or quality of work covered by this item. Surfaces which cannot be put into an acceptable condition through preparatory work as included in Part 3.2, Preparation of Surfaces, shall be immediately brought to the attention of the Engineer.

B. Do not proceed with surface preparation or coating application until surface conditions are suitable.

PART 3.2 PREPARATION OF SURFACES

A. Surface Preparation Specifications

1. General. Where abrasive blasting is specified, a low free silica abrasive with a silica content of <5% shall be used. Mineral slag by-products may
not be used. Abrasive blasting should produce a surface profile of not less than 1.5 mils or greater than 3.5 mils.

2. SSPC-SP 1 "Solvent Cleaning": Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces.

3. SSPC-SP 2 "Hand Tool Cleaning": Hand tool cleaning is a method of preparing steel surfaces by the use of non-power hand tools. Hand tool cleaning removes all loose mill scale, loose rust, paint, and other loose detrimental foreign material. It is not intended that adherent mill scale, rust, and paint be removed by this process. Mill scale, rust, and paint are considered tightly adherent if they cannot be removed by lifting them with a dull putty knife.

4. SSPC-SP 3 "Power Tool Cleaning": Power tool cleaning is a method of preparing steel surfaces by the use of power assisted hand tools. Power tool cleaning removes loose rust, paint, and other loose detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Mill scale, rust, and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.

5. SSPC-SP 5 "White Metal Blast Cleaning": A white metal blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter.

6. SSPC-SP 6 "Commercial Blast Cleaning": A commercial blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter, except for staining. Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks or minor discolorations caused by stains of rust, stains of mill scale or stains of previously applied paint. Slight residues of rust and paint may also be left in the bottoms of pits if the original surface is pitted.

7. SSPC-SP 7 "Brush-Off Blast Cleaning": A brush-off blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust and loose paint. Tightly adherent mill scale, rust and paint may remain on the surface. Mill scale, rust and paint are considered tightly adherent if they cannot be removed by lifting with a dull putty knife.
8. **SSPC-SP 10 "Near-White Blast Cleaning":** A near-white blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and any other foreign matter, except for staining. Staining shall be limited to no more than 5 percent of each square inch of surface area and may consist of light shadows, slight streaks or minor discolorations caused by stains of rust, stains of mill scale or stains of previously applied paint.

B. **Wood surfaces to be primed and/or painted shall be prepared in accordance with the following requirements prior to application of primer or paint:**

1. **Exterior or Interior, Painted:** Surface must be dry, clean, and free of contaminants. Rough areas shall be sanded to a smooth, even surface and then vacuum cleaned. Knots, pitch pockets, and/or resinous sapwood shall be sealed with shellac, not over 2 pounds cut, prior to the application of primer. Holes, cracks, open joints, and other defects shall be puttied smooth following the application of the primer. Putty used shall be compatible in all respects with the primer and finish coating.

2. **Interior, Stained:** Surface shall be thoroughly cleaned, sanded, and dusted. Final sanding shall be in the direction of the grain only. Dust shall be removed by vacuuming.

C. **Ferrous Metal (Excluding Stainless Steel)**

1. **Immersion Surfaces:** "Near-White Blast Cleaning" in accordance with SSPC-SP 10 (NACE No. 2). Abrasive blasting shall achieve an anchor pattern or blast profile of between 30 and 40 percent of the dry film thickness of the first applied coat of primer or paint.

2. **Non-Immersion Surfaces:** "Commercial Blast Cleaning" in accordance with SSPC-SP 6 (NACE No. 3). Abrasive blasting shall achieve an anchor pattern or blast profile of between 30 and 40 percent of the dry film thickness of the first applied coat of primer or paint.

3. **High Temperature System:** "Near White Blast Cleaning" in accordance with SSPC-SP 10 (NACE No. 2). Abrasive blasting shall achieve an anchor pattern or blast profile of between 30 and 40 percent of the dry film thickness of the first applied coat of primer or paint.

4. **Field Preparation of Shop Primed Surfaces:** "Solvent Cleaning" in accordance with SSPC-SP 1. Shop primed ferrous metal surfaces which have been damaged or which show signs of corrosion shall be sand blasted and/or cleaned in accordance with the specification given above for...
the particular finish coating to be applied prior to the application of the field primer or finish coating.

D. Nonferrous Metals

1. Galvanized Metal: Surfaces shall be clean, dry, and free of contaminants. Manufacturer or fabricator-applied silicate pretreatment shall be removed by sanding. The surface should always be wiped with an acceptable solvent for removing oil and grease. New galvanized metal should receive a SSPC-SP 7 Brush-Off Blast to ensure good adhesion. The white deposit on weathered galvanized metal should be removed with detergent and water and rinsed well with clean water.

2. Aluminum: The surface should always be wiped with an acceptable solvent for removing oil and grease. Light sanding or light abrasive blast cleaning, and/or a phosphoric etch should be used on aluminum that is not anodized or alodized to assure good adhesion. Etching solutions should be used according to manufacturers recommendations.

3. Copper Piping: Surfaces shall be cleaned with a mild phosphoric acid cleaner followed by water washing. Dull surfaces shall be buffed or polished to a bright color. Primer shall be applied while surface is clean and bright.

E. Stainless Steel Piping: Surfaces shall be clean, dry, and free of contaminants. Oils, greases, waxes, etc., shall be removed by solvent cleaning in accordance with SSPC-SP 1. Surfaces shall be roughened by hand sanding or light blast cleaning.

F. Nonmetallic Piping

1. Polyvinyl Chloride (PVC) Piping: Surface shall be roughened by hand sanding or light blast cleaning. Oils, greases, waxes, etc., shall be removed by solvent cleaning.

2. Fiberglass Piping: Surfaces shall be roughened by hand sanding or light blast cleaning. Oils, greases, waxes, etc., shall be removed by solvent cleaning.

3. Pipe Insulation: Surface shall be dry, clean, and free of all contaminants. Soiled areas shall be cleaned by wire brushing, dusting, and vacuum cleaning. Sections of insulation covering contaminated with oil, grease, wax, or other materials which would affect the proper bonding of the finish shall be removed and replaced.
G. Concrete and Masonry: Surfaces shall be allowed to cure completely before painting. Steel troweled or other smooth concrete surfaces should be abrasive blast cleaned, or etched with hydrochloric (Muriatic) acid to remove the glaze. Flush thoroughly with clean water after etching and allow to dry completely before painting. Concrete surfaces shall be cleaned of all dust, dirt, form oil, curing compounds and other foreign matter. Concrete floors shall be cleaned with a process equal to Shot Blasting with a Blastrac Unit. Cleaned floors shall have the granular appearance of fine sandpaper and shall be recleaned to attain uniformity, if required. Form release compounds used in poured concrete construction should be removed with a suitable solvent as recommended by the manufacturer of such compounds.

H. Gypsum Wallboard and Plaster: Surface shall be dry and free of dust, dirt, powdery residues, grease, oil, wax, or other contaminants. Small cracks or holes shall be filled with shackling compound. Shackling compound, where used, shall be thoroughly dry and sanded smooth before the application of any coating.

PART 3.3 APPLICATION

A. Apply finish coatings with suitable brushes, rollers, or spray equipment per manufacturers instructions.

1. Rate of application shall not exceed the paint manufacturer's recommendation for the surface being coated.

2. Brushes, rollers, and spraying equipment shall be kept clean, dry, and free of contaminants at all times.

3. Stain shall be applied by brush or clean, dry cloth. Wipe or dry brush until desired toning is achieved. If deeper tone is required, repeat application after first coat is thoroughly dry.

4. Coatings shall be applied in accordance with paint manufacturer's recommendations and may be subject to inspection at all times by representatives of the Owner or manufacturer.

5. All spray equipment may be inspected by the Engineer's resident project representative (RPR) or Owner's representative before paint application begins.

6. A moisture trap shall be placed in air line supply between the compressor and the pressure pot, airless pump, and/or blow down hoses.
7. Operational regulators and gauges shall be provided for pressure tanks or airless pumps.

8. All spent abrasive and dust from blasting operations shall be removed from surfaces prior to painting application.

9. Blasted surfaces shall be coated with one coat of primer during the same day that blasting is done.

10. Priming shall not be applied closer than 6 inches to a non-blasted area. Any subsequent blasting operation shall not result in abrasive particles embedded in the paint film.

11. No painting shall take place with the temperature is below 50°F, or when the surface temperature is within 5°F of the dewpoint, or when the relative humidity is above 85%, unless approved by the Engineer.

12. Spray gun must be held perpendicular to the surface being coated, and handled in such a manner that dry over spray is held to a minimum.

13. When paint is being applied to the interior of tanks or confined areas, sufficient explosion proof blowers or fans shall be installed to provide adequate ventilation. Adhere to the paint manufacturer's recommendations for forced air ventilation during application and curing. When isocyanate catalyzed coatings are being applied, positive pressure air supplied respirators must be used.

14. Cover or otherwise protect the finished work of other trades and surfaces which are not to be painted. Any injury or damage to such surfaces shall be remedied to the satisfaction of the Engineer at the expense of the Contractor before final acceptance and payment will be made.

15. All materials used in successive field coats shall be produced by the same manufacturer.

B. Field painting shall be in the number of coats specified in Part 3.5, Painting Schedule, of this section. Shop or field-applied priming coats shall not be considered as one of the required field finish coats.

1. Individual field finish coats shall be tinted differently in order to distinguish each coat from preceding or succeeding coats.

2. Strictly comply with the coating manufacturer's recommendation for drying time between coats.
3. The Engineer shall inspect each coat before additional coats are applied. Only inspected coats will be considered in determining the number of coats applied.

C. Finish Coats. Finish coats shall be smooth, free of brush marks, streaks, runs, laps or pile-up of paint, and skipped or missed areas. Moldings, trim, and other ornaments shall be left clean and true to details with no undue amount of paint in corners and depressions. The edges of paint adjoining other materials or colors shall be clean and sharp with no overlapping. Where any portion of the finish of a wall has been damaged or is not acceptable, the entire wall shall be refinished.

PART 3.4 TESTING AND INSPECTION

A. Ambient Conditions. Prior to and during paint application, the following ambient conditions shall be measured to confirm that all conditions are within specified limits:

1. Air temperature and relative humidity to be measured with a sling or battery operated psychrometer. The dew point shall be determined from approved psychrometric tables using measured wet- and dry- bulb thermometer readings.

2. Surface temperature to be measured with a surface temperature thermometer.

B. Surface Profile. Prior to paint application and after abrasive blasting, the surface to be painted shall be checked with surface profile tape to determine if the depth of profile specified has been achieved.

C. Film Thickness

1. Wet Film Thickness. The wet film thickness of each coat of paint shall be verified by measuring with an approved wet film thickness gauge as it is applied.

2. Dry Film Thickness. The dry film thickness (DFT) of each coat of paint and the entire system shall be measured with a Type 1 or Type 2 magnetic dry film thickness gauge in accordance with SSPC-PA 2. Five spot measurements (3 readings constitute 1 spot measurement) shall be taken for each 100 square feet area as outlined in SSPC-PA 2, Section 3.

D. Holiday Testing. The paint on all interior tank surfaces and submerged steel shall be tested with a Tinker & Rasor M-1 low voltage, wet sponge holiday detector after the paint has cured for at least 5 days. Locations where holidays
are detected shall be marked for repair and retested and after repair work has been completed.

PART 3.5 PROTECTIVE COATING SCHEDULE

Primers and finishes shall be applied in accordance with the following schedule for the surface and exposure specified:
# PROTECTIVE COATING SCHEDULE

<table>
<thead>
<tr>
<th>Generic Type</th>
<th>Surface Preparation</th>
<th>First Coat (Primer)</th>
<th>DFT Mils</th>
<th>Second Coat</th>
<th>DFT Mils</th>
<th>Third Coat</th>
<th>DFT Mils</th>
<th>Total DFT Mils (min)</th>
<th>Total Coats</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plaster and Gypsum Wallboard</strong></td>
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</tr>
<tr>
<td>Interior Exposed</td>
<td>Acrylic Emulsion</td>
<td>Clean and Dry</td>
<td>F-1</td>
<td>2-3</td>
<td>F-1</td>
<td>2-3</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Vinyl Acrylic/Epoxy</td>
<td>Clean and Dry</td>
<td>FS-4</td>
<td>1-2</td>
<td>2-3</td>
<td>F-8</td>
<td>2-3</td>
<td>7</td>
<td>3</td>
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<td>Wood</td>
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<tr>
<td>Interior or Exterior Exposed</td>
<td>Acrylic Emulsion</td>
<td>Clean and Dry</td>
<td>P-1, P-2</td>
<td>2-3</td>
<td>F-1</td>
<td>2-3</td>
<td>F-1</td>
<td>2-3</td>
<td>8, 7</td>
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<td>Latex</td>
<td>Clean and Dry</td>
<td>P-3</td>
<td>1.5-2</td>
<td>2-3</td>
<td>F-2</td>
<td>1.5-2</td>
<td>F-2</td>
<td>1.5-2</td>
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<td><strong>Ferrous Metal</strong></td>
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<tr>
<td>Exterior Exposed</td>
<td>Epoxy/Polyurethane</td>
<td>SSPC-SP6</td>
<td>P-9</td>
<td>4-6</td>
<td>F-8</td>
<td>4-6</td>
<td>F-9(^1)</td>
<td>2-3</td>
<td>10</td>
</tr>
<tr>
<td>Interior Exposed</td>
<td>Epoxy</td>
<td>SSPC-SP6</td>
<td>F-8</td>
<td>3-5</td>
<td>F-8</td>
<td>4-6</td>
<td>F-8</td>
<td>4-6</td>
<td>11</td>
</tr>
<tr>
<td>Immersion</td>
<td>Epoxy</td>
<td>SSPC-SP10</td>
<td>F-4(^2), F-5</td>
<td>3-5</td>
<td>F-4(^2), F-5</td>
<td>4-6</td>
<td>F-4(^2), F-5</td>
<td>4-6</td>
<td>11</td>
</tr>
<tr>
<td>Below Grade/Underground</td>
<td>Coal Tar Epoxy</td>
<td>SSPC-SP10</td>
<td>F-5(^3) Optional</td>
<td>3-5</td>
<td>F-10</td>
<td>16-20</td>
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<td>1 or 2</td>
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<td>Interior/Immersion Severe</td>
<td>Vinyl Ester</td>
<td>SSPC-SP5</td>
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<td>Modified Phenolic</td>
<td>SSPC-SP10</td>
<td>F-7</td>
<td>8</td>
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<tr>
<td>Interior/Exterior Exposed</td>
<td>Silicone Aluminum</td>
<td>SSPC-SP10</td>
<td>P-5(^4) Optional</td>
<td>2-4</td>
<td>F-19</td>
<td>1-1.5</td>
<td>4.5</td>
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<td><strong>Galvanized Steel and Non-Ferrous Metal</strong></td>
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<td>SSPC-SP6</td>
<td>F-8</td>
<td>2-3</td>
<td>F-9(^1)</td>
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<tr>
<td>Interior Exposed</td>
<td>Epoxy</td>
<td>SSPC-SP6</td>
<td>F-8</td>
<td>2-3</td>
<td>F-9(^1)</td>
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<td>Immersion</td>
<td>Epoxy</td>
<td>SSPC-SP1 with Brush Off Blast</td>
<td>F-5</td>
<td>3-5</td>
<td>F-5</td>
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<td>As Recommended(^a)</td>
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<td>3-5</td>
<td>F-8</td>
<td>4-6</td>
<td>F-9</td>
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<td>Epoxy</td>
<td>As Recommended(^a)</td>
<td>F-4, F-5</td>
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<td>F-4, F-5</td>
<td>4-6</td>
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<td>Below Ground</td>
<td>Coal Tar Epoxy</td>
<td>As Recommended(^a)</td>
<td>F-10 Optional</td>
<td>3-5</td>
<td>F-10</td>
<td>16-20</td>
<td>19-25</td>
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<td>Generic Type</td>
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<td>DFT Mils</td>
<td>Second Coat</td>
<td>DFT Mils</td>
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<td>Total Coats</td>
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<td>Scarify</td>
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<td>F-9</td>
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<td>Scarify</td>
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<td>Acrylic Emulsion</td>
<td>Clean and Dry</td>
<td>F-1</td>
<td>2-3</td>
<td>F-1</td>
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<td>Concrete – Precast and Cast-in-Place</td>
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<td>Exterior Exposed</td>
<td>Modified Epoxy</td>
<td>Clean and Dry</td>
<td>F-11</td>
<td>8-10</td>
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<tr>
<td>Interior Exposed</td>
<td>Epoxy</td>
<td>Clean and Dry</td>
<td>F-4$^3$</td>
<td>4-6</td>
<td>F-4$^3$</td>
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<td>10</td>
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<td>Wet well (Interior)</td>
<td>Epoxy</td>
<td>SSPC-SP13</td>
<td>FS-3</td>
<td>As needed</td>
<td>F-6</td>
<td>15-20</td>
<td>F-6</td>
<td>15-20</td>
<td>30</td>
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<td>Clean and Dry</td>
<td>F-10</td>
<td>16-20</td>
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<td>Concrete and Masonry - Porous CMU and Concrete</td>
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<tr>
<td>Exterior Exposed</td>
<td>Modified Epoxy</td>
<td>Clean and Dry</td>
<td>F-11</td>
<td>8-10</td>
<td>F-11</td>
<td>8-10</td>
<td></td>
<td>18</td>
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<tr>
<td>Interior Exposed</td>
<td>Epoxy</td>
<td>Clean and Dry</td>
<td>FS-2</td>
<td>75-100$^6$ (ft$^2$/gal)</td>
<td>F-4</td>
<td>4-6</td>
<td>F-4</td>
<td>4-6</td>
<td>10</td>
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<td>Concrete Floors</td>
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<td>Interior Exposed</td>
<td>Epoxy/Polyurethane</td>
<td>Brush-Off Blast or Acid Etch</td>
<td>F-13</td>
<td>2-3</td>
<td>F-13</td>
<td>2-3</td>
<td>F-20 Optional</td>
<td>2</td>
<td>7</td>
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<tr>
<td></td>
<td>Epoxy (High Solids)</td>
<td>Abrasive Blast</td>
<td>P-10</td>
<td>6-8</td>
<td>F-16</td>
<td>6-8</td>
<td>F-16</td>
<td>6-8</td>
<td>20</td>
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<td>Aggregate Filed Epoxy</td>
<td>Abrasive Blast</td>
<td>P-10</td>
<td>6-8</td>
<td>F-14</td>
<td>1/8” Double Broadcast</td>
<td>F-16</td>
<td>6-8</td>
<td>1/8”+</td>
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<td></td>
<td>Ceramic Filled Decorative Epoxy</td>
<td>Abrasive Blast</td>
<td>F-15</td>
<td>1/8” Double Broadcast</td>
<td>F-17</td>
<td>8-10</td>
<td></td>
<td></td>
<td>1/8”+</td>
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</tbody>
</table>
### PROTECTIVE COATING SCHEDULE

<table>
<thead>
<tr>
<th>Generic Type</th>
<th>Surface Preparation</th>
<th>First Coat (Primer)</th>
<th>DFT Mils</th>
<th>Second Coat</th>
<th>DFT Mils</th>
<th>Third Coat</th>
<th>DFT Mils</th>
<th>Total DFT Mils (min)</th>
<th>Total Coats</th>
</tr>
</thead>
</table>

**NOTES:**

1. Field priming of shop-primed ferrous metal surfaces is required only where the shop primer has been removed because of damage or apparent corrosion and the surface has been re-prepared in accordance with Part 3.2, Preparation of Surfaces, of this section.

2. Where piping is to be striped, 2 full coats of the base color shall be applied prior to the application of the contrasting color of stripe.

3. NSF approved for potable water service.

4. Because the substrate and exposure conditions can vary, it is necessary to contact the protective coatings representative for surface preparation recommendations.

5. Exposures subject to aggressive chemical solutions such as inorganic and organic acids and high concentrations of hydrogen sulfide gas.

6. The actual film thickness of the spreading rate will depend of the porosity of the surface.

7. Depending on the method of application and color of the primer or intermediate coat, certain colors may require multiple coats for complete hiding. **Some film thickness ranges listed are only achievable by spray applications. Roller application may require additional coats.**

END OF SECTION
PART 1 - GENERAL

PART 1.1 SCOPE

A. Furnish all labor, materials, equipment, and incidentals required to install rectangular, monolithic, or sectional precast water and wastewater structures, pipe connectors, and accessories as specified herein.

PART 1.2 RELATED SECTIONS

A. Section 200 - Earthwork

PART 1.3 REFERENCES

A. Prestressed Concrete Institute. Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

B. National Precast Concrete Association. Quality Control Manual for Precast Concrete Plants.

C. American Society for Testing and Materials (ASTM)


2. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.


5. ASTM C913 - Standard Specifications for Precast Concrete Water and Wastewater Structures.


E. American Concrete Institute Building Code Requirements for Reinforced Concrete (ACI 318).

F. Occupational Safety and Health Administration Standard 1926.704 - Requirements for Precast Concrete.
PART 1.4 SUBMITTALS SHALL BE AS FOLLOWS

A. Copy of certificate or report showing that the precast concrete manufacturer conforms to Article 1.5 - Qualifications.

B. Schedule of precast concrete structure sections to be provided on the project, charting the following items, when applicable:
   1. Sheet number where the precast structure plan and profile is shown on the plans.
   2. Line number (when there is more than one line on the project).
   3. Precast structure station number.
   4. Invert elevation of the influent and effluent line as indicated on the plans.
   5. Top elevation of the precast structure frame as indicated on the plans.
   6. Top elevation of precast structure base slab as calculated.
   7. Total height of precast structure required from top of base slab to top of frame.
   8. Total height of assembled base, risers, and cone or top provided from top of base to top of top.
   9. Manufacturer's part number or catalog number and number required of each base, riser, and top provided for the precast structure.
   10. Each pipe size and type and its connector's part number, distance from top of base slab, and horizontal distances from inner wall corners of precast structure.

C. Detail of each precast concrete structure section to be provided showing or charting the following:
   1. Manufacturer's part number or catalog number.
   2. Inside dimensions.
   3. Lay length excluding base slab.
   4. Wall thickness and base or top thickness where applicable.
   5. Handling weight.
   6. Wire size, spacing, and area provided per vertical foot.
   7. Reinforcing bar size and spacing.
   8. Design loads.
   9. Concrete mix number and design strength.
   10. Height, width, slope, and annular space of the tongue and groove.

D. Pipe connector details and material specifications.
E. Joint material detail, material specifications and calculations showing that the joint material cross section is greater than the joint's annular space times its height.

F. Lifting device and hole detail.

G. Submit the following at the request of the Engineer or Owner:

1. Structural analysis and design calculations for precast components, performed in accordance with applicable codes and standards, showing that allowable stresses will not be exceeded. All calculations must be sealed by a registered professional engineer.

2. Calculations or test results verifying that the lifting device components and holes are designed in accordance with OSHA Standard 1926.704.

3. Concrete 28-day compression strength results for every day production of precast components for the project was performed showing the required strength according to the guidelines established in ACI 318.

4. Reinforcing and cement mill reports for materials used in the manufacture of precast components for this project.

5. The above test reports for similar precast components recently produced, submitted prior to production of precast components for this project.

PART 1.5 QUALIFICATIONS

A. The precast manufacturer shall comply with one of the following requirements:

1. Manufacture precast components for the project in a plant certified in the Prestressed Concrete Institute's (PCI) Plant Certification Program.

2. Manufacture precast components for the project in a plant certified in the National Precast Concrete Association's (NPCA) Plant Certification Program.

3. Retain an independent testing or consulting engineering firm approved by the Engineer for precast plant inspection. The basis for plant inspection shall be the National Precast Concrete Association Quality Control Manual or the Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products. The above firm shall inspect the precast plant 2 weeks prior to and at 1 week intervals during production of materials for this project and issue a report, certified by a registered engineer that materials, methods, products, and quality control meet the requirements of the above quality control manuals.

B. The precast manufacturer shall have a recognized quality improvement process installed at the manufacturing facility.

C. The precast manufacturer shall provide engineering certification as to the structural adequacy of any precast component, if requested.
D. All concrete compressive strength testing shall be performed in a laboratory inspected by the CCRL of the National Bureau of Standards.

PART 1.6 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air temperature to minimum 50°F prior to, during, and 48 hours after completion of masonry, grouting or concreting work.

PART 2 - PRODUCTS

PART 2.1 MATERIALS

A. Concrete shall conform to ASTM C478 and as follows:

1. Compressive Strength: 5,000 psi minimum at 28 days.
2. Air Content: 4 percent minimum.
3. Alkalinity: Adequate to provide a life factor, \( A_z = \text{Calcium carbonate equivalent times cover over reinforcement, no less than 0.35 for bases, risers and tops.} \)
5. Coarse Aggregates: ASTM C33. Sound, crushed, angular stone only. Smooth or rounded stone shall not be used.
7. Chemical Admixtures: ASTM C494. Calcium chloride or admixtures containing calcium chloride shall not be used.

B. Reinforcing steel shall be ASTM A615 Grade 60 deformed bar, ASTM A82 wire or ASTM A185 welded wire fabric.

C. Lifting loops shall be ASTM A416 steel strand. Lifting loops made from deformed bars shall not be allowed.

D. Butyl rubber sealant shall conform to Federal Specification SS-S-210A, AASHTO M-198, Type B - Butyl Rubber and as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100°F.

E. Butyl rubber with bentonite sealant shall conform to Federal Specification SS-S-210A, ASTM D-297, and containing no asphaltics as follows: maintaining 99% solids with a
maximum of 1% volatile matter and suitable for application temperatures between 5 and 125°F.

F. Epoxy gels used for interior patching of wall penetrations shall be a 2-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive meeting ASTM C881, Type I and II, Grade 3, Class B and C, Epoxy Resin Adhesive.

PART 2.2 COMPONENTS

A. Precast component fabrication and manufacture shall be as described in this paragraph and as described in the paragraphs for the specific components.

1. Precast structures shall be manufactured in conformance with ASTM C913. Wall and inside slab finishes resulting from casting against forms standard for the industry shall be acceptable, except form ties through the wall of the product are not allowed. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks, minor depressions, chips and spalls will be tolerated. Dimensional tolerances shall be those set forth in the appropriate references and specified below.

2. Joint surfaces for joints between precast structure components shall be keyways or tongue and grooves manufactured to the joint surface design and tolerance requirements of ASTM C913.

3. Lift holes and inserts used for handling precast structures shall be sized for a precision fit with the lift devices, shall not penetrate through the precast structure wall, and shall comply with OSHA Standard 1926.704.

B. Precast base sections shall have the base slab cast monolithically with the walls, or have an approved galvanized or PVC waterstop cast in the cold joint between the base slab and the walls.

C. Precast riser sections. The minimum lay length of precast riser sections shall be 36 inches.

D. Precast cone sections shall have an inside diameter at the top of 24 inches. The width of the top ledge shall be no less than the wall thickness required for the cone section. Concentric cones shall be used only for shallow manholes.

E. Precast top sections. Flat slab top sections shall be designed for HS-20 traffic loadings as defined in ASTM C890. Transition top sections shall provide for transition to other diameter risers, cones, and flat slab top sections with a joint equal to that of a riser section. Venting of top sections shall be as shown on the details.
F. Pipe to manhole connectors shall conform to ASTM C923. On large diameter flexible pipes, provisions for control of the pipe outside diameter to within the tolerances of the connector shall be made.

G. Joints shall be sealed internally between the tongue and the groove and additionally around the external perimeter of the joint as follows:
   1. External seals shall consist of a polyethylene backed flat butyl rubber sheet no less than 1/16-inch thick and 6 inches wide applied to the outside perimeter of the joint.
   2. Joints with a perimeter greater than or equal to 18 feet shall be internally sealed with butyl rubber/bentonite sealant.
   3. Joints with a perimeter less than 18 feet shall be internally sealed with butyl rubber sealant.

H. Manhole rings, covers, hatches and doors, frames and grate to be provided as equal to those shown on the precast structure details. Materials shall be cast iron, steel, or aluminum as conforming to details per application. For dimensions of castings see precast top details.

I. Lifting devices complying with OSHA Standard 1926.704 for handling the precast components shall be provided by the precast manufacturer. The design of lifting devices shall comply with ASTM C913, Paragraph 5.8 standards.

J. The interior/exterior of the precast structure wall shall be coated with 21 mils of coal tar epoxy, Koppers 300M or equal, where shown on the plans. The coating shall be spray applied according to the manufacturer's recommendations by an applicator with a minimum of 5 years experience. The joints between precast sections shall not be coated. Use joint sealant as specified above to seal the interior horizontal joint surface.

PART 2.3 CONFIGURATION

A. Precast concrete structures are to be constructed as specified and as shown on the detail drawings.

B. The number of joints shall be minimized. Use no more than two sections up to 8 feet of depth and no more than one additional section for each 4 feet of depth.

C. Provide inverts conforming to the details shown on the Drawings when rectangular sewer manholes are required.

D. Round transition assemblies shall conform to ASTM C478.
PART 3 - EXECUTION

PART 3.1 EXAMINATION

A. Inspect precast components prior to unloading from the delivery truck.

PART 3.2 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery with the manufacturer. Handle and store the precast components in accordance with ASTM C891 and the manufacturer’s recommendations using methods that will prevent damage to the components and their joint surfaces.

PART 3.3 PLACING PRECAST CONCRETE SECTIONS

A. Excavate the required depth and remove materials that are unstable or unsuitable for a good foundation. Prepare a level, compacted foundation extending 6 inches beyond the precast base and follow ASTM C891 excavation standards.

B. Set base plumb and level, aligning pipe opening with pipe invert.

C. Thoroughly clean bells and spigots to remove dirt and other foreign materials that may prevent sealing. Unroll the butyl sealant rope directly against base of spigot. Leave protective wrapper attached until sealant is entirely unrolled against spigot. Do not stretch. Overlap from side to side -- not top to bottom.

D. Set risers and tops, aligning internal wall surfaces, so that proper alignment is achieved taking particular care to clean, prepare, and seal joints.

E. Fill the void between horizontal joint surfaces with a sand cement grout around the outside perimeter, when recommended by the manufacturer.

F. After joining manhole sections, apply the butyl sealant sheet around the outside perimeter of the joint.

G. Lift holes leaving less than 2 inches of wall thickness shall be plugged from the outside using a sand cement mortar. Lift holes penetrating the wall shall be additionally sealed with an interior application of an epoxy gel 1/8 inch thick extending 2 inches beyond the penetration.

H. Vacuum test the assembled precast structure after completing pipe connections and sealing but before backfilling or placing frame and cover as follows:

   1. Plug pipes with suitably sized and rated pneumatic or mechanical pipeline plugs. Place plugs a minimum of 6 inches beyond the precast wall and brace to prevent displacement of the plugs or pipes during testing.
2. Position the vacuum tester head assembly to seal against the interior surface of the top of the top section and inflate according to the manufacturer's recommendations.

3. Draw a vacuum of 10 inches of mercury, close the valve on the vacuum line, and shut off the vacuum pump.

4. Measure the time for the vacuum to drop to 9 inches of mercury. The precast structure shall pass when the time to drop to 9 inches of mercury meets or exceeds the following:

<table>
<thead>
<tr>
<th>Structure Area in Plain View (square feet)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seconds</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
<td>150</td>
</tr>
</tbody>
</table>

5. If the precast structure fails the test, remove the head assembly and coat the interior with a soap and water solution and repeat the vacuum test for approximately 30 seconds. Leaking areas will have soapy bubbles. After the necessary repairs are made, repeat the test until the precast structure passes.

I. Perform the final finishing to the manhole interior by filling all chips or fractures greater than 1/2 inch in length, width or depth and depressions more than 1/2 inch deep in inverts with a sand cement mortar. Grout joints according to manufacturer's specifications. Clean the interior of the precast structure, removing all dirt, spills, or other foreign matter.

END OF SECTION
PART 1 – GENERAL

1.1 WORK INCLUDED

A. This section covers all equipment, materials, and accessories, and labor required to assemble, install, test, and place into satisfactory service the Pumps and Control system as specified herein and shown on the Drawings.

B. The CONTRACTOR shall furnish and install a duplex pumping system and control panel as manufactured by Gorman-Rupp Pump Company, or approved equal. It is the intent that the work shall be complete in every respect and that any material or work not specifically mentioned in the specifications or shown on the drawings but necessary to fully complete the work shall be furnished and installed.

1.2 RELATED WORK

A. Division 15 – Mechanical

B. Division 26 – Electrical

1.3 SYSTEM DESCRIPTION

A. The Contractor shall purchase, install, and place into satisfactory service two (2) self-priming, solids handling, non-clog pumps, complete with pump suction and discharge piping, motors, wall supports, power and control cables, control panel, pressure transducer level control, backup float system and accessories for the pump station. The pumps shall be complete with all equipment specified herein.

B. Principle items of equipment shall include two (2) horizontal, self-priming, centrifugal sewage pumps, V-belt drives, motors, internal piping, valves, motor control panel with two (2) variable frequency drives (VFDs), programmable logic controller (PLC), automatic liquid level control system, internal wiring, discharge failure alarm circuitry and limit switches on discharge check valves.

C. PERFORMANCE CRITERIA

1. Pumps to meet or exceed the requirements set forth in the following tables:

<table>
<thead>
<tr>
<th>PERFORMANCE CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Units</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Pump Speed</td>
</tr>
<tr>
<td>Design Conditions per Pump:</td>
</tr>
</tbody>
</table>

12/15 SUCTION LIFT PUMPS AND CONTROLS E15019-2 33 32 13.10-1
1.4 QUALITY ASSURANCE

A. GENERAL

1. The Contractor shall be responsible for ensuring that all equipment installed is properly connected to other related equipment for proper functioning of the System.

2. The pump station Manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

   a. The pump shaft seals shall be warranted for a minimum of four (4) years from date of shipment. Should the seals fail within four years, the Manufacturer shall furnish new seals, without charge to Owner, F.O.B. factory.

   b. All other equipment, apparatus, and parts furnished shall be warranted for one (1) year, excepting only those items that are normally consumed in service, such as light bulbs, oils, grease, packing, gaskets, 0-rings, etc. The pump station Manufacturer shall be solely responsible for warranty of the stations and all components.

   c. Components failing to perform as specified by the Engineer, or as represented by the Manufacturer, or as proven defective in service during the warranty period, shall be replaced or repaired by the Manufacturer without cost of parts or labor to the Owner.

B. MANUFACTURER’S QUALIFICATIONS

1. The Manufacturer of work of this section shall have five (5) years minimum proven experience in such work and shall have satisfactorily completed three (3) jobs of similar size and type within the last five (5) years.

2. Substitutions for all work of this section from Manufacturers not complying with the specified experience shall include the following:

   a. Special guarantees and warranties.

      1) Period: 5 years.
      2) Manufacturer’s special guarantees and warranties.
3) Contractor’s and Installer’s special guarantees and warranties.

b. Bond or cash deposit equal to 100% of the specified equipment cost guaranteeing compliance of the above specified special guarantees and warranties.

1.5 SUBMITTALS

A. SHOP DRAWINGS AND ENGINEERING DATA

1. Submit complete shop drawings to the Engineer in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

2. Submit complete engineering data to the Engineer in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

3. Shop drawings shall provide layout of mechanical equipment and anchor bolt locations for each station. Pipe penetrations and station access clearances shall be dimensioned relative to the station centerlines. Electrical ladder logic drawings shall illustrate motor branch and liquid level control circuits to extent necessary to validate function and integration of circuits to form complete working systems.

4. In addition to the above requirements, the following shall be performed and submitted.

a. Performance Testing

1) A certified shop test shall be performed on each pumping unit in accordance with the test code of the Hydraulic Institute protocol. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency for capacity from shutdown to 150% of design flow. A minimum of six points, including shutdown, shall be taken for each test run. At least one point of the six shall be taken as near as possible to each specified condition.

2) Results of the performance tests shall be certified by a Registered Professional Engineer and submitted for approval before final shipment.

B. OPERATION AND MAINTENANCE DATA

1. Submit complete operation and maintenance data on the duplex wastewater suction lift pump stations to the Owner in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

2. The CONTRACTOR is required to provide the OWNER with Operating, Maintenance and Service Manuals for all equipment for the entire system, as furnished. The manuals shall be indexed and bound in binders containing full
information for each system, piece of equipment and all controls. Material submitted shall include, but not be limited to, the following:

a. Manufacturer’s descriptive literature.
b. Normal equipment operating characteristics.
c. Performance data, curve, ratings, etc.
d. Wiring diagram that includes lighting fixture and lamp requirements.
e. Control diagrams with written descriptions of operations.
f. Manufacturer’s maintenance and service manuals.
g. Spare parts and replacement parts lists.
h. Name, address and telephone number of local or nearest manufacturer’s service organization.

The Manual shall include the following items in this order:

a. Table of Contents.
b. Pump Station Hydraulic Design Data. Contractor to provide certified pump curves.
c. Electrical Controls/Pump Controls and VFDs.
d. Pump Motors.
e. Pumps and Valves.
f. Telemetry.
g. Flow Meter.
h. Heater.
i. Schedule of Hardware.
j. Hatches.
k. Generator and Automatic Transfer Switch.
l. Any other special equipment.
NOTE: The CONTRACTOR shall compile all of the above information into six (6) complete manuals and shall deliver the manuals to the owner prior to final payment.

1.6 STORAGE AND PROTECTION

A. Store and protect the suction lift solids handling pumps in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

1.7 GUARANTEE

A. Provide a guarantee against defective products and workmanship in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. The design has been based on equipment provided by the following manufacturers:

2. Or approved equal.

2.2 SYSTEM COMPONENTS

A. PUMP DESIGN

1. Pumps shall be horizontal, self-priming, centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage.

2. Materials and Construction Features

a. Pump casing: Casing shall be cast iron Class 30 with integral volute scroll.

b. Cover plate: Cover plate shall be cast iron Class 30.

1) Shall provide easy complete access to pump interior. Cover plate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wear plate or check valve without removing suction or discharge piping.

2) A replaceable wear plate secured to the cover plate by weld studs and nuts.

3) A pressure relief valve shall be supplied in the cover plate. Relief valve shall open at 100-200 PSI.

4) O-ring of Buna-N material shall seal cover plate to pump casing.
c. Rotating Assembly

1) Seal plate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings.

2) Impeller shall be ductile iron, two-vaned, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lock screw and conical washer.

3) Shaft shall be AISI 41L40 alloy steel.

4) Bearings shall be anti-friction ball or tapered roller type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir.

5) Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium carbide alloy. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings.

6) Adjustment of the impeller face clearance (distance between impeller and wear plate) shall be accomplished by external means. Stainless steel adjusting shims shall be used to move the entire rotating assembly as a unit when adjusting the working clearances.

7) Suction check valve shall be molded Buna-N with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished without disturbing the suction piping.

8) Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. Each spool shall have one 1¼-inch NPT and one ¼-inch NPT tapped hole with pipe plugs for mounting gauges or other equipment.

9) Pumps to be supplied with a drain kit for each station for ease of maintenance. Each kit to contain 10’ length of reinforced plastic hose with a female quick connect fitting at one end, and factory installed drain fittings in each pump. Fittings include a pipe nipple, bushing, bronze gate valve and male quick connect fitting.

10) Each pump volute shall have a temperature sensor that will automatically shut off the pump if the temperature exceeds the manufacturer’s recommended maximum heat temperature in the volute.
11) Station manufacturer will supply one 115 VAC alarm light fixture (external) with vapor-tight shatter resistant red globe, conduit box, and mounting base. The design must prevent rainwater from collecting in the gasketed area of the fixture, between the base and globe. The alarm light will be shipped loose for installation by the contractor.

C. VALVES AND PIPING

1. Check Valve
   a. Each pump shall be equipped with a full flow type check valve, capable of passing a 3-inch spherical solid, with flanged ends and be fitted with an external lever and spring. The valve seat shall be constructed of stainless steel and shall be replaceable. The valve body shall be cast iron and incorporate a 3-inch clean out port. Valve clapper shall have a molded neoprene seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge pin and internal hinge arm shall be stainless steel supported on each end in brass bushings, sealing bushing shall have double o-rings. O-rings shall be easily replaceable without requiring access to interior of valve body. Valve shall be rated at 175 PSI water working pressure, 350 PSI hydrostatic test pressure.

   1) Check valves shall be equipped with adjustable limit switches which feature normally open contacts. Limit switch contacts shall complete a circuit upon check valve opening due to normal pumping operations which indicate that each pump is operating dynamically. The Electrical Contractor shall install control conduit with wiring from limit switches to pump control panel.

2. Plug Valve
   a. Plug valves must allow either or both pumps in each station to be isolated from the force main. Each plug valve shall be non-lubricated, tapered type. Valve body shall be semi-steel with flanged end connections drilled to 125-pound standard. The drip-tight shutoff plugs shall be mounted in stainless steel bearings, and shall have a resilient facing bonded to the sealing surface. Valves shall be operated with a single lever actuator providing lift, turn, and reseat action. The lever shall have a locking device to hold plugs in the desired position.

3. Automatic Air Release Valves
   a. Each pump shall be equipped with an automatic air release valve designed to vent air to atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming or repriming cycle, the valve shall automatically close operating solely on discharge pressure to prevent excess recirculation. A visible indication of valve closure shall be evident. Valves which connect to the suction line or rely on vacuum pumps shall not acceptable.
b. The air release valve shall be constructed of UV-inhibiting, high impact composite polyester containing not less than 30% glass-filler. The valve body shall incorporate an internal passageway that allows all debris to pass through the valve chamber between operational cycles, thus making the valve self-cleaning upon sequential cycles. The valve diaphragms shall be Buna-N, Fluorocarbon or EPDM, and shall incorporate a polyester mesh sufficient to withstand 250 PSI of pressure. Diaphragm materials of lesser-rated durability will not be deemed equal.

c. The vertical valve plunger shall be constructed of Acetal and at least 20% PTFE fluorocarbon filler (DuPont Teflon or equivalent). The independent, dual diaphragms and single, vertical valve plunger shall incorporate a media fluid that passes through an orifice and separates the actions of each. This media fluid will impart sufficient energy for each diaphragm to act on the other to cause a metered stroke, allowing for predictable mechanical movement, thus opening and closing the valve smoothly, preventing chatter and harsh ramming forces. Valves with a single horizontal shaft or that do not incorporate straight-through passageways or media-limiting orifices will not be acceptable. The valve “seat” shall permit a prescribed bypass of the liquid being pumped to ensure that the valve does not become hydraulically locked in submerged discharge piping configurations.

d. The valve shall employ an externally-adjustable restrictor for applications below four feet of static discharge head. Valves having no means to accurately adjust their action, or which require spring selection and lubrication are unacceptable. Being mechanically maintenance-free, provisions for clearing debris in the internal passageway normally associated with valves of this type are incorporated in the valve design and are accessible with only normal hand tools.

e. The valve body shall incorporate passageways having minimal constrictions and no directional course changes integral to the body of the valve. The inlet shall be 1 inch NPT female and the discharge outlet shall be 1-1/4 inch NPT female, assuring that any debris that makes its way through the valve body will have unobstructed passage back to the source. Valves having smaller throughput, bends or turns that restrict or impede flow and create pockets or traps for debris shall not be acceptable. The valve shall be mounted horizontally, 90 degrees to the vertical plunger by means of an integral mounting bracket.

f. The valve shall be able to operate on applications ranging from four to 400 feet of water column without the need for adjustment or interchange of springs or other parts.

g. Connection of the air release valves to pump station piping shall include stainless steel fittings.
4. **Header Piping Air Release Line**
   a. Pump station shall be equipped with an air release line with manual ball valve installed on the top of the station header piping, to allow for venting of air back to the wet well. A 1-inch brass ball valve shall be provided and factory installed by the pump station manufacturer at the high point in the station header piping and piped through the floor of the station, into the wet well. The valve is to be utilized during initial station startup to assure that an air pocket does not occur within the station header piping.

5. **Portable Pump Discharge Connection:**
   a. The station header pipe shall incorporate plug valves to permit emergency access to the pump station force main after isolation of the pumps. Valve body shall be cast iron with flanged end connections drilled to 125 pound standard. Plug valves shall be non-lubricated type, furnished with a drip-tight shutoff plug mounted in stainless steel or Teflon over phenolic bearings, and shall have a resilient facing bonded to the sealing surface.

   b. A gauge kit shall be supplied for each pump. Suction pressure must be monitored by a glycerin-filled compound pressure gauge, and discharge pressure by a glycerin-filled standard pressure gauge. Gauges to be at least 4 inches in diameter, graduated in feet water column. Rated accuracy shall be 1% of full-scale reading. Compound gauge shall be graduated –34 to +34 feet water column minimum. Pressure gauge to be graduated 0 to 200 feet water column minimum.

   1) Gauges to be factory mounted on a resilient panel with frame assembly secured to pumps or piping. Gauge installations shall be complete with all hoses and fittings, including a shutoff valve for each gauge line at the point of connection of suction and discharge pipes.

6. **Piping**
   a. Flanged pipe shall be as subsequently specified in Section 15062, Ductile Iron Pipe and Fittings.
   b. Supports and Thrust Blocks

   1) General Contractor must insure all pipes connected to the pump station are supported to prevent piping loads from being transmitted to pumps or station piping. Pump station discharge force main piping shall be anchored with thrust blocks where shown on the Contract Drawings.

D. **DRIVE UNIT**

1. Pump motors shall be 480V, 3 phase, horizontal ODP, 1,800 RPM, inverter duty NEMA design with cast iron frame with copper windings, induction type, with
Class F insulation and 1.15 Service Factor for normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified.

2. Drive Transmission
   a. Power to pumps transmitted through V-belt drive assemblies. The sheave/belt combination shall provide the speed ratio needed to achieve the specified pump operating conditions.
   b. Pump drives to be enclosed on all sides by a guard constructed of fabricated steel or combination of materials including expanded, perforated, or solid sheet metal.
      1) Guards must be completely removable without interference from any unit component, and shall be securely fastened and braced to the unit base.
      2) The guard shall be finished in accordance with Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.
   c. Both shafts of the two-stage pump shall operate together and be driven by a single motor (i.e. each 2-stage pump shall operate from a single motor.

E. ELECTRICAL CONTROL COMPONENTS

1. The pump station control panel will be tested as an integral unit by the pump station manufacturer. The control panel shall also be tested with the pump station as a complete working system at the pump station manufacturer's facility.

2. Panel Enclosure
   a. Electrical control equipment shall be mounted within a common NEMA 1 steel, dead front type control enclosures. Access doors shall be hinged and sealed with a neoprene gasket and equipped with captive closing hardware. Control components shall be mounted on removable steel back panels secured to enclosure with collar studs.
   b. All control devices and instruments shall be mounted using threaded fasteners, and shall be clearly labeled to indicate function.

3. UL Label Requirement
   a. Pump station components and controls shall conform to third party safety certification. The station shall bear a UL label listed for “Packaged Pumping System”. The panel shall bear a serialized UL label listed for “Enclosed Industrial Control Panels”. The pump station components, panel enclosure, and all components mounted on the sub-panel or control cover shall conform to UL descriptions and procedures.
4. Branch Components

a. Motor branch components to be of highest industrial quality, secured to the sub-plate with machine screws and lockwashers. Mounting holes shall be drilled and tapped; Self-tapping screws shall not be used to mount any component.

b. Circuit Breakers and Operating Mechanisms

1) A properly sized heavy duty circuit breaker, with RMS interrupting rating of 10,000 amperes at 240 volts, or 14,000 amperes at 480 volt, shall be furnished for each pump motor. The circuit breakers must be sealed by the manufacturer after calibration to prevent tampering.

2) An operating mechanism installed on each motor circuit breaker shall penetrate the control panel door. A padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until circuit breakers are in “OFF” position.

c. Variable Frequency Drives

1) A solid state variable frequency motor drive shall be furnished for each pump motor. Solid state drive shall be designed to provide “soft start” and “soft stop” capability to prevent excessive water surges. Drive shall also include adjustable motor speed capability to allow setting of maximum speed and programming the automatic adjustment of the motor speed to the owner’s specifications. Solid state motor starter shall be:

i. Allen Bradley Powerflex Drives.
ii. Or approved equal.

d. Programmable Logic Controller (PLC)

1) A solid state PLC shall be provided to control the pump operation. PLC shall be Allen-Bradley Micrologix 1500 with Panelview operator interface.

e. Overload Relays

1) Overload relays shall be solid-state block type, having visual trip indication with trip-free operation. Electrically resetting the overload will cause one (1) normally open and one (1) normally closed isolated alarm/control contact to reset, thus re-establishing a control circuit. Trip setting shall be governed by solid-state circuitry and adjustable current setting. Trip classes shall be 10, 15, and 20. Additional features to include phase loss protection, selectable jam/stall protection, and selectable ground fault protection.
2) A reset pushbutton, mounted through the control panel door, shall permit resetting the overload relays without opening the door.

f. Transient Voltage Surge Suppressor

1) The control panel shall be equipped with a transient voltage surge suppressor to minimize damage to the pump motors and control from transient voltage surges. The suppressor shall utilize silicon-oxide varistors encapsulated in a non-conductive housing. The arrestor shall have a current rating of 60,000 Amps, and a Joule rating of 1500.

g. Phase Monitor

1) The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, voltage unbalance, and low voltage. A time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart when power conditions return to normal.

h. Control Circuit

1) A normal duty thermal-magnetic circuit breaker shall protect all control circuits by interrupting control power.

2) Pump mode selector switches shall permit manual start or stop of each pump individually, or permit automatic operation under control of the liquid level control system. Manual operation shall override all shutdown systems, except the motor overload relays. Selector switches to be oil-tight design with contacts rated NEMA A300 minimum.

3) Pump alternator relay to be electro-mechanical industrial design. Relay contacts to be rated 10 amperes minimum at 120 volts non-inductive. A switch shall permit the station operator to select automatic alternation of pumps, to select pump number one to be "lead" for each pumping cycle, or to select pump number two to be "lead" pump for each pumping cycle.

4) Six digit elapsed time meter (non-reset type) shall be connected to each motor starter to indicate total running time of each pump in "hours" and "tenths of hours". An integral pilot light shall be wired in parallel to indicate that the motor is energized and should be running.

5) A high pump temperature protection circuit shall override the level control and shut down the pump motor(s) when required to protect the pump from excessive temperature. A thermostat shall be mounted on each pump casing and connected to a pump.
shutdown circuit. If casing temperature rises to a level sufficient to cause damage, the thermostat causes the shutdown circuit to interrupt power to the motor. A visible indicator, mounted through the control panel door shall indicate motor stopped due to high pump temperature. The motor shall remain locked out until the pump has cooled and circuit has been manually reset. Automatic reset of this circuit is not acceptable.

6) A duplex ground fault receptacle providing 115 VAC, 60 Hz, single phase current, will be mounted on the side of the control enclosure. Receptacle circuit shall be protected by a 15 ampere thermal-magnetic circuit breaker.

7) Auxiliary Power Transformer
i. The lift station shall be equipped with a 3 KVA stepdown transformer to supply 115 volt, AC, single phase for the control and auxiliary equipment. The primary and secondary side of the transformer to be protected by a thermal magnetic circuit breaker, sized to meet the power requirements of the transformer. An operating mechanism shall penetrate the control panel door, and a padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until circuit breakers are in "OFF" position.

8) Wiring
i. The pump station, as furnished by the Manufacturer, shall be completely wired, except for power feed lines to the branch circuit breakers and final connections to remote alarm devices.

ii. All wiring, workmanship, and schematic wiring diagrams shall comply with applicable standards and specifications of the National Electric Code (NEC).

iii. All user serviceable wiring shall be type MTW or THW, 600 volts, color coded as follows:

   - Line and Load Circuits, AC or DC Power ....................... Black
   - AC Control Circuit Less than line voltage ................. Red
   - DC Control Circuit ........................................ Blue
   - Interlock Control Circuit from external Source ........ Yellow
   - Equipment grounding conductor ............................ Green
   - Current Carrying ground ....................................... White
iv. Control circuit wiring inside the panel, with exception of internal wiring of individual components, shall be 16 gauge minimum, type MTW or THW, 600 volts. Power wiring to be 14 gauge minimums. Motor branch wiring shall be 10-gauge minimum.

v. Motor branch and other power conductors shall not be loaded above 60 degree C temperature rating, on circuits of 100 amperes or less, nor above 75 degrees C on circuits over 100 amperes. Wires must be clearly numbered at each end in conformance with applicable standards. All wire connectors in the control panel shall be ring tongue type with nylon insulated shanks. All wires on the sub-plate shall be bundled and tied. All wires extending from components mounted on door shall terminate at a terminal block mounted on the back panel. All wiring outside the panel shall be routed through conduit.

vi. Control wires connected to door mounted components must be tied and bundled in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall allow the door to swing full open without undue stress or abrasion. Bundles shall be held on each side of hinge by mechanical fastening devices.

5. Conduit

a. Factory installed conduit shall conform to the following requirements:

1) All conduit and fittings to be UL listed.

2) Liquid tight flexible metal conduit to be constructed of smooth, flexible galvanized steel core with smooth abrasion resistant, liquid tight polyvinyl chloride cover.

3) Conduit to be supported in accordance with articles 346, 347, and 350 of the National Electric Code.

4) Conduit shall be sized according to the National Electric Code.

6. Grounding

a. Station Manufacturer shall ground all electrical equipment inside the pump station to the control panel back plate. All paint must be removed from the grounding mounting surface before making final connection.
b. The Contractor shall provide an earth driven ground connection to the pump station at the main grounding lug in accordance with the National Electric Code (NEC).

7. Equipment Marking

a. Permanent corrosion resistant name plate(s) shall be attached to the control equipment and include following information:

1) Equipment serial number.
2) Supply voltage, phase and frequency.
3) Current rating of the minimum main conductor.
4) Electrical wiring diagram number.
5) Motor horsepower and full load current.
6) Motor overload heater element.
7) Motor circuit breaker trip current rating.
8) Name and location of equipment manufacturer.

b. Control components shall be permanently marked using the same identification keys shown on the electrical diagram. Labels shall be mounted adjacent to device being identified.

c. Switches, indicators, and instruments mounted through the control panel door shall be labeled to indicate function, position, etc. Labels shall be mounted adjacent to, or above the device.

F. LIQUID LEVEL CONTROL

1. The Manufacturer of the liquid level control systems shall have a quality management system in place and shall be ISO 9001 certified.

2. The level control systems shall start and stop the pump motors in response to changes in wet well level, as set forth herein.

3. The level control systems shall be a pressure transducer type level control system with an emergency high water level and emergency low water level sealed mercury float switches.

4. The level control systems shall utilize the alternator relay to select first one pump, and then the second pump, to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle.

5. The level control systems shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the electronic pressure switch shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the PLC shall stop this pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the electronic PLC shall start the second pump when the
liquid reaches the "lag pump start level" so that both pumps are operating. These levels shall be adjustable as described below.

a. The level control system shall include integral components to perform all level sensing, signal conditioning, EMI and RFI suppression, DC power supply and 120 volt outputs. Comparators shall be solid state, and shall be integrated with other components to perform as described below.

b. The level control system shall be capable of operating on a supply voltage of 12VDC in an ambient temperature range of -10 degrees C (14 degrees F) through 55 degrees C (131 degrees F). Control range shall be 0 to 12.0 feet of water with an overall repeat accuracy of (plus/minus) 0.1 feet of water. Memory shall be retained using a non-volatile lithium battery back-up.

c. The level control system shall consist of the following integral components: pressure transducer, PLC, Panelview touch screen operator interface display, electronic comparators and output relays.

1) The pressure transducer shall convert the input to a proportional electrical signal for distribution to the display and electronic comparators. The transducer output shall be filtered to prevent control response to level pulsations or surges. The transducer range shall be 0-15 PSI, temperature compensated from -40 degrees C (-40 degrees F) through 85 degrees C (185 degrees F), with a repeat accuracy of (plus/minus) 0.25% full scale about a fixed temperature. Transducer overpressure rating shall be 3 times full scale.

2) The electronic pressure switch shall incorporate a digital back lighted LCD panel display which, upon operator selection, shall indicate liquid level in the wet well, and the preset start and stop level for both lead and lag pump. The display shall include twenty (20), 0.19” high alpha-numeric characters calibrated to read out directly in feet of water, accurate to within one-tenth foot (0.1 foot), with a full scale indication of not less than 12 feet. The display shall be easily convertible to indicate English or metric units.

3) Level adjustments shall be electronic comparator set-points to control the levels at which the lead and lag pumps start and stop. Each of the level settings shall be easily adjustable with the use of membrane type switches, and accessible to the operator without opening any cover panel on the electronic pressure switch. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or introduction of pressure to the electronic pressure switch.

4) Each output relay in the electronic pressure switch shall be solid state. Each relay input shall be optically isolated from its output.
and shall incorporate zero crossover switching to provide high immunity to electrical noise. The "ON" state of each relay shall be indicated by illumination of a light emitting diode. The output of each relay shall be individually fused providing overload and short circuit protection. Each output relay shall have an inductive load rating equivalent to one NEMA size 4 contactor. A pilot relay shall be incorporated for loads greater than a size 4 contactor.

d. The electronic pressure switch shall be equipped with an output board which shall include LED status indicators and a connector with cable for connection to the main unit.

e. The electronic pressure switch shall be equipped with pump start delay(s) preset at a fixed delay time of five (5) seconds.

f. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.

g. The electronic pressure switch shall be equipped with a simulator system capable of performing system cycle testing functions.

h. The electronic pressure switch shall be capable of controlling liquid levels in either a pump up or pump down application.

i. The electronic pressure switch shall be equipped with a security to prevent accidental set-up changes and provide liquid level set-point lock-out.

j. The electronic pressure switch shall be equipped with one (1) 0-33 ft. W.C. input, one (1) scalable analog input of either 0-5VDC, 0-10VDC, or 4-20mA, and one (1) 4-20mA scalable output. Output is powered by 10VDC supply. Load resistance for 4-20mA output shall be 100-400 ohms.

k. The electronic pressure switch shall include a DC power supply to convert 120VAC control power to 12VDC EPS power. The power supply shall be 500 mA (6W) minimum and be UL listed Class II power limited power supply.

l. The electronic pressure switch shall be contained within a NEMA 4X enclosure including a polycarbonate face and stainless steel case.

m. The electronic pressure switch shall be equipped with an electronic comparator and solid state output relay to alert maintenance personnel to a high liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a high wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered and the circuit has been manually reset. High water alarm shall be furnished with a dry contact wired to terminal blocks.
n. Low Water Alarm

1) The electronic pressure switch shall be equipped with an electronic comparator and solid state output relay to alert maintenance personnel to a low liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a low wet well level exists. The alarm signal shall be maintained until the cause for the low wet well level has been corrected and the circuit has been manually reset. A low liquid level condition shall disable both pump motors. When the wet well rises above the low level point, both pump motors shall be automatically enabled. Low water alarm shall be furnished with a dry contact wired to terminal blocks.

7. Additional Features

a. The panel shall be equipped with the following additional features:

1) U.L. 913 labeled with intrinsically safe circuit extensions for pressure transducer and floats, heat sensor and seal sensor circuitry.

2) High water level alarm – non flashing.

3) Dry contact digital outputs to the SCADA system for Pump No. 1 trouble, Pump No. 2 trouble, low level lockout (float), transducer failure, Pump No. 1 run, Pump No. 2 run, and high level alarm (transducer).

4) Digital inputs from the SCADA system for Pump No. 1 start/stop and Pump No. 2 start/stop.

5) Analog output (4-20 mA) to the SCADA system for wet well level.

6) Elapse time meter for each pump.

7) Anti-condensate heater (50 watt) with thermostat.


9) Phase failure protection.

10) Lead pump selector switch.

11) Lightning suppresser.

12) Lag pump on time delay (15-20 seconds).

13) 24-hour time clock, adjustable to 15 minute intervals to control pump operation.
14) 120 volt convenience outlet.
15) Cycle counter.
16) Swing dead front door with a non-fused disconnect switch.
17) 120 volt power supply terminals for RTU.
18) All alarm and signal lights on the control panel shall be LED push-to-test type.

2.3 FINISHES
A. GENERAL
1. Factory Finish
   a. Exterior surfaces of pumps, piping, and steel framework shall be chemically or mechanically cleaned prior to painting. Exposed surfaces to be coated with a primerless, low VOC, alkyd based, high solids, semigloss enamel incorporating rust inhibitive additives. The finish coat shall be 1.5 MIL dry film thickness (minimum), resistant to oil mist exposure and solvent contact. Salt spray exposure test shall be rated 100 hours (minimum). The factory finish shall allow for over-coating and touch up after final installation.

PART 3 – EXECUTION
3.1 INSTALLATION
A. GENERAL
1. Install equipment in accordance with Manufacturer’s recommendations.
2. Install, level, align, and lubricate pumps as indicated on project drawings. Installation must be in accordance with written instructions supplied by the Manufacturer at time of delivery.
3. Suction pipe connections are vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump station piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.
4. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to station control panel.
5. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit
breakers and disconnects before connecting utility power. Verify line voltage, phase sequence, and ground before actual start-up.

6. After all anchor bolts, piping, and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

B. TOUCH-UP COATING

1. Touch up all damaged coating surfaces with compatible coating of identical color in such manner that there shall be no evidence of damage.

3.2 START-UP AND OPERATION

A. START-UP SERVICES

1. The manufacturer shall furnish the services of a factory-trained field engineer specializing in this work to inspect and adjust the equipment after installation, to test the equipment, to supervise start-up, and to instruct the Owner’s personnel in its proper use. Provide a minimum of one day of operator training for both operation and routine maintenance requirements.

B. FIELD TESTS

1. Test each unit under actual operating conditions to show that the pump operates satisfactorily without cavitations, overheating, or overloading, and is free from excessive vibration and noise throughout the complete head and capacity range at rated speed.

2. Allow Engineer to observe field tests. Give ten days’ written notice to Engineer before performing tests.

3. Test system operation with control scheme specified or shown on the Drawings.

C. PROTECTION

1. The pumps should be placed into service immediately. If operation is delayed, drain water from pumps and piping. Open motor circuit breakers and protect station controls and interior equipment from cold and moisture.

END OF SECTION
SECTION 40 05 13.53

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

PART 1.1 SCOPE

A. The work covered by this section includes furnishing all labor, equipment, and materials required to furnish, install, and test ductile iron piping, including all fittings, wall pipe and sleeves, couplings, toppings, anchor blocks, and accessories, as specified herein and/or shown on the Drawings.

PART 1.2 QUALITY ASSURANCE

A. Submit to the Engineer written evidence that the pipe furnished under this Specification is in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM or AWWA testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on samples of pipe materials.

B. Clearly mark each ductile iron pipe length and fitting with the pressure rating, metal thickness class, heat mark, net weight (excluding lining or coating), and name of the manufacturer. In addition, each item of piping shall be marked with an identifying mark corresponding to the appropriate mark on the shop drawings for that particular item of piping.

PART 1.3 SHOP DRAWINGS AND ENGINEERING DATA

A. Submit complete shop drawings and engineering data on all piping and accessories to the Engineer in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

B. Shop drawings shall indicate piping layout in plan and elevations as may be required and shall be completely dimensioned. The Drawings shall include a complete schedule of all pipe, fittings, specials, hangers, and supports. Special castings shall be clearly detailed showing all pertinent dimensions.

C. Furnish the Engineer with lists, in duplicate, of all pieces of pipe and fittings in each shipment received. These lists shall give the serial or mark number, weight, class, size, and description of each item received.
PART 1.4 STORAGE AND PROTECTION

A. Equipment and products stored outdoors shall be supported above the ground on suitable wooden blocks or braces arranged to prevent excessive deflection or bending between supports. Items such as pipe, structural steel, and sheet construction products shall be stored with one end elevated to facilitate drainage.

PART 1.5 SHOP PAINTING

A. All ductile iron pipe and fittings shall be cleaned and provided with a bituminous coating and cement lining applied at the factory, unless otherwise specified herein.

PART 1.6 GUARANTEE

A. Provide a guarantee against defective materials and workmanship in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

PART 2 - PRODUCTS

PART 2.1 GENERAL

A. No broken, cracked, deformed, misshapened, imperfectly coated, or otherwise damaged or defective pipe or fittings shall be used. All such material shall be removed from the site of the work.

B. Minimum pipe wall thickness and pressure class of pipe shall be as follows, unless otherwise shown on the Drawings or directed by the Engineer:

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<thead>
<tr>
<th>Pipe Size</th>
<th>Pressure Class (psi)</th>
<th>Metal Wall Thickness in Inches</th>
</tr>
</thead>
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<tr>
<td>3-Inch Ductile Iron</td>
<td>350</td>
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</tr>
<tr>
<td>4-Inch Ductile Iron</td>
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<tr>
<td>60-Inch Ductile Iron</td>
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</tbody>
</table>
PART 2.2 DUCTILE IRON PIPE

A. Ductile iron pipe shall be designed in accordance with ANSI/AWWA C150/A21.50, "Thickness Design of Ductile Iron Pipe," using 60,000-psi tensile strength, 42,000-psi yield strength, and 10 percent elongation. Additionally, ring bending stress is limited to 48,000 psi to provide a 2.0 safety factor based upon ultimate bending stress.

B. Ductile iron pipe shall be manufactured in accordance with ANSI/AWWA C151/A21.51, "Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids," and shall be made of ductile iron having a minimum tensile strength of 60,000 psi, a minimum yield strength of 42,000 psi, and 10 percent minimum elongation.

PART 2.3 DUCTILE IRON FITTINGS

A. All fittings shall conform in every respect to ANSI/AWWA C110/A21.10, "3 Inch through 48 Inch for Water and Other Liquids" or ANSI/AWWA C153/A21.53, "3 Inch through 16 Inch for Water and Other Liquids."

B. All fittings shall be for pressure rating of 250 psi, unless otherwise shown on the Drawings, directed, or specified.

C. Flanged fittings, in general, shall be ANSI pattern using long radius elbows except where space limitations prohibit the use of same. Design of all fittings, whether long or short pattern, shall be as indicated or dimensioned on the Drawings. Special fittings, wall pipes, and sleeves shall conform to the dimensions and details shown on the Drawings.

PART 2.4 JOINTS FOR DUCTILE IRON PIPE AND FITTINGS

A. General

1. Joints for ductile iron pipe and fittings shall be mechanical joints, flanged joints, push-on joints, or bell and spigot joints, as shown on the Drawings or specified herein.

2. All ductile iron pipe laid underground shall be joined using mechanical joints or push-on type joints, unless otherwise shown on the Drawings, specified, or directed.

B. Mechanical Joints

1. Mechanical joints shall consist of a bolt joint of the stuffing box type as detailed in ANSI A21.10 and described in ANSI A21.11.
2. Mechanical joints shall be thoroughly bolted in accordance with the manufacturer's recommendations with Tee Head Bolts and bolts of high strength, low-alloy steel having a minimum yield point strength of 40,000 psi and an ultimate tensile strength of 70,000 psi.

3. Gaskets, bolts, and nuts shall conform to ANSI A21.11. Gaskets shall be of neoprene or rubber of such quality that they will not be damaged by the liquid or gases with which they will come into contact.

4. Glands shall be of high strength ductile iron.

C. Flanged Joints

1. Flanged joints shall conform to ANSI B16.1, Class 125, in accordance with Table 10.23 of ANSI A21.10.

2. Flanged joints shall be bolted with through stud or tap bolts of required size as directed. Bolts and nuts shall conform in dimensions to the American Standard heavy series. Nuts shall be hexagonal, cold pressed. Bolts and nuts shall be cadmium plated, cold pressed, steel machine bolts, conforming to ASTM A 307, Grade B. Cadmium plating shall be by an approved process and shall be between 0.003 and 0.0005 inch thick. After each joint has been made, all bolts, heads, and nuts shall be coated with two coats of coal tar epoxy (total of 16 mil thickness D.F.T.), or approved equal coating.

3. Gaskets shall be full face type, 1/16 inch thick, conforming to the requirements of AWWA C111.

4. Flanged ductile iron pipe approximately 12 inches or less in length shall have flanges cast solidly to the pipe barrel. Flanges on ductile iron pipe longer than 12 inches may be of the screw type. Pipe threads shall be of such length that with flanges screwed home, the end of the pipe shall project beyond the face line of the flange. Flange and pipe shall then be machined to give a flush finish to the pipe and the flange and surface shall be normal to the axis of the pipe. Ductile iron flanges shall be of such design that the flange neck completely covers the threaded portion of the pipe to protect same against corrosion. All pipe with screw type flanges shall be assembled, faced, and drilled at the point of manufacture, unless otherwise approved by the Engineer.

5. Where tap or stud bolts are required, flanges shall be drilled and tapped accordingly.

D. Push-On Joints

1. Push-on joints shall conform to ANSI A21.11. Details of the joint design shall be in accordance with the manufacturer's standard practice.
2. Gaskets shall be in accordance with ANSI A21.11 and shall be of such quality that they will not be damaged by the liquid or gases with which they will come into contact.

PART 2.5 PIPE COATING AND LINING

A. All ductile iron pipe and fittings buried underground or submerged shall have a standard bituminous outside coating conforming to ANSI A21.6 or A21.51. All exposed ductile iron pipe and fittings shall have an outside shop coating of Rust Oleum 950 rust inhibitive primer.

B. All ductile iron pipe used for water or wastewater shall have cement mortar lining of standard thickness in accordance with ANSI A21.4. Cement mortar lining for ductile iron fittings shall be double the standard thickness under ANSI A21.4.

C. No lining shall be provided for ductile iron pipe and fittings used for air.

D. Where a special lining is indicated on the Drawings for resistance to corrosive wastewaters, pipe and fittings shall be furnished with a minimum 20-mil-thick lining of chemically inert, abrasion-resistant polyethylene. The lining shall be a blend of high density and low density polyethylene powders complying with ASTM D 1248 compounded with carbon black to provide resistance to ultraviolet rays during storage above ground. The pipe shall be preheated in a furnace (to ensure uniformity of heat distribution) to an adequate temperature to provide uniform fusing of the polyethylene powders and proper bonding to the pipe. The lining shall be unaffected by hydrogen sulfide, detergents, grease, oil, inorganic acids, alkalis, and most organic materials found in municipal wastewaters and shall be suitable for service at operating temperatures of up to 180°F. The lining shall have a Hazen-Williams "C" coefficient of approximately 150 and a Manning "n" coefficient of approximately 0.010. Polyethylene-lined ductile iron pipe shall be U.S. Pipe "Polylined," American Cast Iron Pipe "Polybond," or equal.

PART 2.6 PIPE COUPLINGS

A. Pipe couplings shall be installed where shown on the Drawings, required for installation, or directed by the Engineer.

B. Pipe couplings shall conform to the requirements of Section 15090, Pipe Couplings and Expansion Joints.

PART 2.7 WALL PIPE AND WALL SLEEVES

A. Furnish and install ductile iron wall pipe or wall sleeves where ductile iron piping connects with or passes through concrete walls or floors and in locations where small piping and electric wiring and conduits connect with or pass through concrete walls or floors.
B. Where wall pipes or sleeves are to be installed flush with the wall or slab, the flange or bell shall be tapped for studs. Where the flange or bell will project beyond the wall, the projection shall be sufficient to allow for installation of connecting bolts.

PART 2.8 SPARE PARTS

A. Furnish 4 spare gaskets for each size and type of joint requiring the use of a gasket. Furnish 8 bolts and nuts of each size and type used for ductile iron pipe joints.

PART 3 - EXECUTION

PART 3.1 LAYING

A. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Great care shall be taken to prevent the pipe coating from being damaged, particularly cement linings on the inside of the pipes and fittings. Any damage shall be remedied as directed by the Engineer.

B. Carefully examine all pipe and fittings for defects just before laying and no pipe or fitting shall be laid which is defective. If any defective pipe or fitting is discovered after having been laid, it shall be removed and replaced in a satisfactory manner with a sound pipe or fitting by the Contractor at his own expense.

C. Thoroughly clean all pipes and fittings before they are laid and keep clean until they are used in the completed work. Open ends of pipe shall be kept plugged with a bulkhead during construction.

D. Pipe laid in trenches shall be laid true to line and grade on a firm and even bearing for its full length at depths and grades as shown on the Drawings. Adequate precautions shall be taken to prevent flotation of pipelines prior to backfilling. Installation of ductile iron pipe in underground pressure piping systems shall conform to the requirements of AWWA C600. Excavation of trenches and backfilling around pipes shall conform to the requirements of the Section 02200, Earthwork.

E. All ductile iron piping laid underground shall have a minimum of 36 inches of cover above the top of the pipe unless otherwise shown on the Drawings.

F. All elbows, tees, branches, crosses, and reducers in pressure piping systems shall be adequately restrained against thrust. Underground pressure piping shall be restrained by thrust restrained joints (EBAA Meg-a-Lug Series 11005D, or approved equal). Install restraints in accordance with manufacturer's recommendations. Install number of restraints recommended by manufacturer for size of pipe, type of fitting, and type of soil. In lieu of restrained joints, Contractor may use thrust blocks of size shown on the Drawings.
G. All ductile iron pipes entering buildings or basins shall be adequately supported between the structure and undisturbed earth as shown on the Drawings to prevent breakage resulting from settlement of backfill around the structure.

H. Wall pipe and wall sleeves shall be accurately located and securely fastened in place before concrete is poured. All wall pipe and wall sleeves shall have wall collars properly located to be in the center of the wall where the respective pipes are to be installed.

I. Wall pipe and wall sleeves shall be installed when the wall or slab is constructed. Blocking out or breaking of the wall for later insertion shall not be permitted.

J. Cutting or weakening of structural members to facilitate pipe installation shall not be permitted. All piping shall be installed in place without springing or forcing.

K. Sufficient couplings and flanged joints shall be provided to facilitate equipment installation and removal.

L. Exposed ductile iron piping shall be supported as shown on the Drawings.

PART 3.2 CUTTING

A. Whenever pipe requires cutting to fit the lines, the work shall be done in such manner as to leave a smooth end at right angles to the axis of the pipe. When a piece of pipe is cut to fit into the line, no payment will be made for the portion cut off and not used.

B. Whenever existing pipe requires cutting to install new fittings, the work shall be done in such manner as to leave a smooth end at right angles to the axis of the pipe and special care shall be exercised to guard against breaking or splitting the existing piping.

C. All cutting of ductile iron pipe shall be done with a cutting saw. All burrs shall be removed from the inside and outside edges of all cut pipe.

PART 3.3 JOINING

A. Mechanical Joints

1. The successful operation of the mechanical joint specified requires that the spigot be centrally located in the bell and that adequate anchorage be provided where abrupt changes in direction and dead ends occur.

2. The surfaces with which the rubber gasket comes in contact shall be brushed thoroughly with a wire brush just prior to assembly to remove all loose rust or foreign material which may be present and to provide clean surfaces which shall be brushed with a liberal amount of soapy water or other approved lubricant just prior to slipping the gasket over the spigot end and into the bell. Lubricant shall be brushed over the gasket prior to installation to remove loose dirt and lubricate the gasket as it is forced into its retaining space.
3. Joint bolts shall be tightened by the use of approved wrenches and to a tension recommended by the pipe manufacturer. When tightening bolts, it is essential that the gland be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. This may be done by partially tightening the bottom bolt first, then the top bolt, next the bolts at either side, and last, the remaining bolts. This cycle shall be repeated until all bolts are within the range of acceptable torques. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation shall not be permitted.

4. After installation, bolts and nuts in buried or submerged piping shall be given 2 heavy coats of a bituminous paint.

B. Flanged Joints

1. All flanges shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations, or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the finished pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe.

2. Connections to equipment shall be made in such a way that no strain is placed on the equipment flanges. Connecting flanges must be in proper position and alignment and no external force may be used to bring them together properly.

3. After installation, bolts and nuts in buried or submerged piping shall be given 2 heavy coats of a bituminous paint.

C. Push-On Joints

1. The inside of the bell and the outside of the pipe from the plain end to the guide stripe must be wiped clean immediately before assembling the pipe joint. Then the rubber gasket shall be inserted into a groove or shaped recess in the bell. Both the bell and spigot ends to be joined shall be wiped again to ensure they are thoroughly clean. A liberal coating of special lubricant furnished by the pipe manufacturer shall be applied to the outside of the pipe from the plain end to the yellow guide stripe and to the inside of the gasket. The plain end shall be centered in the bell and the spigot pushed home. Wherever possible the pipe shall be socketed by hand; however, jacking may be required to push the spigot in place on the larger sizes of pipe. The completed joint shall be permanently sealed and watertight.
2. Whenever the pipe is cut in the field, the cut end shall be conditioned so it can be used in making up a joint by filing or grinding the cut end to remove burrs or sharp edges that might damage the gasket.

D. Permissible Deflection of Joints

1. Deflection of ductile iron pipe at joints for long radius curves or for avoiding obstacles shall be permitted only upon approval of the Engineer.

2. Where deflection of joints is permitted, such deflection shall be made in accordance with and shall not exceed limits provided in Section 9b.5 and Section 9c.4, as applicable, of AWWA C600.

E. Joints of Dissimilar Metals. When a flanged joint consists of a ductile iron flange mated to a steel or alloy flange, the steel flanges shall be flat-faced and furnished with full-faced gaskets, insulating bushings, and stainless steel bolts.

PART 3.4 SERVICE CONNECTIONS

A. Small service lines and branches shall connect to larger ductile iron mains using ductile iron tapped tees and crosses, in general and unless otherwise shown.

B. Tapped tees and crosses shall have minimum 2-inch NPT branch connections and shall be furnished with mechanical joint ends.

PART 3.5 CUT-INS TO EXISTING PIPING

A. Cut-ins to existing ductile iron piping for installation of new mechanical joint fittings and valves shall be made using ductile iron cutting-in sleeves, in general and unless otherwise shown.

B. Cutting-in sleeves shall have a pressure rating not less than that of the existing pipeline and shall be furnished with a mechanical joint end on one end and a plain end on the other.

PART 3.6 DRILLING AND TAPPING

A. Wherever required, ductile iron pipe and fittings shall be drilled and tapped to receive drainage or any other piping. All holes shall be drilled accurately at right angles to the axis of any pipe or fitting. Where plugs are drilled, holes shall be at right angles to the face of the plug.

B. Where the size of the pipe to be connected is such as to require bosses for connection and when the pipe wall thickness is too thin to permit the effective length of pipe threads to be utilized as necessary for the size pipe being connected by threads, furnish such pipe with cast-on bosses suitable for drilling, tapping, and connecting such pipe. Alternately, where shown or specified, a tapped saddle clamp may be used in lieu of a
cast-on boss. Saddle clamp shall be of the heavy-duty type with O-ring gaskets and 2 heavy U-bolt clamps.

C. All tapping shall be carefully and neatly done by skilled workmen with suitable tools.

D. Where connections are made between new and old piping, the connections shall be made in a thorough and workmanlike manner using proper fittings and specials to suit actual conditions.

E. Cut-ins to existing and operating pipelines shall be done at times agreeable to the Owner upon approval of the Engineer.

F. Existing pipelines that may be cut or damaged during the performance of work under this item shall be repaired, reconnected, and returned to service in equal or better condition in which they were found and in accordance with the requirements of this Specification.

G. No separate payment will be made for drilling, tapping, making connections, cut-ins, repairs to damaged existing pipelines, and reconnections in existing pipelines.

PART 3.7 FIELD TESTING

A. After all piping has been placed and backfilled between the joints, each run of newly laid pipe, or any valved section thereof, shall be tested by the Contractor in the presence of the Engineer, and tests shall be continued until all leaks have been made tight to the satisfaction of the Engineer.

B. All force main and pump discharge piping shall be subject to a hydrostatic pressure test with a gauge pressure equal to 150 percent of the maximum operating pressure of the pipe section under test (Test Pressure = 135 psi). The above pressures shall be maintained for a minimum of two consecutive hours. No leakage will be allowed. Leakage may be determined by loss of pressure or other methods approved by the Engineer.

C. Take all precautions necessary to protect any equipment that might be damaged by the pressures used in the tests. Delicate equipment shall be valved off, removed, or otherwise protected.

D. Securely anchor and restrain all piping against movement prior to application of test pressures. Prior to the pressure test, pipe laid in trenches shall be partially backfilled to adequately secure the pipe during the test. All joints, fittings, and valves will be left open where possible. All exposed pipe, fittings, valves, and joints shall be carefully examined during the pressure test.

E. Expel all air from the pipe before applying the specified test pressure. If hydrants, blow-offs, or air release valves are not available at the high places, make the necessary taps at points of highest elevation before the test is made and insert plugs after the test has been completed.
F. Any leakage developing during the test shall be corrected at the Contractor's expense by tightening, replacing packing or gaskets, or replacing defective portions of the piping system. Caulking will not be permitted. If the defective portion cannot be located, the Contractor, at his expense, shall remove and reconstruct as much of the original work as necessary to obtain a facility tested without leakage.

G. Carefully clean, blow out, and drain the line of all water after all tests on any section have been completed to the satisfaction of the Engineer. Demonstrate to the satisfaction of the Engineer that any and all lines are free from obstructions and foreign material.

H. The Contractor shall bear the complete cost of the tests, including set-up, labor, temporary piping, blocking, gauges, bulkheads, water, air, soap solutions, and any other materials required to conduct the tests.

END OF SECTION
SECTION 40 05 23
VALVES

PART 1 - GENERAL

PART 1.1 SCOPE

A. The work covered by this section includes furnishing all labor, equipment, and materials required to furnish and install all metal valves, including operators, boxes, and accessories, as specified herein, shown on the Drawings, or required for proper completion of the work under these Contract Documents.

B. The Contractor's attention is called to the fact that all valves, especially in the smaller sizes, are not necessarily shown completely on the Drawings, which are more or less schematic. Furnish and install all valves indicated or required for proper operation of the equipment or services requiring such valves.

PART 1.2 SHOP DRAWINGS AND ENGINEERING DATA

A. Submit complete shop drawings and engineering data to the Engineer in accordance with the Conditions of Contract and Division 1 Specification sections.

PART 1.3 STORAGE AND PROTECTION

A. Store and protect valves and accessories in accordance with the requirements of the valve manufacturer or as directed by the Engineer.

B. Completely drain valves prior to shipment. Protect ends of flanged and mechanical joint valves with full size wooden baffles securely bolted to the valve ends. Size of baffles shall be at least equal to outside diameter of flange. Secure valves 24 inches in size and larger to a wooden skid to facilitate handling and storage.

PART 1.4 SHOP PAINTING

A. Clean, shop prime, and shop paint valves and accessories in accordance with the requirements of these Specifications.

B. All interior and exterior nonmachined, nonbearing ferrous surfaces on iron body valves, gates, and accessories shall be blast-cleaned and painted at the factory with two coats of asphaltic varnish conforming to Federal Specification TT-V-51c, unless otherwise specified. Exterior nonmachined, nonbearing ferrous surfaces on valve operators and on nonsubmerged or nonburied butterfly and eccentric plug valves shall be blast-cleaned and painted at the factory with one coat of zinc chromate primer conforming to Federal Specification TT-P-645 and one coat of compatible alkyd enamel. Other paint systems may be proposed by the valve supplier, subject to the Engineer's approval.
PART 1.5 OPERATION AND MAINTENANCE DATA

A. Submit complete operation and maintenance data on the valves in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

PART 1.6 QUALITY ASSURANCE

A. The valve manufacturers shall furnish a written certification to the Engineer that all valves and operators furnished comply with all applicable requirements of the governing AWWA standards specified herein.

PART 1.7 GUARANTEE

A. Provide a guarantee against defective equipment and workmanship in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

PART 2 - PRODUCTS

PART 2.1 GENERAL

A. All castings, regardless of material, shall be free from surface defects, swells, lumps, blisters, sandholes, or other imperfections.

B. All valves shall have the name of the manufacturer, rated working pressure, and size of the valve cast upon the body or bonnet in raised letters. Alternately, the name of the valve manufacturer, rated working pressure, and size may be stamped on a stainless steel identification plate permanently attached to the valve body or bonnet. Valves specified to conform with AWWA requirements shall have the letters "AWWA" cast upon the valve body or bonnet in raised letters.

C. Valves and operating mechanisms shall be of the proper size and dimensions to fit the pipe connections thereto and shall be installed in the position and within the space shown on the Drawings.

D. The direction of rotation of the operator to open the valve shall be to the left (counterclockwise), unless otherwise specified. Each valve body or operator shall have thereon the word OPEN and an arrow indicating the direction to open.

E. A union or coupling shall be provided within 2 feet on each side of a threaded end valve unless the valve can be otherwise easily removed from the piping. This shall not apply to soldered end valves in copper plumbing.

F. All exposed bolts and nuts on buried or submerged valves and operators shall be brass or stainless steel for corrosion resistance. Exposed bolts and nuts on exposed valves and operators shall be of corrosion-resistant materials or shall be zinc or cadmium plated.
G. Valves and operators shall be of the proper size to fit the pipe connections and shall fit in the position and space as shown on the Drawings.

H. Valve operators shall be of sufficient size and capacity to seat, unseat, and operate the valve under the maximum specified differential pressure. Where no maximum differential pressure is specified, the operator shall be designed for a differential pressure equal to the maximum working pressure of the valve. Additional allowances shall be made for the lubricating and/or scale-forming tendencies of the fluid.

PART 2.2 TWO-WAY PLUG VALVES

A. Two-way plug valves, unless otherwise shown or specified, shall be of the eccentric, non-lubricated type with resilient, neoprene-faced or epoxy-coated plugs providing drip-tight shut-off at rated pressure. Port area shall not be less than 80 percent of the corresponding full pipe area in sizes 16 inches and smaller and 100 percent of the corresponding full pipe area in valves 18 inches and larger. Two-way valves shall operate from fully open to fully closed with a 90 degree rotation of the valve stem.

B. Valves shall be designed for a working pressure of not less than 175 psi in sizes through 16 inches and 150 psi in sizes 18 inches and larger. Valves shall be drip-tight at rated pressure differential in both directions.

C. Valves shall have bodies of ASTM A126, Grade B or ASTM A48, Grade 40 cast iron. Valves 4 inches and larger in size shall have bolted bonnet.

D. Body seats for resilient-faced plugs shall be welded in and contain a minimum of 90 percent nickel. Welded-in seats shall conform to the applicable requirements of AWWA C507, Section 3.2 and AWWA C504, Section 3.5.

E. Plugs without a resilient coating or facing shall be epoxy coated and shall have a field replaceable, full-circle rubber seat securely attached to the plug. Body seats shall be nylon coated.

F. Shaft seal shall be of the self-adjusting or split-V type of Buna-N and shall comply with the applicable requirements of AWWA C504, Section 3.7 and AWWA C507, Section 3.2. Seals requiring adjustment shall be adjustable and replaceable without bonnet or shaft removal.

G. Supply bearings in both the upper and lower journals. Bearings shall be permanently lubricated and replaceable with stainless steel, bronze, or specially coated corrosion-resistant sleeves and bushings. Bearings shall conform to the applicable requirements of AWWA C504, Section 9 and AWWA C507, Section 8.

H. Valves sized 2½ inches and smaller shall have threaded ends per ANSI B2.1. End connections for valves sized 3 inches and larger shall be 125-pound flanged per ANSI B16.1, except for valves to be buried underground, which shall have mechanical joint ends per ANSI A21.11 (AWWA C111). Flanged end valves in sizes 12 inches and
smaller shall have a laying length equal to that of an AWWA gate valve of the same size.

I. Valves intended for buried or submerged service shall be sealed against the entrance of water and dirt.

J. Furnish valves with a lever operator, rotary manual operator, or electric motor operator as shown on the Drawings. Unless otherwise shown or specified, a lever operator shall be furnished on valves 6 inches and smaller, and a rotary manual operator with handwheel shall be furnished on valves 8 inches and larger. Extension stem, floorstand, and valve box shall be furnished where shown or required.

K. Two-way plug valves shall be DeZurik “Series 100 Eccentric Plug Valve,” Dresser “X-Centric,” or equal.

PART 2.3 CURB STOPS AND CORPORATION STOPS

A. Curb stops shall be of all-bronze construction with straight-through unobstructed pattern flow, Teflon-coated plug, top and bottom O-ring plug seals, O-ring port seals, and solid tee handle. Valves shall be suitable for 175-psi minimum working pressure. A quarter turn shall operate the valve from fully open to fully closed position. Valves shall comply with the applicable requirements of AWWA C800.

B. Furnish curb stops with cast iron foot pieces to permit the curb box to rest on a solid surface without bearing on the curb stop or piping.

C. Curb boxes shall be of cast iron, have a 2-inch inside diameter, and be of the extension type with lid and plug. One compatible steel shut-off rod of suitable length shall be furnished. Coat curb boxes and bases with a suitable bituminous coating.

D. Corporation stops for service line connections shall be precision fitted, individually lapped, ground joint key stops of all bronze construction. For tapped connections to water mains, inlet threads shall be of the steep taper, corporation stop type. Corporation stops shall conform to the applicable requirements of AWWA C800.

PART 2.4 AIR RELEASE VALVES

A. Air release valves shall have cast iron body and cover, stainless steel float, stainless steel or bronze trim, and Buna-N seat. All other attaching parts or internal parts shall be stainless steel or bronze.

B. Valve shall be designed for a working pressure of 0 to 150 psi unless otherwise shown or specified and shall be equipped with an orifice appropriate to the venting needs of the pipeline.

C. Sewage valves shall be equipped with an elongated body, a 2-inch NPT inlet connection, and a 1/2-inch NPT outlet connection and shall be provided with 2-inch
inlet shut-off valve, 1-inch blow-off valve, and 1/2-inch back-flush valve with quick-disconnect coupling and flushing hose with quick-disconnect connections.

D. Pressure water valves shall be installed in valve pit, complete with tapping saddle and connecting line to main, gate valve, etc., and at the location(s) shown on the Drawings. Clean, prime, and paint valve exterior with bituminous paint. Valves 2 inches and smaller shall have NP screwed inlet. Combination air vacuum/air release valve shall be Valve and Prime Corporation, APCO Combination Air Release Valve (Standard), Crispin Universal Air Valve, or equal.

PART 2.5 CHECK VALVES

A. Check valves shall be of the swing type suitable for use in either horizontal or vertical piping, unless otherwise shown or specified. Disc shall swing entirely clear of the path of flow when in the open position. All internal parts shall be readily accessible and easily replaced in the field.

B. Check valves in sizes 2-1/2 inches and smaller shall be Y-pattern, regrinding, bronze body, bronze mounted valves. Valves shall have 200-pound cast bronze body, renewable bronze disc, screwed cap, and threaded ends per ANSI B2.1. Bronze for body and cap shall conform to ASTM B 61. Brass nuts and pin shall conform to ASTM B 16. Valves shall have a hinge bumper capable of preventing the valve from sticking in the open position and an arrow cast on the valve body to indicate direction of flow. Bronze check valves shall be Powell Fig. 560Y, Stockham Fig. B-345, Nibco Fig. T-453-B, or equal.

C. Check valves in sizes 3 inches and larger shall be iron body, bronze mounted valves conforming to AWWA C508, epoxy-coated inside and outside. Valves shall have 125-pound cast iron body, bolted and gasketed cover, stainless steel or bronze hinge pin, rubber faced, renewable, bronze or cast iron disc, renewable bronze seat ring, outside lever and adjustable weight, and 125-pound flanged ends per ANSI B16.1. Cast iron for body and cap shall conform to ASTM A 126, Grade B. Bronze for disc and seats shall conform to ASTM B 584. Iron body check valves shall be Mueller Fig. A2600-6-01, Clow F-5345, or equal.

D. Valves shall be installed with pressure under the disc.

E. Check valves in air or gas piping sized 2-1/2 inches or smaller shall be bronze, swing type check valves conforming to the requirements of Item B above, except that the disc shall have a replaceable, resilient seat of Buna-N or Teflon. Bronze check valves for air or gas service shall be Nibco Fig. T-453-W, Kennedy Fig. 442, or equal.

F. Check valves in air or gas piping sized 3 inches and larger shall be of the double plate, spring-loaded, clapper type with cast iron body, aluminum bronze or bronze plates, stainless steel hinge pin and springs, and Buna-N seats. When operating temperatures exceed 180°F, Viton seats shall be used. Check valves shall be wafer style bodies suitable for mounting between two 125-pound ANSI B16.1 flanges. Check valves shall be rated for a working pressure of not less than 150 psi. Clapper style check valves
shall be Mission "Duo-Check," FMC, or equal. Install clapper style check valves in horizontal piping with the pin in a vertical position.

PART 2.6 FLAP VALVES

A. Flap valves shall be designed to withstand the stresses resulting from high-head seating applications and to maintain sensitivity to unseating heads.

B. Flap valves shall have iron bodies and shall be bronze mounted. Valves shall be furnished with bronze hinge pins, flap rings, and seat rings.

C. Valves shall be furnished with 125-pound flanged ends per ANSI B 16.1.

D. Flap valves shall be Clow F-3012, Mueller A-2540-6, M&H (Dresser) Figure 47, or equal.

PART 2.7 MANUAL VALVE OPERATORS

A. All gate valves shall be furnished with manual operators as follows, unless otherwise shown or specified:

1. Buried Extension stem and valve box with standard operating nut

2. Submerged or Located Extension stem with floor stand and in Deep Vault handwheel operator

B. Operating nuts for buried or submerged valves shall be standard 2-inch-square nuts and shall conform to AWWA C500, Section 19. Extension stems, valve boxes, and stem guides shall be furnished where shown, specified, or required for proper operation.

C. Manual rotary operators for buried or submerged service shall be totally enclosed and completely sealed to prevent the entrance of water and dirt. Buried or submerged operators shall be finished on the outside with a bituminous or other approved coating. Rotary operators for buried or submerged service shall be capable of withstanding 300 foot-pounds of torque on the operating nut or handwheel. A corrosion-resistant, dial type valve position indicator shall be provided at the operating nut on the extension stem of buried operators to provide a remote indication of valve position.

D. All manual rotary and lever operators shall be capable of seating or unseating the valve disc under the most adverse conditions in the particular application with not more than an 80-pound pull on the handwheel or lever. Valve operators shall be capable of holding the valve in any position between fully open and fully closed without creeping or fluttering. Operators shall be provided with adjustable, mechanical, stop-limiting devices to prevent over-travel of the valve disc in the open and closed positions. Manual rotary and lever operators shall comply with all applicable requirements of AWWA C540, Sections 11.1, 11.2, and 11.3.
PART 2.8 VALVE BOXES

A. All buried valves shall be provided with three-piece, cast iron, extension sleeve type valve boxes suitable for the depth of cover as shown on the Drawings.

B. Valve boxes shall not be less than 5 inches in diameter, shall have a minimum thickness of 3/16 inch at any point, and shall be provided with suitable cast iron bases and covers. Covers shall have cast thereon an appropriate name designating the service for which the valve is intended ("W" for water, "S" for drain or waste lines). Covers in roadways shall be of the deep locking type.

C. All parts of valve boxes, bases, and covers shall be heavily coated with a suitable bituminous finish.

D. Valves and boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves with the top of the box flush with the finished grade.

PART 2.9 T-HANDLE OPERATING WRENCH

A. Furnish two T-handle, steel valve operating wrenches with sockets compatible with standard 2-inch-square valve operating nuts.

B. The operating wrenches shall be at least 36 inches in length.

PART 2.10 HOSE BIBBS

A. Hose bibbs shall be angle hose valves of bronze construction suitable for 200 psi minimum working pressure. Valves shall have a renewable Teflon or resilient disc and shall be furnished with a 3/4-inch male hose outlet connection. Body and bonnet shall be ASTM B 62 bronze. Valves shall be furnished with a suitable cap and chain. Inlet connection shall be threaded per ANSI B2.1.

PART 2.11 SPARE PARTS

A. Furnish the following spare parts where applicable for the valves specified herein:

1. Stem packing  One set each type and size of valve
2. Renewable stainless steel or bronze seat ring  One each type and size of valve
3. O-ring stem or shaft seals  One set each type and size of valve
4. Resilient seat or disc  One each type and size of valve
5. Shaft bearings or bushings  One set each type and size of valve
6. Hinge pin, disc, spring, and valve  One set each type and size of check disc bolts
7. Gaskets  One set each type and size of valve
8. Special tool or seat wrench One each required for valve servicing and maintenance

B. Suitably protect spare parts against corrosion and impact to withstand long-term storage. All parts shall be clearly labeled and identified by manufacturer's name and number and the valve to which they belong.

PART 3 - EXECUTION

PART 3.1 FACTORY TESTS

A. Test all valves at the point of manufacture for proper and unobstructed operation and for leakage and adequacy of design.

B. Test iron body gate valves in accordance with AWWA C500, Section 5.

C. Test butterfly and plug valves in accordance with AWWA C504, Section 5.

D. Test iron body check valves in accordance with AWWA C508, Section 5.

E. All other valves shall be given an operation test, a leakage test at rated pressure differential, and a hydrostatic test at two times rated pressure. During the hydrostatic test, there shall be no leakage through the metal, the end joints, or the shaft or stem seal, nor shall any part be permanently deformed. During the leakage test, leakage shall not exceed that permitted by ANSI B16.104, Class IV for metal seated valves and Class VI for resiliently seated valves.

PART 3.2 INSTALLATION

A. Install all valves in strict conformance with the Drawings and approved shop drawings and manufacturer's instructions.

B. Install all underground valves using a concrete valve box with cast iron frame and cover or in a cast iron valve box as specified herein.

C. Install valves in such a way that operators and packing are easily accessible. Valves with field replaceable seats shall be installed with sufficient clearance to permit removal of valve bonnet and stem without removing valve from the line.

PART 3.3 FIELD TESTING

A. Following installation, test all valves under the anticipated operating conditions. The ability of the valves to operate properly without leakage, binding, sticking, fluttering, or excessive operating torque shall be demonstrated to the satisfaction of the Engineer. At Contractor's expense, adjust and/or replace any valve as necessary to ensure satisfactory operation.
END OF SECTION
PART 1 - GENERAL

PART 1.1 SCOPE

A. The work covered by this section includes furnishing all labor, equipment, and materials required to furnish and install pipe couplings and expansion joints, including grooved couplings, flanged adaptors, expansion couplings, and rubber expansion joints, as shown on the Drawings, specified herein, and/or required for proper installation of piping and equipment.

PART 1.2 SHOP DRAWINGS AND ENGINEERING DATA

A. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

PART 1.3 STORAGE AND PROTECTION

A. Equipment and products stored outdoors shall be supported above the ground on suitable wooden blocks or braces arranged to prevent excessive deflection or bending between supports. Items such as pipe, structural steel, and sheet construction products shall be stored with one end elevated to facilitate drainage.

PART 1.4 SHOP PAINTING

A. Clean, shop prime, and shop paint all pipe couplings as specified herein.

PART 1.5 GUARANTEE

A. Provide a guarantee against defective materials and workmanship in accordance with the requirements of the applicable provisions of the Conditions of Contract and Division 1 Specification sections.

PART 2 - PRODUCTS

PART 2.1 EXPANSION COUPLINGS

A. Unless otherwise shown or specified, expansion couplings shall be of a gasketed, short sleeve type, with a diameter to fit the pipe properly. Expansion couplings shall have a working pressure of not less than 150 psig.
B. Each short sleeve coupling for joining ductile iron or steel pipe shall consist of one cylindrical steel middle ring without pipe stop, two steel follower rings, two rubber-compound, wedge section gaskets, and a sufficient number of track head, electroplated steel bolts to compress the gaskets properly. Steel couplings shall be Dresser Style 38, Rockwell Style 411, or equal.

C. Where expansion couplings are required for joining ductile iron pipe to steel pipe of the same nominal size, steel transition couplings, Dresser Style 62, Rockwell Style 413, or equal, shall be used.

D. Rubber gaskets shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil and grease.

PART 2.2 FLANGED ADAPTORS

A. Flanged adaptors shall be used for joining plain end ductile iron pipe to flanged valves, pumps, and fittings. Flanged adaptors shall be suitable for working pressures to 150 psig.

B. Flanged adaptors in sizes 12-inch and smaller shall consist of an ASTM A 126, Class B cast iron flanged body drilled to mate with a 125-pound cast iron flange per ANSI B16.1, a cast iron follower ring, a rubber-compound, wedge section gasket, and a sufficient number of track head, electroplated steel bolts to compress the gasket properly.

C. Flanged adaptors in sizes 14-inch and larger shall consist of a high strength steel flanged body drilled to mate with a 125-pound cast iron flange per ANSI B16.1, a high strength steel follower ring, a rubber-compound, wedge section gasket, and a sufficient number of electroplated steel bolts to compress the gasket properly.

D. Rubber gasket shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil and grease.

PART 2.3 FLANGED RUBBER EXPANSION JOINTS

A. Flanged rubber expansion joints shall be standard spool-type single or multiple arch expansion joints constructed of abrasion-resistant rubber reinforced with high tensile strength synthetic fabric and steel rings.

B. Ends of the expansion joint shall be integral with the body and shall be full faced and drilled per ANSI B16.1 for 125-pound flanges. Beveled and split, galvanized steel retaining rings shall be provided to prevent damage to flanges and to distribute bolting stresses during assembly.

C. Tube, body, and flanges shall be constructed using Buna-N for wastewater, natural rubber for clean water, and Buna-N or neoprene for air. For working temperatures in excess of 180°F or for chemical service, tube, body, and flanges shall be constructed of Viton. The exterior of the expansion joint shall be coated with Hypalon to resist weathering.
D. When used to convey slurries, raw water, or untreated wastewater in horizontal piping, arches shall be filled with a special soft rubber compound integrally cured in the arches.

E. In unrestrained piping systems or pipe systems subject to excessive longitudinal deflection, joints shall be furnished with two plated steel control rods fitted with nuts to limit compression and extension and prevent damage to the joint.

F. Rubber expansion joints shall be "Redflex," as manufactured by Red Valve Company, "Invincible Expansion Joint," as manufactured by Mercer Rubber Company, or equal, subject to the requirements of this section.

PART 2.4 SHOP COATINGS

A. Couplings and adaptors shall have finish as follows:

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<thead>
<tr>
<th>Material</th>
<th>Location</th>
<th>Primer</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ductile Iron</td>
<td>Buried, Submerged, or Exposed</td>
<td>Epoxy Primer</td>
<td>Epoxy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interior</td>
<td></td>
</tr>
<tr>
<td>Ductile Iron</td>
<td>Buried, Submerged, or Exposed</td>
<td>Epoxy Primer</td>
<td>Epoxy</td>
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<td></td>
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<td>(Exterior)</td>
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<tr>
<td>Steel</td>
<td>Buried, Submerged, or Exposed</td>
<td>Epoxy Primer</td>
<td>Epoxy Finish</td>
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<td></td>
<td></td>
<td>Interior</td>
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</tr>
<tr>
<td>Steel</td>
<td>Buried, Submerged, or Exposed</td>
<td>Epoxy Primer</td>
<td>Coal Tar Epoxy</td>
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<td></td>
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<td>(Exterior)</td>
<td></td>
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</tbody>
</table>

B. Coatings used for couplings and adaptors in potable water shall be approved for use with potable water.

PART 2.5 SPARE PARTS

A. Furnish 2 spare gasket sets and 2 spare track head bolt sets for each size and type of coupling.

PART 3 - EXECUTION

PART 3.1 INSTALLATION

A. Pipe couplings and expansion joints shall be installed where shown on the Drawings, required, or directed by the Engineer. Couplings and joints shall be installed in strict conformance with the manufacturer's instructions.
B. Pipe ends shall be cleaned, brushed, or filed to produce a mating surface for the gasket that is free from dirt, rust, chuck marks, mill scores, dents, burrs or other foreign substances that would impede proper gasket seating.

C. Grooves for grooved couplings shall be accurately located and cut with a suitable grooving tool.

D. A lubricant recommended by the coupling manufactured shall be used in seating all gaskets.

E. On expansion couplings and flanged adaptors, bolts shall be tightened diametrically opposite each other and in progression so that the inner rims project an equal distance over the flares of the middle ring at all points. Bolts shall be tightened sufficiently to ensure a watertight joint but shall not be tightened beyond the point of stretching.

F. On grooved couplings, bolts shall be tightened alternately and uniformly so the housing clamps come together evenly and the gasket is not pinched. Bolts shall be tightened until the housing clamps meet.

G. Couplings shall be field painted, following installation and testing, in accordance with the requirements listed previously in this section. Rubber expansion joints shall not be painted.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. This section covers all pipe supports, hangers, and brackets necessary to install piping furnished under these Contract Documents. The Contractor shall furnish and install all foundations, anchor bolts, pipe supports, shims, hangers, clamps, and hardware required for a complete installation as shown on the Drawings and/or specified herein.

1.2 SHOP DRAWINGS AND ENGINEERING DATA

A. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the Conditions of Contract and Division 1 Specification sections.

1.3 STORAGE AND PROTECTION

A. Pipe supports and accessories shall be stored and protected in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

1.4 SHOP PAINTING

A. Fabricated pipe supports and accessories not specified to be galvanized or cadmium plated shall be cleaned, shop primed, and/or shop painted as specified and/or shown on the Drawings.

1.5 GUARANTEE

A. Provide a guarantee against defective equipment and workmanship in accordance with the requirements of the Conditions of Contract and Division 1 Specification sections.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All supports and hangers shall meet the following material requirements:

B. All structural steel shall conform to ASTM A 36.

C. All pipe support columns shall conform to ASTM A 53, Grade B, and shall be minimum Schedule 40.
D. All embedded anchor bolt materials shall conform to ASTM A 193, Grade B8; ASTM A 276, Type 304; or IFI-104, Grade 304. Nuts shall be heavy hex nuts conforming to ASTM A 194, Grade 8 or IFI-104, Grade 304. Minimum anchor bolt size for pipe supports shall be 5/8-inch diameter.

E. All rod and bolting materials in contact with cold piping (less than -20°F) shall conform to ASTM A 320, Grade B8. Nuts shall be heavy hex nuts conforming to ASTM A 194, Grade 8 or 8T.

F. All rod and bolting materials shall conform to ASTM A 307, Grade B, and shall be cadmium plated. Nuts shall be heavy hex nuts conforming to ASTM A 307. Cadmium plating shall conform to ASTM A 165, Type NS.

G. All carbon steel or malleable iron straps, hangers, clamps, U-bolts, and other hardware in contact with the pipe shall be cadmium plated or hot-dip galvanized.

H. Expansion type anchor bolts shall be of stainless steel construction and shall comply with Federal Specification FF-S-325.

I. Long runs of pipe subject to expansion shall be hung by means of adjustable swivel pipe roll hangers, Grinnell, Figure 174; Fee and Mason, Figure 2729; or equal.

J. Short runs of uninsulated pipe subject to expansion in sizes up to and including 3-1/2 inches as well as all pipe of those sizes not subject to expansion shall be hung by means of adjustable swivel, split pipe ring, Grinnell, Figure 104; Fee and Mason, Figure 199; or equal.

K. Insulated piping and tubing, short lengths of 4-inch and larger pipe subject to expansion, and pipe 4 inches and larger not subject to expansion shall be hung by means of adjustable steel clevis hangers, Grinnell, Figure 260; Fee and Mason, Figure 239; or equal.

L. Pipe 2 inches and less in diameter and not subject to expansion may, when paralleling walls, be supported by single hook clamp hangers, Grinnell, Figure 168; Fee and Mason, Figure 327B, or equal.

M. Flat strap hangers will not be permitted. Hangers relying on mastics or adhesives shall not be used.

N. Pipe supported from underneath and subject to expansion shall have adjustable pipe roll stand supports, Grinnell, Figure 274; Fee and Mason, Figure 161; or equal. The pipe roll stand shall be supported by concrete piers, structural steel, or steel brackets as required.

O. Pipe supported from underneath and not subject to expansion shall have cast-in-place concrete supports as shown on the Drawings or adjustable pipe saddle supports on properly sized pipe stanchions and ample properly grouted floor.
flanges. Saddle supports shall be Grinnell, Figure 264; Fee and Mason, Figure 291; or equal.

P. Hangers suspended from structural steel shall be supported on U.F.S. beam clamp, Grinnell, Figure 228L or 2921; Fee and Mason, Figure 252L or 253L; or equal with links as required.

Q. Hangers from concrete work shall be secured by universal, galvanized metal inserts, Grinnell, Figure 282; Fee and Mason, Figure 2570; or equal, placed in the concrete at the time of pouring. Wooden plugs or other improvised means shall not be used for any form of hanger fastening.

R. Steel or concrete pipe supports for all piping between undisturbed earth and face of structures shall be in accordance with the details shown on the Drawings.

S. All interior and exterior concrete piers shall be Class A concrete meeting the requirements of these Specifications.

T. Rods for supporting suction bells or foot valves of pump intakes shall be stainless steel of the size shown on the Drawings. The rods shall be furnished complete with stainless steel turnbuckles and eyes or other approved means for connection to the suction bell and stainless steel eye bolt anchored in the concrete. Supports for other pump suction pipelines shall be as shown on the Drawings.

U. Uninsulated copper tubing shall be hung by means of copper-plated, split-ring hangers with copper-plated sockets, Grinnell Figure CT-109, Fee and Mason Figure 360, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contact between ferrous supports and non-ferrous piping materials shall not be permitted. Supports and clamps shall be rubber coated or copper plated as necessary to prevent this condition.

B. Adequate supports shall be provided so that there is no movement or visible sagging between supports.

C. Hangers shall permit a minimum of 1-1/2-inch vertical adjustment after installation.

D. Hanger rods shall be galvanized carbon steel conforming to the following sizes:

<table>
<thead>
<tr>
<th>Minimum Pipe Size (Inches)</th>
<th>Rod Diameter (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 and under</td>
<td>1/4</td>
</tr>
<tr>
<td>3/4 - 2</td>
<td>3/8</td>
</tr>
</tbody>
</table>
E. Carbon steel, alloy steel, stainless steel, and hard-drawn copper pipe shall be supported on maximum intervals as follows:

<table>
<thead>
<tr>
<th>(Inches)</th>
<th>Maximum Interval for Steel, (Feet)</th>
<th>Maximum Interval for Copper (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liquid</td>
<td>Gas</td>
</tr>
<tr>
<td>1/2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3/4</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>1-1/2</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>2-1/2</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td>19</td>
<td>24</td>
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<tr>
<td>10</td>
<td>22</td>
<td>27</td>
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<tr>
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<td>14</td>
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<td>32</td>
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<td>16</td>
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<td>35</td>
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<td>18</td>
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<td>37</td>
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<td>20</td>
<td>30</td>
<td>39</td>
</tr>
<tr>
<td>24</td>
<td>32</td>
<td>42</td>
</tr>
</tbody>
</table>

F. Annealed copper tubing, polyethylene tubing, and PVC piping shall be supported on maximum intervals as follows:

<table>
<thead>
<tr>
<th>Tube Size (Inches)</th>
<th>Maximum Interval (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 and smaller</td>
<td>2</td>
</tr>
<tr>
<td>1/2 - 5/8</td>
<td>3</td>
</tr>
<tr>
<td>3/4 - 1-1/8</td>
<td>4</td>
</tr>
<tr>
<td>1-1/4 - 2</td>
<td>5</td>
</tr>
<tr>
<td>2-1/2 - 3-1/2</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

G. Exposed piping and tubing carrying liquid shall be sloped as necessary to permit complete draining, where indicated or directed by the Engineer. Pipe deflection between supports shall be considered when determining the slope required to permit complete drainage. All underground piping shall be sloped uniformly for complete drainage.
H. Cast iron or ductile iron piping shall be supported as recommended by the manufacturer, and at all valves and fittings larger than 4 inches in size. At least one support shall be provided per pipe section or at every other joint, whichever is closer. Supports shall be located next to hubs or bells.

I. Open ends of pipe columns used for support shall be completely covered with a 1/4-inch-thick plate or angle leg welded in place.

J. All threaded connections installed loose, such as hanger rods and U-bolts, shall have a double nut installation.

K. Vertical piping shall be supported as shown or required to prevent buckling or swaying utilizing special brackets. Unless otherwise shown, vertical piping shall be supported at the bottom and at each floor. Vertical copper tubing 1 inch and smaller in size shall be supported at 5-foot intervals.

L. Provide a support within 18 inches of each elbow and within 24 inches of each equipment connection.

M. Pipes passing through non-load bearing walls and partitions shall not bear on building construction. Pipes shall not be supported from roof decking, bar joists, or ceiling suspension systems unless approved by the Engineer.

N. Insulation on hot piping (carrying fluids above 70°F) shall be protected at supports and hangers with a 12-inch-long galvanized steel protection saddle with welded center support. Protection saddle shall be Grinnell Figure 160 or 161, Fee and Mason Figure 171 or 1710, or equal.

O. Insulation on cold piping (carrying fluids at 70°F or below) shall be protected at supports and hangers by galvanized steel insulation shields with a 180-degree contour. Insulation shields shall be Grinnell Figure 167, Fee and Mason Figure 81, or equal.

P. On insulation finished with an aluminum jacket, a 1/32-inch-thick sheet of neoprene shall be provided between the jacket and the shield.

Q. Hangers shall be selected to fit around insulation.

R. Following installation, all pipe supports shall be field primed and painted with the painting system specified and/or shown on the Drawings.

S. Piping shall not be fastened to a support in such a manner that would prevent axial movement due to thermal expansion and contraction, unless otherwise shown.

T. No pipe supports shall be anchored to or supported from floor grating.
U. Unless otherwise noted, piping dimensions shown on the Drawings are for reference only and shall be verified in the field by the Contractor. The Contractor shall size supports and hangers using actual field dimensions.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION

A. The work covered under this section consists of furnishing and installing a 6-inch diameter magnetic flowmeter complete with signal converters as shown on the Drawing and/or described herein.

B. The magnetic flowmeters shall be Fischer and Porter "Copa-X," ABB Kent-Taylor "Magmaster," or approved equal.

C. The magnetic flowmeter shall be suitable for measuring municipal wastewater.

1.2 SUBMITTALS

A. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the requirements of Section 01 33 23, Shop Drawings, Product Data, and Samples.

1.3 STORAGE AND PROTECTION

A. Equipment and controls shall be stored and protected in accordance with the requirements of Section 01 60 00, Materials and Equipment.

1.4 OPERATION AND MAINTENANCE DATA

A. Complete operation and maintenance data shall be submitted in accordance with the requirements of Section 01 78 23, Operating and Maintenance Data.

1.5 GUARANTEE

A. Provide a guarantee against defective or deficient equipment and workmanship in accordance with the requirements of Section 01 78 36, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The magnetic flowmeter (magmeter) shall be of the low frequency electromagnetic induction type and shall produce a pulsed DC signal directly proportional to and linear with the liquid flow rate. The magmeter shall be designed for operation on 120V AC ±10%, 60 Hz ±5%.

1. Construct the metering tube of carbon steel.

2. Line magmeter with polyurethane and supply with 316 stainless steel electrodes. The use of removable electrodes will not be acceptable.
3. Design the magmeter to mount directly in the pipe between ANSI Class 150 flanges. Flange material shall be carbon steel.

4. The magmeter length-to-diameter dimensional ratio shall be a minimum of 1.5 in order to minimize inaccuracies generated by the effects of inner wall conductivity of adjacent piping.

5. House the magmeter in an epoxy-coated NEMA 4X enclosure. Magmeter shall be capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the instrument or interruption of the flow measurement.

6. Where insulated or nonconductive pipe is used, the use of two orifice plate type stainless steel grounding rings per magmeter shall be required. In order to ensure integrity of the magmeter liner, grounding electrodes which penetrate the liner will not be acceptable.

7. Provide "bullet nose" type electrodes.

B. The signal converter (converter) portion of the magmeter shall include both a magnet driver and the converter electronics.

1. The converter shall be either integrally or remotely mounted. Thirty feet of interconnection cable shall be supplied with remote mounted versions.

2. Converters shall be interchangeable without affecting meter accuracy or the need for recalibration for all meter sizes.

3. House the converter in an epoxy-coated NEMA 4X enclosure.

4. The converter shall include a separate customer connection compartment to isolate the electronics from power connections and to protect the electronics from environmental hazards.

5. The converter electronics shall be of the solid state, feed back type, utilize integrated circuitry, and be microprocessor controlled. All operational parameters shall be user configurable locally via an integral push button/display arrangement.

6. An integral display to the converter electronics shall maintain two rows of not less than 16 alpha-numeric characters for simultaneous view of both instantaneous rate of flow readings in percent or direct engineering units and totalization. The display shall be backlighted with a matrix-type liquid crystal display (LCD) for easy viewing.

7. The converter shall have input impedance of $10^{12}$ Ohms or greater and shall not be affected by quadrature noise. Input and output signals shall be fully isolated.

8. The converter output signal shall be 4 to 20 mA DC into 0 to 750 Ohms and shall be capable of accommodating bidirectional flow.

9. The converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure or optional automatic empty pipe detection circuit to minimize totalizer inaccuracies caused by empty pipe conditions.
C. The magmeter shall be hydraulically calibrated at a facility located in the United States and the calibration shall be traceable to the National Institute of Science and Technology (NIST). A computer printout of the actual calibration data giving indicated versus actual flow at a minimum of three flow rates shall be provided with the meter. The accuracy of the magmeter shall be ±½% of rate from 2% to 100% of meter factor (0.67 fps to 33 fps) without the need for system calibration.

D. Construct the magmeter in a facility operating under a total quality system to provide assurance of product quality. To ensure this, the facility must be certified to be in compliance with the quality requirements of ISO Standard 9001.

E. Ends of meter liner shall be protected during shipment and storage with full size wooden blanks bolted to end flanges.

F. Provide local indication and flow totalizer for each flowmeter.

G. Provide flow transmitter for remote indication and totalizer in the pump control panel for flowmeter located on discharge of pumps.

PART 3 - EXECUTION

3.1 INSTALLATION AND EQUIPMENT CHECKOUT

A. The magnetic flowmeter shall be installed where shown on Drawings and shall be calibrated in accordance with manufacturer's approved shop drawings and installation instructions.

B. Provide the services of a factory certified service representative to inspect installation of probes.

C. Mount transmitters, where noted on Drawings and install conduit and wiring to connect to pump station system control panel.

D. Coordinate installation of centrifuge sludge feed flowmeter with centrifuge supplier control panel.

3.2 FIELD TESTING AND TRAINING

A. Factory certified service representative shall calibrate each flowmeter and provide service report to the Engineer and Owner.

B. Provide training to Owner’s maintenance personnel for proper operation and maintenance of flowmeters.

END OF SECTION