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***SECTION 5***  
***SPECIFICATIONS***

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## SECTION 011100 - SUMMARY OF WORK

### PART 1 - GENERAL

#### 1.1 LOCATION OF THE PROJECT

A. The project is located at three sites:

1. The Village of Cadiz Water Treatment Plant, 316 W. Warren St., Cadiz, OH 43907.
2. The WTP's primary raw water intake facility located on the north shore of Tappan Lake approximately 10 miles northwest of Cadiz (at coordinates N 40° 20' 03.0" and W 81° 09' 53.0") and along the raw water transmission main from Tappan Lake to the WTP.
3. The WTP's back-up raw water intake facility located at the dam of Sparrow Reservoir approximately 1.1 miles due east of downtown Cadiz (at coordinates N 40° 16' 24.0" and W 80° 58' 32.8").

#### 1.2 PROJECT DESCRIPTION

A. The project consists of performing equipment replacements and upgrades throughout the WTP. A list of each area affected and the work to be performed in each follows:

1. Raw Water Intake Facility
  - a. Replace all three (3) raw water pumps with two (2) new raw water pumps.
  - b. Install two (2) non-electric check valves.
  - c. Replace 6" piping with new 8" piping.
  - d. Replace all pump motor electrical power drives with variable speed drives to operate the new pumps.
2. Raw Water Transmission Main
  - a. Replace line, drain, and combination air valves (16 valves total).
3. Sparrow Reservoir
  - a. Install two (2) new pumps in existing pump house.
  - b. Install interconnecting 4" and 3" piping, three (3) gate valves, two (2) check valves, and two (2) air valves.
  - c. Install the pumps' variable speed drives and common control panel.
  - d. Heat trace and insulate raw water intake pipe on catwalk.
4. Pre-Treatment Area
  - a. Replace four (4) sludge drain plug valves and four (4) mud valves.
  - b. Replace sludge collector mechanisms in two (2) sedimentation tanks.
  - c. Replace and reinforce grating over flocculation tanks.
  - d. Place re-carbonation system back into service. Includes carbon dioxide storage tank pressure relief valve replacement and inspecting tank refrigeration system and repairing/replacing as necessary.

- e. Install automatic pH control system and replace carbon dioxide piping and diffusers in re-carbonation tank.
  - f. Install polymer injection vault (12' deep manhole) on raw water line with retractable chemical injection quill and 1" polymer feed pipe from pre-treatment room to vault.
5. Filter Room
- a. Replace granular filter media in all four (4) filter cells. Media consists of two grades of silica sand and anthracite coal totaling approximately 36 tons.
  - b. Install new 3", 8", 10", and 16" piping and four (4) 3", five (5) 10", and four (4) 16" valves with electric actuators to improve the operation of the sand filters' backwash cycles by adding a filter-to-waste step.
  - c. Install one 10" mag-meter and four (4) insertion flow meters (one for each filter cell).
  - d. Integrate the operation of the 3", 10", and 16" valve operation into the filter media backwash cycling program.
  - e. Install filter-to-waste duplex pump station and air break manhole.
  - f. Provide temporary filtration treatment while filters are out of service.
6. High Service Pump Room
- a. Replace all three (3) high service pumps with three (3) new high service pumps.
  - b. Replace three (3) electric check valves with new non-electric check valves.
  - c. Install three new air release valves.
  - d. Replace all three (3) pump motor electrical power drives with variable speed drives.
7. Fluoride Room
- a. Sand blast, patch and finish the room floor with chemically resistant coating.
8. Clearwell
- a. Replace four (4) outdoor vent screens.
  - b. Install two (2) separate water quality monitoring systems, one in each clearwell. The monitoring system will monitor for chlorine, temperature, and pH.

### 1.3 SPECIFICATIONS

- A. In general, these Specifications describe the work to be performed by the various trades, other than work specifically excluded. It shall be the responsibility of the Contractor and Subcontractors to perform all work incidental to their trade, whether or not specific mention is made of each item, unless such incidentals are included under another Item.
- B. It is advised that the Contractor and all Subcontractors familiarize themselves with the contents of the complete Specifications, particularly for the trades preceding, following, related or adjacent to their work.

## 1.4 DRAWING SCHEDULE

A. The work to be done under this Contract is shown on the following Drawings:

| SHEET NUMBER | SHEET TITLE   | SHEET NAME |
|--------------|---|------------|
| 1            | TITLE SHEET   | 00G-01     |
| 2            | SHEET INDEX, ABBREVIATIONS & ANNOTATION REFERENCES        | 00G-02     |
| 3            | GENERAL NOTES   | 00G-03     |
| 4            | VALVE SCHEDULE  | 00G-04     |
| 5            | WASTEWATER TREATMENT PLANT GENERAL SITE AND PIPING PLAN   | 01C-01     |
| 6            | RAW WATER PUMPING FACILITY DEMOLITION PLAN                | 10D-01     |
| 7            | RAW WATER PUMPING FACILITY DEMOLITION SECTIONS            | 10D-02     |
| 8            | RAW WATER PUMPING FACILITY PROCESS PLAN                   | 10D-03     |
| 9            | RAW WATER PUMPING FACILITY PROCESS SECTIONS AND DETAIL    | 10D-04     |
| 10           | RAW WATER TRANSMISSION MAIN VALVE AND DRAIN WORK          | 15D-01     |
| 11           | RAW WATER TRANSMISSION MAIN VALVE DETAILS                 | 15D-02     |
| 12           | PRETREATMENT DEMOLITION PLAN @ EL. 1156.00                | 20D-01     |
| 13           | PRETREATMENT DEMOLITION PLAN @ EL. 1145.00                | 20D-02     |
| 14           | PRETREATMENT DEMOLITION - SECTION A                       | 20D-03     |
| 15           | PRETREATMENT IMPROVEMENTS PLAN @ EL. 1156.00              | 20D-04     |
| 16           | PRETREATMENT IMPROVEMENTS PLAN @ EL. 1145.00              | 20D-05     |
| 17           | PRETREATMENT IMPROVEMENTS PLAN - SECTION A                | 20D-06     |
| 18           | FILTER AND CLEAR WELL DEMOLITION PLAN AT EL 1159.00       | 30D-01     |
| 19           | FILTER AND CLEAR WELL DEMOLITION PLAN AT EL 1138.00       | 30D-02     |
| 20           | FILTER & CLEAR WELL DEMOLITION SECTION                    | 30D-03     |
| 21           | FILTER AND CLEAR WELL DEMOLITION AND PLAN AT EL 1145.00   | 30D-04     |
| 22           | FILTER AND CLEAR WELL NEW PROCESS PLAN AT EL. 1159.00     | 30D-04     |
| 23           | FILTER AND CLEAR WELL NEW PROCESS PLAN AT EL. 1138.00     | 30D-05     |
| 24           | FILTER AND CLEAR WELL NEW PROCESS - SECTIONS 1            | 30D-06     |
| 25           | FILTER AND CLEAR WELL NEW PROCESS - SECTIONS 2            | 30D-07     |
| 26           | FILTER AND CLEAR WELL NEW PROCESS - 3D MODEL              | 30D-08     |
| 27           | RAW WATER PUMPING FACILITY GENERAL & ELECTRICAL SITE PLAN | E-01       |
| 28           | STANDARD DETAILS - 1                                      | SD-C-01    |

END OF SECTION 011100



## SECTION 011419 – USE OF SITE

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. The Contractor will be allowed the use of as much of the site designated for the improvements as is necessary for his operation.

#### 1.2 USE OF STREETS

- A. During the progress of the work, the Contractor shall make ample provisions for both vehicle and pedestrian traffic on any public street and shall indemnify and save harmless the Owner from any expense whatsoever due to their operations over said streets. The Contractor shall also provide free access to all the fire hydrants, water, and gas valves located along the line of his work. Gutters and waterways must be kept open or other provisions made for the removal of storm water. Street intersections may be blocked only one-half at a time, and the Contractor shall lay and maintain temporary driveways, bridges and crossings, such as in the opinion of the Engineer are necessary to reasonably accommodate the public.
- B. In the event of the Contractor's failure to comply with these provisions, the Owner may cause the same to be done, and may deduct the cost of such work from any monies due the Contractor under this Agreement, but the performance of such work by the Owner at its instance shall serve in no way to release the Contractor from his general or particular liability for the safety of the public or the work.
- C. The Contractor shall repair at no cost to the Owner, all existing roads, parking areas, grassed areas that are damaged due to the execution of his work. The Contractor shall remove daily all mud, soil and debris that may be tracked onto existing streets, drives, or walks by his equipment or that of subcontractors or suppliers.

#### 1.3 CLOSING STREETS TO TRAFFIC

The Contractor may with the approval of the Engineer, close streets, or parts of streets, to vehicular traffic. The streets are to remain closed as long as the construction work or the condition of the finished work requires or as determined by the Engineer. The Engineer shall be the judge of how many streets or parts of streets it is necessary for the Contractor to close at any time, and may refuse to permit the closing of additional streets to traffic until the majority of the work on the closed streets is completed and they are opened to traffic.

#### 1.4 RIGHTS-OF-WAY

- A. Whenever it is required to perform work within the limits of public or private property or in rights-of-way, such work shall be done in conformity with all agreements between the Owner and the owners of such. Care shall be taken to avoid injury to the premises entered, which premises shall be left in a neat and orderly condition by the removal of rubbish and the grading of surplus materials, and the restoration of said public or private property to the same general conditions as pertained at the time of entry for work to be performed under this contract.
- B. The Contractor shall not (except after consent from the proper parties) enter or occupy with men, tools or equipment, any land outside the rights-of-way or property of the Owner.
- C. When the Contractor performs construction within 10 ft. of a right-of-way or easement line, he shall place tall stakes properly identified at points of change in width or direction of the right-of-way or easement line and at points along the line so that at least two stakes can be seen distinctly from any point on the line.

#### 1.5 EASEMENTS

- A. Where the work is to be constructed upon easements, such easements will be secured by the Owner without cost to the Contractor. The Contractor shall not enter upon or occupy any private property outside of the limits of the easements furnished.
- B. Care shall be taken to avoid injury to the premises entered, which premises shall be left in a neat and orderly condition by the removal of rubbish and the grading of surplus materials, and the restoration of said public or private property to the same general conditions as pertained at the time of entry for work to be performed under this contract.

#### 1.6 PROTECTING EXISTING BUILDINGS, STRUCTURES AND ROADWAYS

- A. The Contractor shall, at his own expense, shore up and protect any buildings, roadways, utilities or other public or private structures which may be encountered or endangered in the prosecution of the work, and that may not be otherwise provided for, and he shall repair and make good any damages caused to any such property by reason of his operations. All existing fences removed due to the prosecution of the work shall be replaced by the Contractor. No extra payment will be made for said work or material, but the cost of this work must be included in the price stipulated for the work to be done under this contract.

#### 1.7 SITE FACILITIES

- A. The Contractor shall furnish and place sufficient quantities of portable toilet facilities at locations convenient for use by the Contractor's personnel, Subcontractors, the Engineer, and the Owner.

1.8 RESTORATION

- A. The contractor shall restore all areas per the plans and specifications and if not specified, at least to the condition existing prior to the start of work.

END OF SECTION 011419

## SECTION 011423 - ADDITIONAL WORK, OVERTIME

### PART 1 - GENERAL

#### 1.1 NIGHT, SUNDAY AND HOLIDAY WORK

- A. No work will be permitted at night, Sunday or legal holidays except as noted on the plans or in the case of emergency and then only upon written authorization of the Engineer. Where no emergency exists, but the Contractor feels it advantageous to work at night, Sunday or legal holidays, the Contractor shall notify the Engineer at least two (2) days in advance, requesting written permission. Any work performed during the absence of the Engineer will be done at the Contractor's risk and responsibility and may be subject to rejection upon later inspection.

END OF SECTION 011423

## SECTION 012513 – PRODUCT SUBSTITUTION PROCEDURES

### PART 1 - GENERAL

#### 1.1 MATERIALS AND EQUIPMENT

- A. In the specifications and on the Engineer's drawings, are specified and shown certain pieces of equipment and materials deemed most suitable for the service anticipated. This is not done to eliminate other equipment and materials equally as good and efficient. The Contractor shall prepare his bid on the particular materials and equipment specified. Following the award of the contract, should the Contractor desire to use other equipment and materials, he shall submit to the Owner a written request for such change and state the advantage to the Owner and the savings or additional cost involved by the proposed substitution. The determination as to whether or not such change will be permitted rests with the Owner and the Engineer.
- B. Each major item of equipment shall be inspected by a manufacturer's representative during installation and upon completion of the work. The Contractor shall supply the Engineer with a certificate of such inspection.

END OF SECTION 012513

## SECTION 013119 - PROJECT MEETINGS

### PART 1 - GENERAL

#### 1.1 PRECONSTRUCTION MEETING

- A. Prior to the Contractor beginning any work on the project, the Owner will schedule and hold a preconstruction meeting to discuss all aspects of the contract work.
- B. The Contractor shall be present and be prepared to comment in detail on all aspects of his work.
- C. The Contractor shall bring to the preconstruction meeting a proposed construction progress schedule, erosion control plan, quality control program, concrete mix designs, asphalt mix designs (JMF), etc. Approval of each by the Engineer is required prior to the start of any work.
- D. Included in the construction progress schedule shall be an implementation sequence of the proposed erosion control efforts required by the contract.

#### 1.2 PROGRESS MEETINGS

- A. Monthly progress meetings will be held at a location to be determined by the Owner on a regularly scheduled day mutually convenient to the Owner, Contractor, and Engineer.
- B. The Contractor shall provide an updated construction progress schedule and be prepared to comment in detail on all aspects of his work.

END OF SECTION 013119

## SECTION 013216 – CONSTRUCTION PROGRESS SCHEDULE

### PART 1 - GENERAL

#### 1.1 PROGRESS SCHEDULE

- A. Immediately after signing the Contract, the General Construction Contractor shall prepare a graphic progress schedule, indicating the work to be executed during each month and the rate of expected progress to secure completion on the agreed-upon completion date. The progress schedule shall be approved by the Engineer and Owner prior to starting work on the site. Copies of such graphic progress charts, upon which has been indicated the actual progress, shall be furnished to the Engineer with each requisition for payment.
- B. Should the rate of progress fall materially behind the scheduled rate of progress, and unless the delay is authorized by the Engineer, each offending Contractor shall furnish additional labor, work overtime, or take other necessary means required for completion of the work on the scheduled date. No additional compensation beyond the set Contract price shall be paid for action taken or overtime expense incurred in maintaining scheduled progress.

END OF SECTION 013216

## SECTION 013223 – SURVEY AND LAYOUT DATA

### PART 1 - GENERAL

#### 1.1 STAKING

- A. The Contractor shall hire a surveyor licensed in the state the work is to be installed to provide all reference points not already established and staking. The Contractor shall protect and preserve the established staking and reference points as long as required for installation of the work and field verifications by any party. The Contractor's surveyor shall replace and accurately relocate all staking and reference points so lost, destroyed or moved.

#### 1.2 LAYOUT OF WORK

- A. The Contractor shall lay out his work and be responsible for correct locations, elevations and dimensions of all work executed by him under this Contract. The Contractor must exercise proper precautions to verify the figures shown on the Drawings before laying out the work and will be held responsible for any error resulting from his failure to exercise such precaution. The Contractor shall insure the new construction aligns with any existing work.

END OF SECTION 013223



## SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following
  1. Preconstruction photographs.
  2. Periodic construction photographs.
  3. Final Completion construction photographs.

#### 1.3 SUBMITTALS FOR REVIEW

- A. Construction Photographs: Contractor shall submit electronic photographic image files within seven (7) days of taking photographs /weekly to the Engineer.
  1. Format: Provide photographs as cut and paste files onto Word document (maximum 4 images to a page). Save digital page files in PDF format.
  2. Identification: On each page of photos provide the following information:
    - a. Owner's Name
    - b. Contract Description
    - c. Contractor's Name
    - d. Description of view, indicating location, direction (by compass point) and elevation or story of construction
    - e. Date photograph was taken

#### 1.4 COORDINATION

- A. Temporary Serviced: Contractor to cooperate with photographer and provide temporary services request, including access to Project site and use of temporary facilities including temporary lighting.

### PART 2 - PRODUCTS

#### 2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in PDF format as noted above or as otherwise posted to the website as individual photographs, with minimum sensor size of 4 megapixels.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. **Date Stamp:** Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
- B. **Field Office Prints:** Retain one set of prints of progress photographs in the field office at Project site, available at all times for reference. Identify photographs the same as for those posted on the project's website.

END OF SECTION 013233

## SECTION 013236 – VIDEO MONITORING AND DOCUMENTATION

### PART 1 - GENERAL

#### 1.1 SCOPE

- A. Provide all labor, materials, equipment, and services, and perform all operations necessary to furnish to the Owner a complete color audio-video DVD record of the surface features within the proposed construction zone of influence. This record shall include, but not be limited to, all audio-video DVDs, storage cases, video logs, and indexes. The purpose of this coverage shall be to accurately document the pre-construction condition of these surface features.

#### 1.2 QUALIFICATIONS

- A. The video DVD documentation shall be done by a responsible commercial firm known to be skilled and regularly engaged in the business of pre-construction color audio-video DVD documentation. The firm shall furnish such information as the Owner deems necessary to determine the ability of that firm to perform the work in accordance with the Contract specifications.

#### 1.3 PRODUCTS

- A. The color audio-video recording delivered to the Owner shall be on a high quality DVD format.

END OF SECTION 013236

## SECTION 013319 - FIELD TEST REPORTING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes, but is not limited to, services performed by an independent testing laboratory. Laboratory services covered under this section are for testing materials used for field constructed elements of the work. Performance testing of manufactured items and shop fabricated materials shall be covered under their respective specification section.
- B. All testing performed under this item shall be for the protection and benefit of the Owner and shall not be construed by the Contractor as a comprehensive quality control program intended to protect the Contractor, his subcontractors, or his suppliers. The testing frequency and types of testing shall be as scheduled herein and specified elsewhere.
- C. Inspections, tests, and related actions specified in this section and elsewhere in the contract documents are not intended to limit the Contractor's own quality control procedures and testing, which facilitate overall compliance with requirements of the contract documents. Requirements for the Contractor to provide quality control services as required by the Engineer, the Owner, governing authorities, or other authorized entities are not limited by the provisions of this Section.
- D. The Contractor is required to cooperate with the independent testing laboratories performing required inspections, test, and similar services and the Engineer or his representative.
- E. Materials and installed work may require testing or retesting at any time during progress of work. Retesting of rejected materials or installed work shall be done at Contractor's expense.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Supplementary Conditions and Division 1 Specifications sections, apply to work of this section.
- B. The Contract Documents may include testing requirements furnished under other Sections. Work elements which may include other testing requirements are:
  - 1. Water distribution systems.
  - 2. Storm sewer systems.
  - 3. Sanitary sewer systems.
  - 4. Water tightness of tanks.
  - 5. Pile foundations.
  - 6. Air balancing.
  - 7. Electrical systems tested and certified by the Electrical Contractor.

### 1.3 SELECTION AND PAYMENT

- A. The Contractor will employ an independent testing laboratory to perform specified testing. Payment shall be incidental to the related work bid item. The laboratory shall be mutually agreed upon by the Owner, Engineer, and Contractor.
- B. Employment of testing laboratory in no way relieves the Contractor of the obligation to perform work in accordance with requirements of the contract documents.
- C. The testing laboratory and their personnel shall be under the direction of the Engineer's on-site representative, regardless of who employs their services.

### 1.4 REFERENCES

- A. AASHTO T-19, Standard Method of Test for Unit Weight and Voids in Aggregate.
- B. AASHTO T-37, Standard Method of Test for Sieve Analysis of mineral Filler for Road and Paving Materials.
- C. AASHTO T-230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
- D. ASTM C-29, Standard Method of Test for Unit Weight and Voids in Aggregate.
- E. ASTM C-31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
- F. ASTM C-33, Standard Specification for Concrete Aggregates.
- G. ASTM C-39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- H. ASTM C-40, Test Method for Organic Impurities in Fine Aggregates for Concrete.
- I. ASTM C-42, Standard Test Methods for Obtaining and Testing Drilled Cored and Sawed Beams of Concrete.
- J. ASTM C-88, Standard Test Method for Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate.
- K. ASTM C-94, Standard Specification for Ready-Mixed Concrete.
- L. ASTM C-117, Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing.
- M. ASTM C-136, Standard Method for Sieve Analysis of Fine and Course Aggregate.

- N. ASTM C-142, Test Method for Clay Lumps and Friable Particles in Aggregate.
- O. ASTM C-143, Standard Test Method for Slump of Hydraulic Cement Concrete.
- P. ASTM C-172, Standard Practice for Sampling Freshly Mixed Concrete.
- Q. ASTM C-173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
- R. ASTM C-231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- S. ASTM C-535, Standard Test Method for Resistance to Degradation of Large-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
- T. ASTM C-1064, Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
- U. ASTM D-698, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb. (2.49-kg) Rammer and 12-inc. (305-mm) Drop.
- V. ASTM D-2487, Standard Test Method for Classification of Soils for engineer purposes.
- W. ASTM D-2940, Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
- X. ASTM D-4253, Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- Y. ASTM D-4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- Z. ASTM D-4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
- AA. ODOT Supplement 1021, Method of Test for Determination of the Percent of Fractured Pieces in Gravel.
- AB. ODOT Supplement 1029, Method of Test for Determining the Percentage of Deleterious Materials in Course Aggregate.
- AC. ODOT Supplement 1036, Method of Test for Determination of Percent Air Voids in Compacted Dense Bituminous Paving Mixtures.
- AD. ODOT Supplement 1044, Mix Design Method for Bituminous Aggregate Base.

- AE. Uni-Bell PVC Pipe Association UNI-B-6-98 for Low Pressure Air Testing of Installed Sewer Pipe.
- AF. ASTM – C969 – Standard practice for infiltration and exfiltration acceptance of installed concrete sewer pipe.

## 1.5 SUBMITTALS

- A. Prior to the start of work, submit testing laboratory name, address, and telephone number, and names of full-time (*registered Engineer*) (*specialist*) and responsible officer.
- B. Submit copy of the testing laboratory's evaluation report issued by one of the evaluation authorities identified in Article 1.6 of this Section with memorandum of remedies of any deficiencies reported by the inspection.
- C. Submit the chain of custody and other QA/QC procedures for each test to be utilized by the laboratory.

## 1.6 QUALITY ASSURANCE

- A. Except as otherwise indicated, the testing laboratory engaged shall be prequalified by the appropriate regulatory agency for the types of services specified herein.
- B. The field personnel utilized to perform all field-testing and preparation shall be certified for those tests being performed.

## 1.7 RESPONSIBILITIES

- A. Testing Laboratory Responsibilities:
  - 1. Provide qualified personnel at the site. Cooperate with the Engineer and Contractor in performance of services.
  - 2. Perform specified sampling and testing of products in accordance with the specified standards.
  - 3. Ascertain compliance of materials and mixes with requirements of the contract documents.
  - 4. Immediately notify the Engineer and Contractor of observed irregularities or nonconformance of work or products.
  - 5. Perform additional tests required by the Engineer.
  - 6. Testing personnel are to report to the Engineer or his representative upon arrival on site for instructions and requirements. Prior to leaving the site, furnish the Engineer or his representative all test results whether in a formal or informal format.
  - 7. Attend preconstruction meetings and progress meetings.

- B. Contractor Responsibilities:
1. Provide access to materials proposed to be used which require testing.
  2. Cooperate with laboratory personnel and provide access to the work and to manufacturers' facilities as necessary.
  3. Provide incidental labor and facilities:
    - a. To provide access to work to be tested.
    - b. To obtain and handle samples at the site or at the source of products to be tested.
    - c. To facilitate tests.
    - d. To provide storage and curing of test samples as required by the testing laboratory.
  4. Notify the Engineer and laboratory 24 hours prior to expected time for operations requiring testing services for scheduling purposes. Materials will not be permitted to be placed without the proper testing being performed in conformance with this Section.

## 1.8 LIMITS OF LABORATORY AUTHORITY

- A. The laboratory may not release, revoke, alter, or enlarge the requirements of the contract documents.
- B. The laboratory may not approve or accept any portion of the work.
- C. The laboratory may not assume any duties of the Contractor.
- D. The laboratory has no authority to stop the work.

## 1.9 SCHEDULE OF TESTS

Testing anticipated on this project shall include, but is not limited to:

- A. Earthwork
1. Special backfill material sieve analysis per ASTM C-136, one test per source.
  2. On-site trench backfill analysis per ASTM D-2487, as directed by Engineer.
  3. Pipe bedding and cover sieve analysis per ASTM C-136, one test per source.
  4. Drainage fill sieve analysis per ASTM C-136, one test per source.
  5. Soil compaction per ASTM D-698.
    - a. Embankment testing shall be at least one (1) test/5,000 S.F. of each lift;
    - b. Trench backfill testing shall be at least one (1) test/50 L.F. of each lift;
    - c. Subgrade and/or subbase testing shall be at least one (1) test/200 L.F. of pavement or 5,000 S.F. of slabs subject to greater frequency due to soil conditions or Engineer's direction.
  6. Backfill compaction per ASTM D-4253 and D-4254, one test per 50 L.F. of each lift.
  7. Low Strength Mortar testing per ASTM D-4832.



B. Concrete

1. Concrete aggregate deleterious substances per ASTM C-40, ASTM C-117, and ASTM C-142, one test per source.
2. Concrete aggregate abrasion per ASTM C-535, one test per source.
3. Sodium sulfate soundness of coarse aggregate per ASTM C-88, one test per source.
4. Sampling Fresh Concrete: ASTM C-172, except modified for slump to comply with ASTM C 94.
  - a. When cylinders and/or beam samples are made, the slumps and air test shall be made using concrete from the same batch.
  - b. Slump: ASTM C-143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
  - c. Air Content: ASTM C-173, volumetric method of lightweight concrete; ASTM C-231 pressure method for normal weight concrete; at least one for each pour of each type of air-entrained concrete, and each time a set of compression test specimens is made.
  - d. Concrete Temperature: ASTM C-1064, test hourly when air temperature is 40° F. (4° C.) and below, and when 80° F. (27° C.) and above; and each time a set of compression test specimens is made.
  - e. Compression Test Specimen: ASTM C-31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
  - f. Compressive Strength Tests: ASTM C-39; one set for each day's pour exceeding 5 cubic yards plus additional sets for each 50 cubic yards over and above the first 25 cubic yards of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days.
    - i. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
    - ii. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
  - g. Two (2) tests beams shall be made for each 250 square yards of concrete pavement and/or slabs on grade placed.
    - i. For traffic to be allowed on pavement or slab, the modulus of rupture shall be a minimum of 600 psi for Class C concrete or 400 psi for ODOT Class MS or FS.

- h. When cylinders and/or beam samples are made, the slumps and air test shall be made using concrete from the same batch.
  - 5. Nondestructive Testing: Penetration resistance, sonoscope, or other nondestructive devices may be permitted but shall not be used as the sole basis for acceptance or rejection.
  - 6. 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.
    - a. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

C. Pavement

  - 1. Aggregate base sieve analysis per ASTM D-2940, one test per source.
  - 2. Sodium sulfate soundness of aggregate base per ASTM C-88, one test per source.
  - 3. Percent of fractured pieces for aggregate base per ODOT Supplement 1021, one test per source.

D. Asphalt

  - 1. Provide testing for mixture acceptance in accordance with Ohio Department of Transportation Procedures. The person performing the testing must have a current Level 1 Bituminous Concrete approval from ODOT.

E. Sewers

  - 1. Deflection Testing
    - a. All thermoplastic gravity sanitary sewer pipe shall be tested for allowable deflection.
    - b. Deflection tests shall be performed before final acceptance and no sooner than thirty (30) days after installation of final backfill
    - c. Maximum allowable pipe deflection shall be five (5) percent of the average inside diameter for the size and class of pipe specified.
    - d. Acceptance testing shall be performed with a non-adjustable "go, no-go" mandrel with a minimum of eight (8) contact points. Adjustable mandrels for acceptance testing shall be used only with permission of the Engineer.
    - e. The mandrel size shall be ninety-five (95) percent of the average inside diameter for the size and class of pipe specified.
    - f. If the "go, no-go" mandrel will not pass through a section of pipe a deflectometer or adjustable mandrel may be used to determine the extent and/or severity of the non-acceptable area. A "go, no-go"

mandrel shall be re-run through the pipe section for final acceptance testing at no additional cost to the Owner.

- g. The Contractor or subcontractor performing the test shall be experienced and qualified to perform deflection testing with the equipment and procedures utilized. The contractor shall provide all labor, materials, tools and equipment necessary to clean and test all sections of sewer pipe, locate deficient areas, repair, deficient areas, and retest all repaired areas.
- h. All sewer runs shall be cleaned prior to testing.
- i. The acceptance test shall be performed without mechanical pulling devices.
- j. All pipe failing the deflection test shall be exposed, repaired or replaced and retested at no additional cost to the Owner.

2. Leakage Testing

- a. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- b. The Contractor shall perform sufficient tests to determine that the installation of all pipe materials have been as specified and that test results are in accordance with those required for approval of the installation.
- c. The Contractor shall furnish all pressure gauges, suitable pump or pumps, pipes, test heads, and any other apparatus and materials used for these tests. These tests are to be considered as part of the work, and no additional compensation shall be made.
- d. The tests shall be conducted under the direction of the Engineer or an appointed agent. Any testing done without direction and supervision as specified shall not be considered as a proper means of approval.
- e. The Contractor may obtain water for testing as may be required by observing the rules and regulations enforced in the municipality in which the work is being done.
- f. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

3. Infiltration and Exfiltration Testing

- a. All sewers shall be tested using an exfiltration test or, where specifically allowed in writing by the Engineer, an infiltration test.
- b. All sewers shall be tested. No visible leakage in the sewers or manholes shall be permitted.
- c. Bulkheads shall be used to isolate the test sections as required to perform the work. All service laterals, stubs and fittings shall be plugged or capped at the connection to the test section.
- d. Each manhole run shall be tested separately.

4. Exfiltration Testing

- a. The test shall be performed first with a minimum head of water of three (3) feet above the top of the high end of the sewer or two (2) feet above the high end of the highest lateral in the section or sections to be tested, or three (3) feet above the existing groundwater elevation, whichever is higher.
- b. The exfiltration test shall be conducted between two manholes by sealing the downstream end of the test section and all inlet sewers at the upstream manhole with pipe stoppers.
- c. The average internal pressure in the system shall not exceed 11.6 feet of water or 5 psi and the maximum internal pipe pressure at the lowest end shall not exceed 23 feet of water or 10 psi.
- d. Water shall be added to the pipe section at a steady rate from the upstream manhole to allow air to escape from the sewer until the water is at the specified level above the crown of the pipe. The water may stand in the pipe and manhole up to seventy-two (72) hours prior to measurement of leakage to allow for absorption by the pipe and bleeding of air. After absorption into the pipe and manhole has stabilized, the water in the upstream manhole shall be brought to test level.
- e. The leakage rate shall be determined by measurement of the drop in water elevation measured in the upstream manhole and the loss of water calculated. The test period shall be a minimum of sixty (60) minutes duration. Use the following table to determine loss of water as measured in the manhole:

| Water Level Change<br>in Test Manhole |        | Volume of Leakage |                  |
|---------------------------------------|--------|-------------------|------------------|
|                                       |        | 4 Ft. Dia.<br>MH  | 5 Ft. Dia.<br>MH |
| (Inches)                              | (Feet) | (Gals.)           | (Gals.)          |
| 1/8                                   | 0.01   | 0.98              | 1.53             |
| 1/4                                   | 0.02   | 1.96              | 3.06             |
| 3/8                                   | 0.03   | 2.94              | 4.59             |
| 1/2                                   | 0.04   | 3.92              | 6.12             |
| 5/8                                   | 0.05   | 4.90              | 7.65             |
| 3/4                                   | 0.06   | 5.87              | 9.18             |
| 7/8                                   | 0.07   | 6.85              | 10.71            |
| 1                                     | 0.08   | 7.83              | 12.24            |
| 1-1/8                                 | 0.09   | 8.81              | 13.77            |
| 1-1/4                                 | 0.10   | 9.79              | 15.30            |
| 1-3/8                                 | 0.11   | 10.77             | 16.83            |
| 1-1/2                                 | 0.12   | 11.75             | 18.36            |
| 1-5/8                                 | 0.13   | 12.72             | 19.89            |
| 1-3/4                                 | 0.14   | 13.71             | 21.42            |
| 1-7/8                                 | 0.16   | 14.69             | 22.90            |
| 2                                     | 0.17   | 15.67             | 24.48            |
|                                       |        |                   |                  |

5. Infiltration Testing
  - a. An infiltration test shall be conducted for all sections of sewer, only when the ground water level is two (2) feet or more above the elevation of the inside crown of pipe at the upstream limit of the section being tested.
  - b. The use of well point pumps or other dewatering devices shall have been discontinued for 24 hours prior to testing to permit the groundwater table to return to a static condition.
  - c. The leakage rate shall be measured by a weir, by determination of the time required to fill a container of known volume, or other measuring device approved by the Engineer in the lower end of the sewer section to be tested.
  - d. The incoming sewer or sewers in the upper end of the test section shall be securely sealed.
6. Allowable Leakage
  - a. The maximum allowable leakage for either infiltration or exfiltration shall be 100 gallons per inch of internal pipe diameter per mile per day.
  - b. If actual leakage measured exceeds the limits specified, the Contractor must locate and repair or remove and replace the defective pipe sections to the satisfaction of the Engineer and retest the section accordingly at no additional cost to the Owner.
  - c. All sanitary manholes shall be tested separately by using an exfiltration test (or infiltration test where groundwater conditions permit) to two (2) feet above the highest joint with no measurable leakage for a one hour test.
7. Low Pressure Air Testing
  - a. PVC sanitary sewers 54-inch diameter and less may be air tested as specified. If the groundwater level is two (2) feet or more above the top of the pipe at the upstream end or if the air pressure required for the test is greater than 5 psig, the air test method should not be used for RCP sanitary sewers.
  - b. Each manhole run shall be tested separately, unless otherwise approved by the Engineer, as the construction progresses. Backfill shall be brought to final grade before testing. Testing shall be done prior to surface restoration, and preferably with not more than four (4) manhole runs constructed ahead of testing.
  - c. Test equipment consists of valves and pressure gages to control airflow and to monitor pressure within the test section.
  - d. The sewer shall be flushed and cleaned prior to testing to clean out any debris. The pipe surface should be wet for more consistent results.
  - e. The section of pipe to be tested shall be plugged at each end and the ends of laterals, stubs and fittings to be included in the test section shall be plugged and securely braced to prevent air leakage, and possible blowouts.

- f. Equipment used shall meet the following minimum requirements and be approved by the Engineer:
  - i. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.
  - ii. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
  - iii. All air used shall pass through a single control panel.
  - iv. Three (3) individual hoses shall be used for the following connections:
    - a). From control panel to pneumatic plugs for inflation.
    - b). From control panel to sealed line for introducing the low pressure air.
    - c). From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.
- g. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be used for the test. The sealed pipe shall be pressurized to 9 psig. The plugs must hold against this pressure without having to be braced. No persons shall be allowed in the alignment of the pipe during plug testing.
- h. After a manhole to manhole run of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole. Low pressure air shall be slowly introduced into this sealed line until the internal air pressure reaches approximately 4 psig greater than the average groundwater back pressure, but not greater than 9 psig for PVC pipe or 5 psig for RCP.
- i. In areas where groundwater is known to exist, the Contractor must determine the average groundwater back pressure. The Contractor shall install a 1/2-inch diameter capped pipe nipple, approximately 10 inches long, through the manhole wall on top of one of the sanitary sewer lines entering the manhole. See Figure No. 1. This shall be done at the time the sanitary sewer line is installed or install an 8-inch diameter stand pipe outside of the manhole backfilled with a column of clean stone of 2-inch minimum diameter to subgrade. Immediately prior to the performance of the low pressure air test, the ground water back pressure shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the nipple. The plastic tube shall be vertical and a measurement of the height, in feet of water over the invert of the pipe shall be taken after the water has stopped rising in this plastic tube. This height, divided by 2.307, will equal the average groundwater back pressure.
- j. At least two (2) minutes shall be allowed for the air to stabilize when the specified internal air pressure has been obtained. When the pressure has stabilized and is at or above 3.5 psig, the air hose from the control panel to the air supply shall be disconnected. The portion of the line being tested shall be termed "acceptable" if the time

required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average groundwater back pressure calculated) shall not be less than the time in the tables in Reference Table 1.

- k. If a one (1) psi drop in pressure does not occur within the test time, the line has passed. If the pressure drop is more than one (1) psi during the test time, the line is presumed to have failed the test. If the line fails the test, segmented testing may establish the location of any leaks.
  - l. The Contractor must repair the leak or remove and replace the defective pipe section and re-test the section to the satisfaction of the Engineer at no additional cost to the Owner.
  - m. The pneumatic plugs must be installed in such a way as to prevent blowouts. Inasmuch as a force of 250 pounds is exerted on an 8-inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or a plug, which is partially deflated before the pipe pressure is released, can be dangerous.
  - n. The Contractor should internally restrain or externally brace the plugs to the manhole wall as an added safety precaution throughout the test.
  - o. Pressurizing equipment shall include a regulator or relief valve set at no higher than 9 psig for PVC pipe or 5 psig for RCP pipe to avoid over-pressurizing and damaging an otherwise acceptable line.
  - p. No one shall be allowed in the trench or manholes during testing.
  - q. Plugs shall not be removed until all pressure has been released.
  - r. All sanitary manholes shall be tested separately by using an exfiltration test (or infiltration test where groundwater conditions permit) to two (2) feet above the highest joint with no measurable leakage for a one hour test.
  - s. The air test data sheet marked Exhibit "A" at the end of this section shall be filled out for each section of piping tested in this manner.
  - t. Testing concrete pipe sewer lines by the low pressure air test method will be per ASTM C924-02 and C1103.
8. Hydrostatic Testing – Pressure Pipe, For Watermain and Force Main
- a. The pipe to be tested must be sufficiently backfilled to prevent movement while under test pressure.
  - b. Joint restraint at fittings should be permanent and constructed to withstand test pressure. If concrete thrust blocks are used, sufficient time must be allowed before testing to permit the concrete to cure. A cure time of seven (7) days is recommended when Type I Portland Cement is used; three (3) days is recommended when Type III high-early Portland Cement is used.
  - c. Test ends should be restrained to withstand the appreciable thrusts that are developed under test pressure.
  - d. Air pressure testing of installed pressure pipe is expressly prohibited.

- e. Any testing performed without the knowledge of the Engineer shall not be considered a test for the purpose of this specification.
- f. The hydrostatic testing sheet marked "Exhibit D" following this section shall be filled out for each section of piping tested in this manner.
- g. After the pipe has been installed and partially backfilled (if applicable) subject all newly installed pipe, or any valved sections of it in such lengths of the force main as determined by the responsible agency, unless otherwise specified, to a hydrostatic pressure test equal to 1-1/2 times the line working pressure (50% over the working pressure) but not less than 1.25 times the working pressure at the highest point along the test section; but, in no case, shall such force mains be tested at less than 150 pounds per square inch.. The duration of each test shall be at least 2 hours.
- h. Each section of pipeline shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation, shall be applied by means of a booster pump connected to the pipe in a manner satisfactory to the Engineer. The duration of the test shall be for a minimum of sixty (60) minutes.
- i. No pipe installation will be accepted unless the leakage rate for the section of pipe being tested does not exceed a rate as shown on hydrostatic test chart, during a 24-hour test duration.
- j. The Contractor shall furnish suitable means for determining the quantity of water lost by leakage during the test.

9. Manhole Vacuum Testing

- a. Temporarily plug all pipe entering the manhole. Each plug must be installed at a location beyond the manhole/pipe gasket (i.e. outside the manhole wall), and shall be braced to prevent the plug or pipe from being drawn into the Manhole.
- b. The test head shall be placed inside the rim of the cast iron frame at the top of the manhole and inflated, in accordance with the manufacturer's recommendations.
- c. A vacuum of at least 10 inches of mercury (10" Hg) shall be drawn on the manhole. Shut the line on the vacuum line to the manhole and shut off the pump or disconnect the vacuum line from the pump.
- d. The pressure gauge shall be liquid filled, having a 3.5" diameter face with a reading from zero to thirty inches of mercury.
- e. The manhole shall be considered to pass the vacuum test if the vacuum reading does not drop more than 1" Hg (i.e from 10" to 9" Hg) during the Table 1 minimum test time.
- f. If a manhole fails the vacuum test, the manhole shall be repaired with non-shrinkable grout or other material or method approved by the engineer. The manhole surfaces shall be properly prepared prior to any repairs. Once the repair material has cured according to the manufacturer's recommendations, the vacuum test shall be repeated. This process shall continue until a satisfactory test is obtained.
- g. All temporary plugs and braces shall be removed after each test.



## PART 2 – PRODUCTS (NOT APPLICABLE)

## PART 3 – EXECUTION

### 3.1 SEQUENCING AND SCHEDULING

- A. The Contractor shall coordinate the sequence of work activities so as to accommodate required testing and shall allow sufficient time for testing of materials by the laboratory so as to cause no delay in the work or the work of any other Contractor. In addition, the Contractor shall coordinate his work so as to avoid the necessity of removing and replacing work to accommodate inspections and tests.

### 3.2 LABORATORY TEST RESULTS

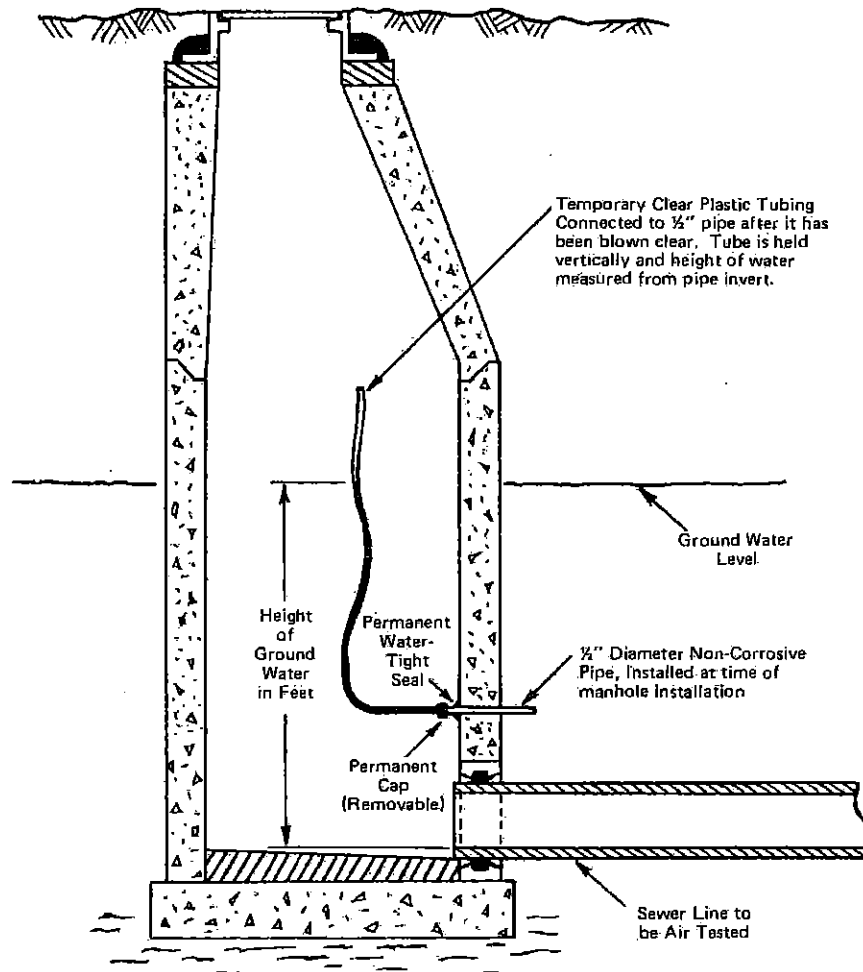
- A. The testing laboratory shall submit a certified written report of each inspection, test, or similar service concurrently to the Owner, Engineer, and Contractor.
- B. Written reports of each inspection, test, or similar service shall include, but not be limited to, the following:
  - 1. Name of testing laboratory.
  - 2. Project name and construction contract reference number.
  - 3. Dates and locations of samples and tests or inspections.
  - 4. Date of report.
  - 5. Names of individuals making the inspection or test.
  - 6. Designation of the work and test method.
  - 7. Test results.
  - 8. Notation of significant ambient conditions at the time of sample taking and testing.

END OF SECTION 013319

UNI-B-6-98

FIGURE NO. 1

**MANHOLE CROSS-SECTIONAL VIEW  
OF THE PROPER METHOD FOR  
DETERMINING GROUND WATER HEIGHT**



**NOTE:** Pressurize pipe to 4.5 P.S.I.F. and let stabilize for 5 minutes. Pressure should then be backed off to 4.0 P.S.I.G. and test time started.

[illegible]

REMARKS:

**TABLE I**

Minimum specified time required for a 1.0 P.S.I.G. Pressure Drop

| 1<br>Pipe<br>Diameter<br>(Inches) | 2<br>Minimum<br>Time<br>(Min:Sec) | 3<br>Length<br>for<br>Minimum<br>Time<br>(Ft.) | 4<br>Time for<br>Longer<br>Length<br>(Sec) | Specification Time for Length (L) Shown (Min:Sec) |         |         |         |         |         |         |         |
|-----------------------------------|-----------------------------------|--|--|---|---------|---------|---------|---------|---------|---------|---------|
|                                   |                                   |  |  | 100 Ft.   | 150 Ft. | 200 Ft. | 250 Ft. | 300 Ft. | 350 Ft. | 400 Ft. | 450 Ft. |
| 4                                 | 3:46                              | 597  | .380 L                                     | 3:46  | 3:46    | 3:46    | 3:46    | 3:46    | 3:46    | 3:46    | 3:46    |
| 6                                 | 5:40                              | 398  | .854 L                                     | 5:40  | 5:40    | 5:40    | 5:40    | 5:40    | 5:40    | 5:42    | 6:24    |
| 8                                 | 7:34                              | 298  | 1.520 L                                    | 7:34  | 7:34    | 7:34    | 7:34    | 7:36    | 8:52    | 10:08   | 11:24   |
| 10                                | 9:26                              | 239  | 2.374 L                                    | 9:26  | 9:26    | 9:26    | 9:53    | 11:52   | 13:51   | 15:49   | 17:48   |
| 12                                | 11:20                             | 199  | 3.418 L                                    | 11:20   | 11:20   | 11:24   | 14:15   | 17:05   | 19:56   | 22:47   | 25:38   |
| 15                                | 14:10                             | 159  | 5.342 L                                    | 14:10   | 14:10   | 17:48   | 22:15   | 26:42   | 31:09   | 35:36   | 40:04   |
| 18                                | 17:00                             | 133  | 7.692 L                                    | 17:00   | 19:13   | 25:38   | 32:03   | 38:27   | 44:52   | 51:16   | 57:41   |
| 21                                | 19:50                             | 114  | 10.470 L                                   | 19:50   | 26:10   | 34:54   | 43:37   | 52:21   | 61:00   | 69:48   | 78:31   |
| 24                                | 22:40                             | 99   | 13.674 L                                   | 22:47   | 34:11   | 45:34   | 56:58   | 68:22   | 79:46   | 91:10   | 102:33  |
| 27                                | 25:30                             | 88   | 17.306 L                                   | 28:51   | 43:16   | 57:41   | 72:07   | 86:32   | 100:57  | 115:22  | 129:48  |
| 30                                | 28:20                             | 80   | 21.366 L                                   | 35:37   | 53:25   | 71:13   | 89:02   | 106:50  | 124:38  | 142:26  | 160:15  |
| 33                                | 31:10                             | 72   | 28.852 L                                   | 43:05   | 64:38   | 86:10   | 107:43  | 129:16  | 150:43  | 172:21  | 193:53  |
| 36                                | 34:00                             | 66   | 30.768 L                                   | 51:17   | 76:55   | 102:34  | 128:12  | 153:50  | 179:29  | 205:07  | 230:46  |
| 42                                | 39:48                             | 57   | 41.883 L                                   | 69:48   | 104:42  | 139:37  | 174:30  | 209:24  | 244:19  | 279:13  | 314:07  |
| 48                                | 45:34                             | 50   | 54.705 L                                   | 91:10   | 136:45  | 182:21  | 227:55  | 273:31  | 319:06  | 364:42  | 410:17  |
| 54                                | 51:02                             | 44   | 69.236 L                                   | 115:24  | 173:05  | 230:47  | 288:29  | 346:11  | 403:53  | 461:34  | 519:16  |
| 60                                | 56:40                             | 40   | 85.476 L                                   | 142:28  | 213:41  | 284:55  | 356:09  | 427:23  | 498:37  | 569:50  | 641:04  |

for size and length of pipe indicated for Q = 0.0015

**NOTE: If there has been no leakage, (zero P.S.I.G. drop), after one hour of testing, the test shall be accepted and the test complete. (See Section 7.5)**

**TABLE II**

Minimum specified time required for a 0.5 P.S.I.G. Pressure Drop  
for size and length of pipe indicated for Q = 0.0015

| 1<br>Pipe<br>Diameter<br>(Inches<br>) | 2<br>Minimum<br>Time<br>(Min:Sec) | 3<br>Length<br>for<br>Minimum<br>Time<br>(Ft.) | 4<br>Time<br>for<br>Longer<br>Length<br>(Sec) | Specification Time for Length (L) Shown (Min:Sec) |         |         |         |         |         |         |         |
|---------------------------------------|-----------------------------------|--|---|---|---------|---------|---------|---------|---------|---------|---------|
|                                       |                                   |  |   | 100 Ft.   | 100 Ft. | 100 Ft. | 100 Ft. | 100 Ft. | 100 Ft. | 100 Ft. | 100 Ft. |
| 4                                     | 1:53                              | 597  | .190 L  | 1:53  | 1:53    | 1:53    | 1:53    | 1:53    | 1:53    | 1:53    | 1:53    |
| 6                                     | 2:50                              | 398  | .427 L  | 2:50  | 2:50    | 2:50    | 2:50    | 2:50    | 2:50    | 2:51    | 3:12    |
| 8                                     | 3:47                              | 298  | .760 L  | 3:47  | 3:47    | 3:47    | 3:47    | 3:48    | 4:26    | 5:04    | 5:42    |
| 10                                    | 4:43                              | 239  | 1.187 L                                       | 4:43  | 4:43    | 4:43    | 4:57    | 5:56    | 6:55    | 7:54    | 8:54    |
| 12                                    | 5:40                              | 199  | 1.709 L                                       | 5:40  | 5:40    | 5:42    | 7:08    | 8:33    | 9:58    | 11:24   | 12:50   |
| 15                                    | 7:05                              | 159  | 2.671 L                                       | 7:05  | 7:05    | 8:54    | 11:08   | 13:21   | 15:35   | 17:48   | 20:02   |
| 18                                    | 8:30                              | 133  | 3.846 L                                       | 8:30  | 9:37    | 12:49   | 16:01   | 19:14   | 22:26   | 25:38   | 28:51   |
| 21                                    | 9:55                              | 114  | 5.235 L                                       | 9:55  | 13:05   | 17:27   | 21:49   | 26:11   | 30:32   | 34:54   | 39:16   |
| 24                                    | 11:20                             | 99   | 6.837 L                                       | 11:24   | 17:57   | 22:48   | 28:30   | 34:11   | 39:53   | 45:35   | 51:17   |
| 27                                    | 12:45                             | 88   | 8.653 L                                       | 14:25   | 21:38   | 28:51   | 36:04   | 43:16   | 50:30   | 57:42   | 64:54   |
| 30                                    | 14:10                             | 80   | 10.683 L                                      | 17:48   | 26:43   | 35:37   | 44:31   | 53:25   | 62:19   | 71:13   | 80:07   |
| 33                                    | 15:35                             | 72   | 12.926 L                                      | 21:33   | 32:19   | 43:56   | 53:52   | 64:38   | 75:24   | 86:10   | 96:57   |
| 36                                    | 17:00                             | 66   | 15.384 L                                      | 25:39   | 38:28   | 51:17   | 64:06   | 76:55   | 89:44   | 102:34  | 115:23  |
| 42                                    | 19:54                             | 57   | 20.942 L                                      | 34:54   | 52:21   | 69:49   | 87:15   | 104:42  | 122:10  | 139:37  | 157:04  |
| 48                                    | 22:47                             | 50   | 27.352 L                                      | 45:35   | 68:23   | 91:11   | 113:58  | 136:46  | 159:33  | 182:21  | 205:09  |
| 54                                    | 25:31                             | 44   | 34.618 L                                      | 57:42   | 86:33   | 115:24  | 144:15  | 173:05  | 201:56  | 230:47  | 259:38  |
| 60                                    | 28:20                             | 40   | 42.738 L                                      | 71:14   | 106:51  | 142:28  | 178:05  | 213:41  | 249:18  | 284:55  | 320:32  |

**NOTE:** If there has been no leakage, (zero P.S.I.G. drop), after one hour of testing, the test shall be accepted and the test complete. (See Section 7.5)

**CT CONSULTANTS, INC.**  
**HYDROSTATIC LEAKAGE TEST**

JOB. NO. \_\_\_\_\_ PROJECT: \_\_\_\_\_

CONTRACTOR: \_\_\_\_\_ CLIENT: \_\_\_\_\_

WATERLINE TESTED AT: \_\_\_\_\_  
(Street Name) (Station of Gauge)

FROM STATION \_\_\_\_\_ TO STATION \_\_\_\_\_ ON \_\_\_\_\_

WATERLINE SIZE \_\_\_\_\_ TYPE \_\_\_\_\_

TESTED \_\_\_\_\_ AT \_\_\_\_\_ FOR \_\_\_\_\_  
TOTAL L.F. PIPE SIZE PSI DURATION

ALLOWABLE LEAKAGE \_\_\_\_\_ PER 1,000 L.F. OR \_\_\_\_\_ PER \_\_\_\_\_  
GALS./HR. TOTAL GALS. TOTAL L.F.

1<sup>ST</sup> TEST \_\_\_\_\_ AND \_\_\_\_\_  
PASS / FAIL PRESSURE LOST GALLONS LOST

2<sup>ND</sup> TEST \_\_\_\_\_ AND \_\_\_\_\_  
PASS / FAIL PRESSURE LOST GALLONS LOST

APPROVED BY \_\_\_\_\_  
(INSPECTOR)

COMMENTS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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ALLOWABLE LEAKAGE PER 1,000 FEET OF WATERMAIN:

| <u>PIPE SIZE</u><br><u>INCH DIAMETER</u> | <u>ALLOWABLE LEAKAGE</u><br><u>GALS. / 1,000 FEET</u> |
|--|---|
| 6  | 1   |
| 8  | 1.3   |
| 10                                       | 1.6   |
| 12                                       | 1.9   |
| 16                                       | 2.5   |
| 20                                       | 3.2   |
| 24                                       | 3.8   |
| 30                                       | 4.8   |
| 36                                       | 5.7   |

**NOTE: IN NO CASE SHALL THE TESTED SECTION EXCEED 2,000 FEET IN LENGTH.**

**PROJECT:** \_\_\_\_\_ **SHEET NO. 1 OF** \_\_\_\_\_

**JOB NO.** \_\_\_\_\_ **STREET:** \_\_\_\_\_

**CONTRACTOR:** \_\_\_\_\_ **PROJECT REP:** \_\_\_\_\_

**MANHOLE VACUUM TEST**

| M.H. NO. | M.H. Diameter (in.) | M.H. Depth (ft.) (btm.m.h. cover to shelf) | Vacuum Required (in Hg) | Vacuum Attained (in Hg) | Vacuum Drop (in Hg) | Holding Time Required (sec.) | Pass/Fail | Date Tested | Contractor Attest | Engineer Attest | Remarks |
|----------|---------------------|--|-------------------------|-------------------------|---------------------|------------------------------|-----------|-------------|-------------------|-----------------|---------|
|          |                     |  |                         |                         |                     |                              |           |             |                   |                 |         |
|          |                     |  |                         |                         |                     |                              |           |             |                   |                 |         |
|          |                     |  |                         |                         |                     |                              |           |             |                   |                 |         |

| Depth   |    | Diameter, in. |    |    |    |    |     |     |     |  |  |
|---------|----|---------------|----|----|----|----|-----|-----|-----|--|--|
| (ft)    | 30 | 33            | 36 | 42 | 48 | 54 | 60  | 66  | 72  |  |  |
| Time(s) |    |               |    |    |    |    |     |     |     |  |  |
| 8       | 11 | 12            | 14 | 17 | 20 | 23 | 26  | 29  | 33  |  |  |
| 10      | 14 | 15            | 18 | 21 | 25 | 29 | 33  | 36  | 41  |  |  |
| 12      | 17 | 18            | 21 | 25 | 30 | 35 | 39  | 43  | 49  |  |  |
| 14      | 20 | 21            | 25 | 30 | 35 | 41 | 46  | 51  | 57  |  |  |
| 16      | 22 | 24            | 29 | 34 | 40 | 46 | 52  | 58  | 67  |  |  |
| 18      | 25 | 27            | 32 | 38 | 45 | 52 | 59  | 65  | 73  |  |  |
| 20      | 28 | 30            | 35 | 42 | 50 | 53 | 65  | 72  | 81  |  |  |
| 22      | 31 | 33            | 39 | 46 | 55 | 64 | 72  | 79  | 89  |  |  |
| 24      | 33 | 36            | 42 | 51 | 59 | 64 | 78  | 87  | 97  |  |  |
| 26      | 36 | 39            | 46 | 55 | 64 | 75 | 85  | 94  | 105 |  |  |
| 39      | 42 | 49            | 59 | 69 | 81 | 91 | 101 | 113 | 121 |  |  |
| 42      | 45 | 53            | 63 | 74 | 87 | 98 | 108 | 121 | 121 |  |  |

Note: Allowable drop equals 1 in. Hg for time shown

**PROJECT REP:** \_\_\_\_\_

**DATE:** \_\_\_\_\_

SECTION 013319.01 - FIELD TEST REPORTING  
- AGGREGATE, SOILS, CONCRETE AND ASPHALT

PART 1 - GENERAL

1.1 SUMMARY

- A. A. The Contractor shall be responsible for the quality of all materials incorporated into the project work and shall be responsible for all costs of testing and certification of same. The Contractor shall provide the City Engineer a list of three (3) local qualified firms for the City to select from to be the Contractor's testing firm.
- B. The Contractor shall provide the engineer with a Quality Control Plan in which his testing methods/procedures are defined. Said Plan shall meet with the approval of the Engineer and include identification of laboratories, types of testing, and the tentative amount and scheduling of each.

All certification of tests and/or gradations for material to be utilized in the work and all quality control testing shall be performed by an independent laboratory (not affiliated with, owned by, or managed by the Contractor). The laboratory shall be accredited by the AASHTO Materials Reference Laboratory for the type of testing performed.

- C. The Owner may perform field Quality Assurance testing; however, such testing shall not relieve the Contractor from the responsibility of Quality Control testing or from supplying certificates from manufacturers or suppliers to demonstrate compliance with the specifications. It is intended that the testing by the Contractor and the Owner be complimentary toward a quality project; however, the Contractor may not assume the Owner will test or that any tests will be done in lieu of the Contractor's own Quality Control testing. In the same sense, the Contractor may not rely on Owner Quality Assurance testing as a basis of acceptance or approval of his work nor may any Owner-performed testing be reflected in his submitted plan.

1.2 TEST CRITERIA

- A. The following tests at a minimum shall be included with the Contractor's Quality Control Plan in accordance with the specifications:
  - 1. Aggregates
    - a. For each material and/or different source, the laboratory shall perform soundness, gradation, and other tests for all parameters specified. Aggregates incorporated into concrete or asphalt mixes shall also be tested for moisture content daily.



2.    Compaction Tests
  - a.    Compaction tests or field density tests shall be taken on all embankment, trench backfill, subgrade, and subbase materials.
  - b.    Minimum testing shall be as follows:  
Embankment testing shall be at least one (1) test/5,000 SF of each lift; Trench backfill testing shall be at least one (1) test/50 LF of each lift; Subgrade and/or subbase testing shall be at least one (1) test/200 LF of pavement or 5,00 SF of slabs; subject to greater frequency due to soil conditions or Engineer's direction.
  - c.    Proctors or relative density tests shall be performed as often as necessary for the differing soils or granular materials utilized. Proctors shall be run with a minimum of 5 points. Test reports shall show the wet (bulk) weight, dry weight, wet (bulk) density, dry density, moisture content weight and moisture content percentage. Both the dry curve and the wet curve shall be plotted.
3.    Concrete Mix Design
  - a.    For each type of concrete, the laboratory shall perform the necessary mix design providing all test data as required by the specifications.
4.    Concrete Field and Laboratory Tests
  - a.    The laboratory shall cast concrete cylinders and test beams:
    1.    One set of four cylinders per 50 CY with a minimum of two sets per day. The cylinders shall be broken: one at 7 days, two at 28 days, one at 56 days, unless otherwise directed by the Engineer.
    2.    One beam per 50 CY with a minimum of two beams per day.
  - b.    Temperature and unit weight shall be run on fresh concrete at intervals sufficient for the type of structure being placed and a minimum of once per day. Bulk weight, bucket weight, (tare), net weight, bucket factor (bucket volume) and unit weight shall be recorded on the fresh concrete report. Show all batch weights for yield calculations. Slump and air content tests shall be taken a minimum of one test per 20 CY and at least once per day.
  - c.    All field and laboratory testing shall be performed by technicians certified by the American Concrete Institute (ACI) for the type of testing performed.
  - d.    Initial cure of all cylinders shall be in a temperature controlled cure box or temperature controlled water tank with a hi-low thermometer. Hi-low temperature readings shall be recorded on the fresh concrete report.
5.    Asphalt Mix Design
  - a.    For each type of asphalt mix, submit job mix formula (JMF) prepared by an ODOT pre-qualified laboratory from tests performed on the aggregates proposed for use.
  - b.    Sample and test for gradation and bitumen content per ODOT 441.

### 1.3 LABORATORY REPORTS

- A. Reports of laboratory and field tests will be distributed to the Engineer, Owner, and Suppliers within 24 hours of completion.

END OF SECTION 013319.01

## SECTION 013323 - SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. The Contractor shall submit detailed drawings, acceptable catalog data, specifications and material certifications for all equipment and materials specified or required for the proper completion of the work.
- B. The intent of these items is to demonstrate compliance with the design concept of the work and to provide the detailed information necessary for the fabrication, assembly and installation of the work specified. It is not intended that every detail of all parts of manufactured equipment be submitted, however sufficient detail will be required to ascertain compliance with the specifications and establish the quality of the equipment proposed.

Shop Drawings shall be sufficiently clear and complete to enable the Engineer/Architect and Owner to determine that items proposed to be furnished conform to the specifications and that items delivered to the site are actually those that have been reviewed.

- C. It is emphasized that the Engineer/Architect's review of Contractor's submitted data is for general conformance to the contract drawings and specifications but subject to the detailed requirements of drawings and specifications. Although the Engineer/Architect may review submitted data in detail, such review is an effort to discover errors and omissions in Contractor's drawings. The Engineer/Architect's review shall in no way relieve the Contractor of his obligation to properly coordinate the work and to Engineer/Architect the details of the work in such manner that the purposes and intent of the contract will be achieved. Such review by the Engineer/Architect shall not be construed as placing on him or on the Owner any responsibility for the accuracy and for proper fit, functioning or performance of any phase of the work included in the contract.
- D. Shop Drawings shall be submitted in proper sequence and with due regard to the time required for checking, transmittal and review so as to cause no delay in the work. The Contractor's failure to transmit appropriate submittals to the Engineer/Architect sufficiently in advance of the work shall not be grounds for time extension.
- E. The Contractor shall submit Shop Drawings for all fabricated work and for all manufactured items required to be furnished in the Contract in accordance with the General Provisions and as specified herein. Shop Drawings shall be submitted in sufficient time to allow at least twenty-one (21) calendar days after receipt of the Shop Drawings from the Contractor for checking and processing by the Engineer/Architect.
- F. It is the responsibility of each Prime Contractor to furnish to all other Prime Contractors and especially the General Construction Contractor reviewed Shop Drawings for guidance in interfacing the various trades; i.e., sleeves, inserts, anchor bolts, terminations, and space requirements.

- G. No work shall be performed requiring Shop Drawings until same have been reviewed by Engineer/Architect.
- H. Accepted and reviewed Shop Drawings shall not be construed as approval of changes from Contract plan and specification requirements.
- I. The Engineer/Architect will review the first and second Shop Drawing item submittals at no cost to the Contractor. Review of the third submittal and any subsequent submittal will be at the Contractor's expense.

## 1.2 SUBMITTAL PROCEDURE

- A. All required submissions shall be made to the Engineer/Architect by the Prime Contractor(s) only. Any data prepared by subcontractors and suppliers and all correspondence originating with subcontractors, suppliers, etc., shall be submitted through the Contractor.
- B. Contractor shall review and approve all Shop Drawings prior to submission. Contractor's approval shall constitute a representation to Owner and Engineer/Architect that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each Shop Drawing or sample with the requirements of the work and the Contract Documents.
- C. Submittal Preparation: Mark each submittal with a permanent label or page for identification. Provide the following information on the label for proper processing and recording of action taken:
  - 1. Location
  - 2. Project Name
  - 3. Contract
  - 4. Name and Address of Engineer/Architect
  - 5. Name and Address of Contractor
  - 6. Name and Address of Subcontractor
  - 7. Name and Address of Supplier
  - 8. Name of Manufacturer
  - 9. Number and Title of appropriate Specification Section
  - 10. Drawing Number and Detail References, as appropriate.
  - 11. Submittal Sequence or Log Reference Number.
    - a. Provide a space on the label for the Contractor's review and approval markings and a space for the Engineer/Architect's "Action Stamp".
- D. Each Shop Drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor:

Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Company

- E. Shop Drawings shall be submitted in not less than six (6) copies to the Engineer/Architect at the address specified at the Preconstruction Conference. Single mylar or sepia reproducible copies of simple Shop Drawings may be submitted with prior approval of the Engineer/Architect.
- F. At the time of each submission, Contractor shall in writing identify any deviations that the Shop Drawings or samples may have from the requirements of the Contract Documents.
- G. Drawings shall be clean, legible and shall show necessary working dimensions, arrangement, material finish, erection data, and like information needed to define what is to be furnished and to establish its suitability for the intended use. Specifications may be required for equipment or materials to establish any characteristics of performance where such are pertinent. Suitable catalog data sheets showing all options and marked with complete model numbers may, in certain instances, be sufficient to define the articles which it is proposed to furnish.
- H. For product which require submittal of samples, furnish samples so as not to delay fabrication, allowing the Engineer reasonable time for the consideration of the samples submitted. Properly label samples, indicating the material or product represented, its place of origin, the names of the vendor and Contractor and the name of the project for which it is intended. Ship samples prepaid. Accompany samples with pertinent data required to judge the quality and acceptability of the sample, such as certified test records and, where required for proper evaluation, certified chemical analyses.

### 1.3 REVIEW PROCEDURE

- A. Engineer/Architect will review with reasonable promptness all properly submitted Shop Drawings. Such review shall be only for conformance with the design concept of the Project and for compliance with the information given in the plans and specifications and shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
- B. The review of a separate item as such will not constitute the review of the assembly in which the item functions. The Contractor shall submit entire systems as a package.
- C. All Shop Drawings submitted for review shall be stamped with the Engineer/Architect's action and associated comments.

- D. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer/Architect will review each submittal, mark to indicate action taken, and return accordingly. Compliance with specified characteristics is the Contractor's responsibility.

Action Stamp: The Engineer/Architect 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. If Shop Drawings are found to be in general compliance, such review will be indicated by marking the first statement.
  2. If only minor notes in reasonable number are needed, the Engineer/Architect will make same on all copies and mark the second statement. Shop Drawings so marked need not be resubmitted.
  3. If the submitted Shop Drawings are incomplete or inadequate, the Engineer/Architect will mark the third statement, request such additional information as required, and explain the reasons for revision. The Contractor shall be responsible for revisions, and/or providing needed information, without undue delay, until such Shop Drawings are acceptable. Shop Drawings marked with No. 3 shall be completed resubmitted.
  4. If the submitted Shop Drawings are not in compliance with the Contract Documents, the Engineer/Architect will mark the fourth statement. The Contractor will be responsible to submit a new offering conforming to specific products specified herein and/or as directed per review citations.
- E. No submittal requiring a Change Order for either value or substitution or both, will be returned until the Change Order is approved or otherwise directed by the Owner.

## APPLICATION FOR USE OF SUBSTITUTE ITEM

TO: \_\_\_\_\_

PROJECT: \_\_\_\_\_

SPECIFIED ITEM:

| Page | Paragraph | Description   |
|------|-----------|---|
| A.   |           | The undersigned requests consideration of the following as a substitute item in accordance with Article 6.05 of the General Conditions.   |
| B.   |           | Change in Contract Price (indicate + or -) \$ _____   |
| C.   |           | Attached data includes product description, specifications, drawings, photographs, references, past problems and remedies, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified. For consideration of the attached data as SHOP DRAWINGS, submittal shall be in accordance with requirements of Section 013323. |
| D.   |           | Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.   |

The undersigned certifies that the following paragraphs, unless modified by attachments are correct:

1. The proposed substitute does not affect dimensions shown on Drawings.
2. The undersigned will pay for changes to the building design, including engineering design, detailing, and construction costs caused by the requested substitution.
3. The proposed substitution will have no adverse affect on other contractors, the construction schedule, or specified warranty requirements. (If proposed substitution affects construction schedule, indicate below using + or -)

\_\_\_\_\_ CONSECUTIVE CALENDAR DAYS

4. Maintenance and service parts will be locally available for the proposed substitution.

The undersigned further states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item, and agrees to reimburse the OWNER for the charges of the ENGINEER for evaluating this proposed substitute item.

E. Signature: \_\_\_\_\_

Firm: \_\_\_\_\_

Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Telephone: \_\_\_\_\_

Date: \_\_\_\_\_

Attachments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

For use by ENGINEER:

\_\_\_\_\_ Accepted as evidenced by affixed SHOP DRAWING REVIEW stamp.

\_\_\_\_\_ Accepted as evidenced by included CHANGE ORDER.

\_\_\_\_\_ Not accepted as submitted. See Remarks.

\_\_\_\_\_ Acceptance requires completion of submittal as required for SHOP DRAWINGS.

\_\_\_\_\_ Not accepted. Do not resubmit.

By: \_\_\_\_\_

Date: \_\_\_\_\_

Remarks: \_\_\_\_\_  
\_\_\_\_\_  
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\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



## APPLICATION FOR USE OF "OR-EQUAL" ITEM

TO: \_\_\_\_\_

PROJECT: \_\_\_\_\_

SPECIFIED ITEM:

| Page | Paragraph | Description |
|------|-----------|-------------|
|------|-----------|-------------|

A. The undersigned requests consideration of the following as an "or-equal" item in accordance with Article 6.05 of the General Conditions.

B. Change in Contract Price (indicate + or -) \$ \_\_\_\_\_

C. Attached data includes product description, specifications, drawings, photographs, references, past problems and remedies, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified. For consideration of the attached data as SHOP DRAWINGS, submittal shall be in accordance with requirements of Section 013323.

D. Signature:

Firm:

Address:

Telephone: \_\_\_\_\_ Date: \_\_\_\_\_

Attachments: \_\_\_\_\_

For use by ENGINEER:

\_\_\_\_\_ Accepted as evidenced by affixed SHOP DRAWING REVIEW stamp.  
\_\_\_\_\_ Accepted as evidenced by included CHANGE ORDER.  
\_\_\_\_\_ Not accepted as submitted. See Remarks.  
\_\_\_\_\_ Acceptance requires completion of submittal as required for SHOP DRAWINGS.  
\_\_\_\_\_ Not accepted. Do not resubmit.

By: \_\_\_\_\_ Date: \_\_\_\_\_

Remarks: \_\_\_\_\_  
\_\_\_\_\_  
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\_\_\_\_\_

END OF SECTION 013323

## SECTION 013326 – PRODUCT TESTING AND CERTIFYING

### PART 1 - GENERAL

#### 1.1 QUALITY OF MATERIALS

- A. Where the specifications call for mill or shop tests, the Contractor shall furnish duplicate copies of attested manufacturer's certificates showing details of quality or performance sufficient to demonstrate conformity to contract requirements. Mill, shop or witness tests shall be subject to view by the Engineer's representative, but the Engineer's representation shall not relieve the Contractor from the necessity of furnishing certificates specified. The Engineer shall be notified by the Contractor in writing, sufficiently in advance of the time of making tests, so that proper arrangements may be made. Waiving of witness of tests by the Engineer may be in writing only by the Engineer. All costs for travel, lodging, food and transportation that are necessary for the Engineer's representative and the Owner's representative to attend witness tests shall be included in the Contractor's bid for those item(s) specifically designated as being subject to witness testing.
- B. Unless otherwise specified, all materials, equipment and articles shall be erected, installed, applied, or connected, used, cleaned and conditioned in accordance with the printed instructions and directions of the manufacturer.
- C. The installation shall be so made that its several component parts will function together as a workable system. It shall be complete with all accessories necessary for its operation and shall be left with all equipment properly adjusted and in working order.
- D. The work shall be executed in conformity with the best practice and so as to contribute to efficiency of operation, minimum maintenance, accessibility and sightliness. It shall also be executed so that the installation will conform and accommodate itself to the building structure, its equipment and usage.
- E. Whenever in the contract documents a particular brand, make of material, device or equipment is shown or specified, such brand, make of material, device or equipment is to be regarded merely as a standard and such trade name shall be followed by "or equal".

#### 1.2 QUALITY ASSURANCE

- A. The equipment and materials to be furnished under this Contract shall be the products of well established and reliable firms which have had ample experience for at least five (5) years in the manufacture of equipment or materials similar in design and of equal quality to that specified. If required, the manufacturer shall submit a list of installations of similar equipment which have been in successful operation for at least five (5) years.

1.3 EXPERIENCE CLAUSE REQUIREMENT AND PERFORMANCE BONDS FOR MANUFACTURER

- A. For every piece of equipment furnished under this Contract, the manufacturer will be required to have a minimum of five (5) years of experience in providing this specific type of equipment. In lieu of this experience requirement, the manufacturer will be required to provide performance bond(s) for the faithful performance of the equipment and guarantee payment in a sum of not less than one hundred and fifty percent (150%) of the total equipment price for the completed work for that item. In the absence of verifiable experience, the manufacturer will be required to provide the performance bond(s) for the same number of years that the manufacturer was found lacking in experience from the specified five (5) year period. The performance bond(s) shall be from an approved surety company, to the satisfaction of the Owner's Law Director.
- B. Agents of bonding companies which write bonds for the performance and payment of the contract shall furnish power of attorney bearing the seal of the company, evidencing such agent's authority to execute the particular type of bond to be furnished, and evidencing also the right of the surety company to do business in the State of Ohio. Copy of this proof shall be attached to each copy of the contract.
- C. The bond shall be purchased through a surety company with a local agent upon whom service of process can be made.
- D. In event of failure of surety or co-surety, the manufacturer shall immediately furnish a new bond, as required herein. The manufacturer's bond will not be released until all provisions of the contract have been fulfilled.
- E. The surety used for the bid bond and performance bond shall be listed in the latest U.S. Treasury Circular 570 and the Penal Sums shall be within the maximum specified for such company in said Circular 570.

END OF SECTION 013326

## SECTION 013326.01 - QUALITY CONTROL PLAN

### PART 1 - GENERAL

#### 1.1 QUALITY CONTROL

- A. The Contractor shall be responsible for the quality of all materials incorporated into the project work and shall be responsible for all costs of testing and certification of same. The Contractor shall provide the City Engineer a list of three (3) local qualified firms for the City to select from to be the Contractor's testing firm.
- B. The Contractor shall provide the Engineer with a Quality Control Plan in which his testing methods/procedures are defined. Said Plan shall meet with the approval of the Engineer and include identification of laboratories, types of testing, and the tentative amount and scheduling of each.

All certifications of tests and/or gradations for materials to be utilized in the work and all quality control testing shall be performed by an independent laboratory (not affiliated with, owned by, or managed by the Contractor). The laboratory shall be accredited by the AASHTO Materials Reference Laboratory for the type of testing performed.

- C. The Owner may perform field Quality Assurance testing; however, such testing shall not relieve the Contractor from the responsibility of Quality Control testing or from supplying certificates from manufacturers or suppliers to demonstrate compliance with the specifications. It is intended that the testing by the Contractor and the Owner be complimentary toward a quality project; however, the Contractor may not assume the Owner will test or that any tests will be done in lieu of the Contractor's own Quality Control testing. In the same sense, the Contractor may not rely on Owner Quality Assurance testing as a basis of acceptance or approval of his work nor may any Owner performed testing be reflected in his submitted plan.

#### 1.2 TEST CRITERIA

- A. The following tests at a minimum shall be included with the Contractor's Quality Control Plan in accordance with the specifications:
  - 1. Aggregates
    - a. For each material and/or different source, the laboratory shall perform soundness, gradation, and other tests for all parameters specified. Aggregates incorporated into concrete or asphalt mixes shall also be tested for moisture content daily.
  - 2. Compaction Tests
    - a. Compaction tests or field density tests shall be taken on all embankment, trench backfill, subgrade, and subbase materials.

- b. Minimum testing shall be as follows:  
Embankment testing shall be at least one (1) test/5000 S.F. of each lift;  
Trench backfill testing shall be at least one (1) test/50 L.F. of each lift;  
Subgrade and/or subbase testing shall be at least one (1) test/200 L.F. of pavement or /5000 S.F. of slabs; subject to greater frequency due to soil conditions or Engineer's direction.
  - c. Proctors or relative density tests shall be performed as often as necessary for the differing soils or granular materials utilized. Proctors shall be run with a minimum of 5 points. Test reports shall show the wet (bulk) weight, dry weight, wet (bulk) density, dry density, moisture content weight and moisture content percentage. Both the dry curve and the wet curve shall be plotted. The source materials shall be tested for gradation, Atterberg limits, shore-hydrometer and moisture content.
3. Concrete Mix Design
- a. For each type of concrete, the laboratory shall perform the necessary mix design providing all test data as required by the specifications.
4. Concrete Field and Laboratory Tests
- a. The laboratory shall cast concrete cylinders and test beams:
    - 1) One set of four cylinders per 50 C.Y. with a minimum of two sets per day. The cylinders shall be broken: one at 7 days, two at 28 days, one at 56 days, unless otherwise directed by the Engineer.
    - 2) One beam per 50 C.Y. with a minimum of two beams per day.
  - b. Temperature and unit weight shall be run on fresh concrete at intervals sufficient for the type of structure being placed and a minimum of once per day. Bulk weight, bucket weight, (tare), net weight, bucket factor (bucket volume) and unit weight shall be recorded on the fresh concrete report. Show all batch weights for yield calculations. Slump and air content tests shall be taken a minimum of one test per 20 C.Y. and at least once per day.
  - c. All field and laboratory testing shall be performed by technicians certified by the American Concrete Institute (ACI) for the type of testing performed.
  - d. Initial cure of all cylinders shall be in a temperature controlled cure box or temperature controlled water tank with a hi-low thermometer. Hi-low temperature readings shall be recorded on the fresh concrete report.
5. Asphalt Mix Design
- a. For each type of asphalt mix, submit job mix formula (JMF) prepared by an ODOT pre-qualified laboratory from tests performed on the aggregates proposed for use.
  - b. Sample and test for gradation and bitumen content as per ODOT 441.
  - c. Asphalt compaction, thickness, and temperature tests shall be performed during asphalt placement per ODOT Item 448.

### 1.3 LABORATORY REPORTS

- A. Reports of laboratory and field tests will be distributed to the Engineer, Owner, and Suppliers within 24 hours of completion.

END OF SECTION 013326.01

## SECTION 013543 - ENVIRONMENTAL PROTECTION

### PART 1 - GENERAL

#### 1.1 UNNECESSARY NOISE, DUST AND ODORS

- A. The Contractor's performance of this contract shall be conducted so as to eliminate all unnecessary noise, dust and odors.

#### 1.2 SEWAGE, SURFACE AND FLOOD FLOWS

- A. The Contractor shall take whatever action is necessary to provide all necessary tools, equipment and machinery to adequately handle all sewage, surface flows and flood flows which may be encountered during the performance of the work. The entire cost of and liability for handling such flows is the responsibility of the Contractor and shall be included in the price for the appropriate item.

#### 1.3 WORK IN FREEZING WEATHER

- A. Written permission from the Engineer shall be obtained before any work is performed which, in the judgment of the Engineer, may be affected by frost, cold, or snow. When work is performed under such conditions, the Contractor shall provide facilities for heating the materials and for protecting the finished work.

#### 1.4 POLLUTION CONTROL

- A. It shall be the responsibility of the Contractor to prevent or limit pollution of air and water resulting from his operations.
- B. The Contractor shall perform work required to prevent soil from eroding or otherwise entering onto all paved areas and into natural watercourses, ditches, and public sewer systems. This work shall conform to all local ordinances and/or regulations, if any, and if not otherwise regulated by local ordinances or regulations shall at a minimum conform to the Ohio EPA General Storm Water NPDES Permit for Construction Activities and the Ohio Department of Natural Resources Rainwater and Land Development manual. This work may consist of but not be limited to construction and continual maintenance of silt fence, bio bag filters, sedimentation traps, stilling basins, check dams, temporary seeding, temporary mulching, erosion mats and other means to clarify waters containing suspended materials from excavations, embankments, cleared and grubbed or stripped areas, stockpiles, well points, and disposal sites and shall be commensurate with the contractor's schedule, sequence of work, means and methods. If a SWPPP plan is not required for the project, the contractor shall at a minimum submit a plan of his proposed erosion control prevention methods for approval by the Owner and/or other regulatory authorities having jurisdiction prior to starting any construction activities which may cause erosion.



- C. The Contractor shall perform work required to prevent dust attributable to his operations from entering the atmosphere. Dust on unsurfaced streets or parking areas and any remaining dust on surfaced streets shall be controlled with water and/or calcium chloride dust palliative as needed.
- D. Any material removed from sanitary or storm sewers shall be disposed in accordance with all applicable regulations.

END OF SECTION 013543

## SECTION 014126 - GENERAL REGULATIONS AND PERMITS

### PART 1 - GENERAL

#### 1.1 REGISTRATION

All Contractors and subcontractors shall be registered with the Building Department having jurisdiction. Contact the Building Department for additional registration information.

#### 1.2 PERMITS

The Contractor shall apply for and pay for all permits from the Owner and/or other authorities having jurisdiction.

#### 1.3 ARCHAEOLOGICAL DISCOVERIES

Contractors and subcontractors are required under O.R.C. Section 149.53, to notify the Ohio Historical Society and the Ohio Historic Site Preservation Board of Archaeological Discoveries located in the project area, and to cooperate with those entities in archaeological and historic surveys and salvage efforts if such discoveries are uncovered within the project area.

Contact:       Department Head  
                  Resource Protection and Review  
                  Ohio Historic Preservation Office  
                  800 E. 17th Avenue  
                  Columbus, Ohio 43211-2497  
                  614-298-2000

Should archaeological discoveries or other activities delay progress of the work, an adjustment in contract time will be made.

END OF SECTION 014126

## SECTION 014223 - INDUSTRY STANDARDS

### PART 1 - GENERAL

#### 1.1 ABBREVIATIONS

- A. Abbreviations, as used, designate the following:

|        |   |  |
|--------|---|--|
| AASHTO | - | American Association of State Highway and Transportation Officials |
| ACI    | - | American Concrete Institute  |
| AIEE   | - | American Institute of Electrical Engineers                         |
| AISC   | - | American Institute of Steel Construction                           |
| ANSI   | - | American National Standards Institute                              |
| ASTM   | - | American Society of Testing and Materials                          |
| AWWA   | - | American Water Works Association                                   |
| CMS    | - | Construction and Material Specifications                           |
| NEMA   | - | National Electrical Manufacturers Association                      |
| ODOT   | - | Ohio Department of Transportation                                  |
| ORC    | - | Ohio Revised Code  |
| UL     | - | Underwriters Laboratories, Inc.                                    |

#### 1.2 REFERENCE TO OTHER SPECIFICATIONS

- A. Where reference is made to specifications such as ASTM, AWWA or AASHTO, the latest edition shall be used, unless otherwise noted on the plans or in the specifications.

#### 1.3 CODES AND STANDARDS

- A. All work provided for by these specifications must be installed according to the provisions of the State and local building codes, subject to inspection and acceptance by the State and local inspectors.

END OF SECTION 014223

## SECTION 014323 – QUALIFICATIONS OF TRADESMEN

### PART 1 - GENERAL

#### 1.1 CHARACTER OF WORKMEN AND EQUIPMENT

- A. The Contractor shall employ competent and efficient workmen for every kind of work. Any person employed on the work who shall refuse or neglect to obey directions of the Engineer or his representative, or who shall be deemed incompetent or disorderly, or who shall commit trespass upon public or private property in the vicinity of the work, shall be dismissed when the Engineer so orders, and shall not be re-employed unless express permission be given by the Engineer. The methods, equipment and appliances used on the work and the labor employed shall be such as will produce a satisfactory quality of work, and shall be adequate to complete the contract within the specified time limit.
- B. In hiring of employees for the performance of work under this Contract, or any Subcontract hereunder, no Contractor or Subcontractor, nor any person acting on behalf of such Contractor or Subcontractor, shall, by reason of race, sex, creed or color, discriminate against any citizen of the State of Ohio in the work to which the employment relates. No Contractor, Subcontractor, nor any person on his behalf shall, in any manner, discriminate against or intimidate any employee hired for the performance of work under this contract on account of race, creed, sex or color.

END OF SECTION 014323

## SECTION 015100 - TEMPORARY POWER SERVICE

### PART 1 - GENERAL

#### 1.1 ELECTRICAL POWER

- A. The Contractor shall furnish at his own expense all electrical power which may be required for the project. All temporary lines shall be furnished and installed by the Contractor at his own expense in a manner which meets the approval of the Engineer, and shall be removed by the Contractor at the completion of the construction.

END OF SECTION 015100

## SECTION 015136 - TEMPORARY WATER AND DISTRIBUTION

### PART 1 - GENERAL

#### 1.1 WATER

- A. The Contractor shall be responsible for an adequate supply of water suitable for his use for construction and drinking. At his own expense, he shall provide and maintain adequate supplies and supply lines in such locations and installed in such a manner as may be satisfactory to the Engineer.

END OF SECTION 015136

## SECTION 015213 - FIELD OFFICES

### PART 1 - GENERAL

#### 1.1 CONTRACTOR'S OFFICE

Each Contractor shall provide and maintain an office on the site of the work during the construction period of the contract, at which he or his authorized agent shall be present at all times while the work is in progress.

#### 1.2 RESIDENT ENGINEER'S OFFICE

The General Construction Contractor shall be required to provide and maintain the herein described Resident Engineer's office, services and office equipment until completion of the contract including punch list. All equipment shall be provided with a maintenance contract which provides prompt service. During any time a service or equipment is non-operative, the Resident Engineer may utilize a commercial service or rental equipment at the Contractor's expense until the service or equipment is restored.

All items shall remain property of the Contractor upon project completion.

##### A. Office

1. The office shall have two doors minimum and adequate window area. All doors shall be fitted with identical cylinder locks for one key operation. Windows shall be fitted with venetian blinds and 1 in. mesh #12 wire (minimum) security screens.
2. The office shall be equipped with air conditioning, heating, electric lighting, two (2) private line business telephone outlets and one telephone extension outlet, clothes closet, and lavatory with flush type toilet connected to utilities.
3. Where water and sewage facilities are not available, the Contractor shall supply and maintain a portable chemical toilet and a water tank to supply the lavatory. Potable water shall be supplied to the lavatory tank.
4. The minimum floor space shall be 450 square feet. Minimum 10 feet width, divided into at least two (2) offices and one (1) meeting area.

##### B. Services

1. Fuel and electricity for heating, lighting, and equipment.
2. Potable water service with cooler and paper drinking cup supplies.
3. Daily janitorial services to maintain the office in a clean condition. These services shall include paper towels, toilet paper, soap, etc.
4. Wired local telephone service voice, fax, and Internet access and all long distance telephone calls shall be paid by the Contractor until final completion and final acceptance of the contract. The Contractor shall figure in his bid a monthly

allowance in an amount of \$100/mo. for long distance telephone calls made by the Resident Engineer or assistants. On the final pay estimate the Contractor shall credit the Owner or be paid extra for the difference in the sum of the long distance telephone call charges over or under the sum of monthly allowances for the contract period to the date of final acceptance.

5. Wireless telephone service including 1 digital wireless portable phone with fifty phone number memory, spare battery, 120 volt charger, 12 volt charger, and service agreement for digital service with a minimum allowance of 200 minutes per month of air time and no long distance charges within the 216 and 440 area codes. Phone lease, service agreement, additional air time and all long distance telephone calls shall be paid by the Contractor until final completion and final acceptance of the contract. The Contractor shall figure in his bid a monthly allowance in an amount of \$25/mo. for additional air time and long distance telephone calls made by the Resident Engineer or assistants. On the final pay estimate the Contractor shall credit the Owner or be paid extra for the difference in the sum of the additional air time and long distance telephone call charges over or under the sum of monthly allowances for the contract period to the date of final acceptance.
6. Internet service from a local provider with a minimum of 300 minutes per month access time.

#### C. Office Equipment

1. Two (2) Desks with Desk Chairs
2. Two (2) Plan Racks
3. Two (2) Plan Tables
4. One (1) Conference Table (Approximately 3' x 6')
5. Eight (8) Chairs for Conference Table
6. One (1) Drafting Table with Drafting Stool
7. Two (2) Four-Drawer Letter Size Lockable Filing Cabinets
8. One (1) Bookcase (36" x 30" x 10" each)
9. Four (4) Wastepaper Baskets
10. One (1) Printout Calculator
11. One (1) Current ODOT Specification Book
12. One (1) Two-Drawer Letter Size Lockable Filing Cabinet
13. Two (2) Single Line Business Telephones
14. One (1) Digital Telephone Answering Machine with 30 minute minimum recording time. Hardware, services and maintenance of a copier with collator and automatic feeder in the Resident Engineer's office. The copier shall be a plain paper copier, table top unit, capable of making 8-1/2 by 11 inches and 8-1/2 by 14 inches size for size copies. Also included shall be an allowance for copy materials (including paper supply) in the amount of 2,000 copies per month.
15. Hardware, services and maintenance of a computer system in the Resident Engineer's Office.

END OF SECTION 015213



## SECTION 015800 - PROJECT IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 PROJECT SIGN

- A. The Contractor shall be responsible for constructing, installing, maintaining and removing all project signs.
- B. The Contractor shall be responsible for obtaining all permits for project signs from any local authority having jurisdiction including the payment of fees, if any.
- C. The contractor shall install one project sign at a location to be determined by the Owner. The sign shall contain all of the data and graphics depicted on the project drawings.

END OF SECTION 015800

## SECTION 016600 - PRODUCT HANDLING AND PROTECTION

### PART 1 - GENERAL

#### 1.1 DELIVERY AND STORAGE OF MATERIALS

- A. The Contractor shall be responsible for delivery and storage of all materials.
- B. The Contractor shall coordinate with the Engineer on the arrangement for storing construction materials and equipment. Deliveries of all construction materials and equipment should be made at suitable times.
- C. The Contractor shall store all materials required for the performance of this contract at sites designated by the Engineer.
- D. All stockpiles shall be neat, compact, completely safe, and barricaded with warning lights if necessary.
- E. Precautions shall be taken so that no shade trees, shrubs, flowers, sidewalks, driveways or other facilities will be damaged by the storage of materials. The Contractor shall be responsible for the restoration of all stockpile sites to their original condition.
- F. Materials, tools and machinery shall not be piled or placed against shade trees, unless they shall be amply protected against injury therefrom. All materials, tools, machinery, etc. stored upon public thoroughfares must be provided with red lights at night time so as to warn the traffic of such obstruction.
- G. Materials shall be so stored as to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, shall again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the construction site may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required therefore must be provided by the Contractor at his expense. Private property shall not be used for storage purposes without written permission of the property owner or lessee, and copies of such written permission shall be furnished the Engineer. All storage sites shall be restored to their original condition by the Contractor at his expense.

END OF SECTION 016600

## SECTION 017800 - FINAL COMPLIANCE AND SUBMITTALS

### PART 1 - GENERAL

- 1.1 The following forms and related sign-offs shall be documented in accordance with provisions of the contract. These forms shall be completed by the Contractor and approved by the Owner before final retainer is approved for release. Forms for Items A to E will be attached to the Contractor's executed copy of the contract.
- A. Certificate of Substantial Completion (To be submitted at time of Substantial Completion).
  - B. Contractor's Certification of Completion.
  - C. Contractor's Affidavit of Prevailing Wage.
  - D. Consent of Surety Company for Final Payment.
  - E. Affidavit of Final Acceptance Date and Correction Period.
  - F. Before the OWNER will approve and accept the work and release the retainer, the CONTRACTOR will furnish the OWNER a written report indicating the resolution of any and all property damage claims filed with the CONTRACTOR by any party during the construction period. The information to be supplied shall include, but not be limited to, name of claimant, date filed with CONTRACTOR, name of insurance company and/or adjuster handling claim, how claim was resolved and if claim was not resolved for the full amount, a statement indicating the reason for such action.
  - G. DBE Subcontractor Participation Forms SR-EPA.7-8 (Applicable for WPCLF & WSRLA funded projects only).

END OF SECTION 017800

## SECTION 017821 - CLEANING AND PROTECTION

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. On or before the completion date for the work, the Contractor shall tear down and remove all temporary structures built by him, all construction plant used by him, and shall repair and replace all parts of existing embankments, fences or other structures which were removed or injured by his operations or by the employees of the Contractor. The Contractor shall thoroughly clean out all buildings, sewers, drains, pipes, manholes, inlets and miscellaneous and appurtenant structures, and shall remove all rubbish leaving the grounds in a neat and satisfactory condition.
- B. As circumstances require and when ordered by the Engineer, the Contractor shall clean the road, driveway, and/or sidewalk on which construction activity under this contract has resulted in dirt or any other foreign material being deposited with an automatic self-contained mechanical sweeper with integral water spray, vacuum and on-board or supplementary containment.
- C. Failure to comply with this requirement when ordered by the Engineer or his representative, may serve as cause for the Engineer to stop the work and to withhold any monies due the Contractor until such order has been complied with to the satisfaction of the Engineer.
- D. As the work progresses, and as may be directed, the Contractor shall remove from the site and dispose of debris and waste material resulting from his work. Particular attention shall be given to minimizing any fire and safety hazard from form materials or from other combustibles as may be used in connection with the work, which should be removed daily.
- E. The Contractor shall wash all windows and other glass surfaces, leaving all areas free from putty marks, paint, etc.
- F. During and after installation, the Contractor shall furnish and maintain satisfactory protection to all equipment against injury by weather, flooding or breakage thereby permitting all work to be left in a new condition at the completion of the contract.

END OF SECTION 017821

## SECTION 017823 –MAINTENANCE MANUALS

### PART 1 - GENERAL

#### 1.1 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance information shall be submitted for all manufactured items, i.e. equipment, hardware, pumps, valves, motors, etc.
- B. This manual will either contain or make reference to all information that has been issued during the construction and start-up periods, as well as information necessary for the proper operation and maintenance of equipment.
- C. It shall be the responsibility of the Contractor who supplies such equipment to obtain from his vendors the required information and submit to the Engineer. This information will be accepted only if properly identified and only after it has been revised, where necessary, to conform to previous transmittals of the same material that have been "approved as noted" by the Engineer. All submittals shall be on 8-1/2" X 11" size paper or folded to that size.
- D. In general and where applicable, the information shall consist of, but not be limited to, six (6) sets of the following:
  - 1. Descriptive literature, bulletins or other data covering equipment or system.
  - 2. Complete list of equipment and appurtenances included with system, complete with manufacturer and model number.
  - 3. Utility requirements.
  - 4. General arrangement drawing.
  - 5. Sectional assembly.
  - 6. Dimension print.
  - 7. Materials of construction.
  - 8. Certified performance curve.
  - 9. Performance guarantee.
  - 10. Parts list.
  - 11. Recommended spare parts list with part and catalog number.
  - 12. Lubrication recommendations and instructions.
  - 13. Schematic wiring diagrams.
  - 14. Schematic piping diagrams.
  - 15. Instrumentation data.
  - 16. Drive dimensions and data.
  - 17. Control data.
  - 18. Operating instructions.
  - 19. Maintenance instructions including troubleshooting guidelines and preventative maintenance instructions with task schedule.
  - 20. Required tools and equipment for operation and maintenance.
  - 21. Safety considerations for O & M procedures.

END OF SECTION 017823

## SECTION 017839 - PROJECT RECORDS, DRAWINGS

### PART 1 - GENERAL

#### 1.1 RECORD DRAWINGS

- A. The Contractor shall furnish an authentic set of marked-up drawings showing the installation insofar as the installation shall have differed from the Engineer's drawings. The drawings shall be delivered to the Engineer for making revisions to the original drawings immediately after final acceptance by the Owner.
- B. The Contractor shall furnish dimensioned drawings indicating locations of all underground mechanical and electrical facilities.

#### 1.2 SERVICE CONNECTION RECORDS

- A. The Contractor shall record the location of all service and property connections, new or existing, made to utilities constructed under this contract. Such records shall be turned over to the Owner upon completion of the work. The cost of making such records shall be included in the various unit or lump sum prices stipulated for the various items of the work.
- B. The location of each sewer connection as measured along the sewer from the nearest downstream manhole and its description with respect to the sewer shall be recorded. The record shall include the depth of new stubs for future connections and the depth of existing connections as measured from the surface grade. Also, the use of any vertical riser pipe shall be noted.
- C. The location of each water connection as measured along the water line from the nearest fire hydrant.

END OF SECTION 017839

## SECTION 018000 - SYSTEM PERFORMANCES

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. It is the intent of this Contract that the final installation shall be complete in all respects.
- B. The Contractor shall be responsible for all minor details, whether or not shown on the Drawings or specifically included in these Specifications.

#### 1.2 BUILDINGS

- A. The building and components shall function properly and in accordance with the plans, specifications and industry standards.
- B. The following components are included, but not necessarily limited to, the following:
  - 1. Roofing
  - 2. Doors
  - 3. Windows
  - 4. Painting Systems
  - 5. Floor Coverings
  - 6. Equipment
    - a. Architectural
    - b. Mechanical
    - c. Electrical

#### 1.3 FACILITIES

- A. The facilities and equipment shall function properly and in accordance with plans, specifications and industry standards.
- B. The following equipment includes, but is not necessarily limited to, the following:
  - 1. Valves
  - 2. Pumping Equipment
  - 3. Rotating Equipment
  - 4. Aeration Equipment
  - 5. Flotation Equipment
  - 6. Blowers
  - 7. Telemetry
  - 8. HVAC
  - 9. Electrical

#### 1.4 CERTIFICATION

- A. The Contractor shall provide written certification from the manufacturers and/or installers that the various major components are in working order or have been installed in accordance with the manufacturer's instructions.

END OF SECTION 018000



## SECTION 024119 - REMOVAL OF STRUCTURES AND OBSTRUCTIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section includes removal of pavement, piping, and equipment necessary to clear space for new construction and/or to rehabilitate existing construction.

#### 1.3 REQUIREMENTS OF REGULATORY AGENCIES

- A. State and local code requirements shall control the disposal of debris resulting from the removal operation.

#### 1.4 PROTECTION

- A. Structures shall be removed in such a manner as not to damage portions of the existing structure which are to remain in place.

### PART 2 - PRODUCTS (NOT APPLICABLE)

### PART 3 - EXECUTION

#### 3.1 PAVEMENTS, SIDEWALKS, CURBING, SIMILAR STRUCTURES

- A. Removal of existing pavements, sidewalks, curbing, and similar structures shall end at an existing joint or a sawed joint. Sawed joints shall be straight, neat and free from chipped or damaged edges.
- B. For removal of reinforced or non-reinforced concrete, the minimum depth of saw cut shall be 3 in.
- C. For removal of reinforced concrete, the depth of saw cut shall be sufficient to cut the steel.
- D. If the concrete is coated with a bituminous surface or other material, the depth shall be sufficient to cut into the concrete, not including the coating depth, as specified above.

### 3.2 EXCAVATION OF RIGID PAVEMENT

- A. The Contractor shall excavate rigid pavement, consisting of concrete or concrete base with a wearing surface of brick or bituminous concrete, wherever such excavation is required for the purpose of this Contract.
- B. Pavement shall be excavated to neat lines and, only to widths required for trenches, for pipe laying and for construction of structures. Adequate provision shall be made to prevent settlement and breakage of pavement beyond the approved limits of excavation.
- C. All pavement broken or damaged beyond the limits above stated, or the approved extension thereof, shall be replaced by the Contractor at his expense.

### 3.3 CATCH BASINS, INLETS AND SIMILAR STRUCTURES

- A. Completely remove existing drainage structures shown to be removed.
- B. Abandoned sewers shall be sealed and made watertight with approved masonry bulkheads.
- C. All castings salvaged from abandoned or removed drainage structures shall remain the property of the Owner and shall be cleaned and transported by the Contractor to a site designated by the Engineer or incorporated in the work where shown, scheduled, or so directed.

### 3.4 FENCE

- A. Where so required by the Drawings, existing fence shall be carefully dismantled and stored for reuse or for salvage by the Owner.
- B. Dispose of wood posts and other materials not considered salvageable by the Engineer.
- C. The Contractor shall replace, at no cost to the Owner, material lost or damaged by negligence or by the use of improper methods.

### 3.5 EQUIPMENT REMOVAL

- A. All equipment, valves, piping, fittings, and miscellaneous steel structures that are removed shall remain the property of the Owner and shall be stored at site selected by the Owner.
- B. The Owner reserves the right to require the Contractor to dispose of certain unwanted portions of removed equipment and materials. The Owner shall have the right to reject any or all materials removed during construction, and the Contractor shall haul away and dispose of these materials in a suitable manner at no additional cost to the Owner.

### 3.6 DISPOSAL OF DEBRIS

- A. Dispose of all debris resulting from demolition operations; i.e., broken concrete, masonry, pipe, miscellaneous metal, trees and brush, equipment, etc., offsite.
- B. Monitor the hauling of debris to insure that all spillage from haul trucks is promptly and completely removed.

### 3.7 BACKFILLING

- A. Backfill and compact all trenches, holes, and pits resulting from the removal and abandonment of any structure or obstruction in accordance with the requirements of the compacted backfill specification.

END OF SECTION 024119

## SECTION 030000 - CONCRETE WORK

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including form work, reinforcing, mix design, placement procedures and finishes.
  - 1. Extent of concrete work is shown on drawings.
  - 2. Precast concrete is specified in other Division-3 sections.
  - 3. Mechanical finishes and concrete floor toppings are specified in other Division-3 sections.

#### 1.3 SUBMITTALS

- A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Engineer.
- B. Shop Drawings; Reinforcement: Submit original shop drawings prepared for fabrication, bending, and placement of concrete reinforcement. Comply with ACI Detailing Manual showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Shop Drawings; Form work: Submit shop drawings prepared by a registered Professional Engineer for fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joint or reveals, location and pattern of form tie placement, and other items which affect exposed concrete visually.
  - 1. Engineer's review is for general architectural applications and features only. Design of form work for structural stability and efficiency is Contractor's responsibility.
- D. Samples: Submit samples of materials as requested by Engineer, including names, sources, and descriptions.
- E. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design tests.
  - 1. The proposed mix design submittal(s) shall follow the procedures of Chapter 5, Sections 5.2 to 5.3 of ACI-318.

2. Reference should be made to ACI-211.5R "Guide for Submittal of Concrete Proportions" for the required submittal information. Sample forms for presenting the necessary information can be found in the addendum at the end of this section. Example Form B should follow a completed Example A in the submittal when laboratory trial batches are used to document a water-cementitious materials ratio curve.
  3. Additional data summarizing the past performance records should be an integral part of the submittal if the submittal is based on past performance with the proposed materials and proportions.
- F. **Materials Certificates:** Provide materials certificates in lieu of materials laboratory test reports when permitted by Engineer. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

#### 1.4 QUALITY ASSURANCE

- A. **Codes and Standards:** Comply with provisions of following codes, specifications, and standards, latest revisions, except where more stringent requirements are shown or specified:
1. ACI 301 "Specifications for Structural Concrete for Buildings."
  2. ACI 318 "Building Code Requirements for Reinforced Concrete."
  3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."
  4. ACI 347 "Guide to Form work for Concrete."
  5. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- B. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.
- C. Engage a testing agency acceptable to Engineer to perform initial material evaluation and certification tests for mix designs and to design concrete mixes.
- D. **Mockup:** Cast mockup of size indicated or as required to demonstrate typical joints, form tie spacing, and proposed surface finish, texture, and color. Maintain sample panel exposed to view for duration of project, after Engineer's acceptance of visual qualities.
1. Demolish mockup and remove from site when directed by Engineer.
- E. **Pre-installation Conference:** Conduct conference at project site to comply with requirements of Division 1 Section "Project Meetings" and the following:
1. At least 35 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work

progress schedule and procedures for materials, inspection, testing and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

- a. Contractor's Superintendent
- b. Agency responsible for concrete design mixes.
- c. Agency responsible for field quality control.
- d. Ready-mix concrete producer.
- e. Concrete Subcontractor
- f. Primary admixture manufactures.

## 1.5 PROJECT CONDITIONS

- A. Protection of Footings Against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.
- B. Protect adjacent finish materials against spatter during concrete placement.

## PART 2 - PRODUCTS

### 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 plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, 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 (2) edges and one side for tight fit.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Engineer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.
- D. Forms for Cylindrical Columns and Supports: Metal, fiberglass reinforced plastic, or paper or fiber tubes. Construct paper or fiber tubes of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.
- E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

- F. Form Ties: Factory-fabricated, adjustable-length, snapoff metal or glass fiber-reinforced plastic form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units which will leave no metal closer than 1-1/2" to the exposed surface.
  - 1. Provide ties which, when removed, will leave holes not larger than 1" diameter in concrete surface.
  - 2. All form ties shall have a factor of safety of two (2) to determine the recommended safe working load.

## 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf) hot-dip galvanized, after fabrication and bending.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 775.
  - 1. Repair of damaged epoxy-coating - When required, damaged epoxy-coating shall be repaired with patching material conforming to ASTM A 775. Repair shall be done in accordance with the patching material manufacturer's recommendations.
- D. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- E. Welded Wire Fabric: ASTM A 185, welded steel wire fabric. (Flat sheets only)
- F. Welded Deformed Steel Wire Fabric: ASTM A 497.
- G. Epoxy - Coated Welded Wire Fabric: ASTM A884, Class A.
- H. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.
  - 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 which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I, II or I/II and ASTM C595M, Type IP, unless otherwise specified. (See Table I, Concrete Requirements).
  - 1. Use one brand of cement throughout project, unless otherwise acceptable to Engineer.

- B. Fly Ash: ASTM C 618, Class F.
- C. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
  - 1. Limit use of fly ash to not exceed 25% of cement content by weight.
  - 2. Limit use of granulated blast-furnace slag to not exceed 30% of cement content by weight.
- D. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete, with nominal maximum aggregate size of 1 inch.
  - 1. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
  - 2. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Engineer.
  - 3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3-mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3 mm).
- E. Lightweight Aggregates: ASTM C 330.

Maximum nominal aggregate size of 1 inch.
- F. Water: Drinkable and complying with ASTM C94.
- G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Air-Mix"; Euclid Chemical Co.
    - b. "Sika Aer"; Sika Corp.
    - c. "MB-VR or MB-AE"; Master Builders.
- H. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.1 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "WRDA"; W.R. Grace.
    - b. "Eucon WR-75"; Euclid Chemical Co.
    - c. "Pozzolith Normal"; Master Builders.
- I. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C 494, Type F and containing not more than 0.1 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:



- a. "Sikament 300"; Sika Chemical Corp.
  - b. "Eucon 37"; Euclid Chemical Co.
  - c. "Rheobuild or Polyheed"; Master Builders.
- J. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.1 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Accelguard 80"; Euclid Chemical Co.
    - b. "Pozzutec 20"; Master Builders.
    - c. "Daraset"; W.R. Grace & Co.
- K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and containing not more than 0.1 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Pozzolith"; Master Builders.
    - b. "Eucon Retarder 75"; Euclid Chemical Co.
    - c. "Plastiment"; Sika Chemical Co.
- L. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Catexol 1000CL; Axim Concrete Technologies.
    - b. MCI 2000 or MCI 2005; Cortec Corporation.
    - c. DCI or DCI-S; W.R. Grace & Co., Construction Products Div.
    - d. Rheocrete 222+; Master Builders, Inc.
    - e. FerroGard-901; Sika Corporation.
- M. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.
- N. Fiber Reinforcement:
  - 1. Synthetic fiber reinforcing shall be added to the concrete for the areas so indicated in the drawings. Only fibers designed and manufactured specifically for use in concrete shall be acceptable as secondary reinforcement, complying with ASTM C1116, not less than 3/4 inch long.

2. The fibers may be added at the batch plant. The incorporation of said fibers shall be documented on the delivery ticket from the ready mix producer. Fibers shall be added to the concrete in strict accordance with manufacturer's printed instructions. The minimum dosage rate shall be 1.5 lbs/cubic yard.
3. Nylon fibers containing 100% virgin nylon monofilaments shall be utilized to impart a "non-hairy" surface to the finished concrete.
4. Products: Subject to compliance with requirements, provide the following fibrous reinforcement or approved equal:
  - a. Nycon Fiber; Nycon, Inc.
  - b. Nylo-Mono; Forta Corp.
  - c. Fibrasol N; Axim Concrete Technologies

## 2.4 RELATED MATERIALS

- A. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gage galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- B. Waterstops: Provide waterstops at construction joints and other joints as indicated.
- C. Granular Base: Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.
- D. Vapor Retarder: Provide vapor retarder cover, ASTM E1745 Class C, over prepared base material where indicated below slabs on grade. Use only materials which are resistant to deterioration when tested in accordance with ASTM E 154, as follows:
  1. Polyethylene sheet not less than 10 mils thick.
  2. Water resistant barrier paper consisting of heavy Kraft papers laminated together with glass fiber reinforcement and over-coated with black polyethylene on each side.
    - a. Product: Subject to compliance with requirements, provide Moistop Ultra 10 by Fortifiber Corporation, Stego Wrap 10-mil by Stego Industries or equal.
- E. Non-Shrink Grout: CRD-C 621 and ASTM C-1107, factory pre-mixed grout.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Non-metallic
      - 1) "Set Grout"; Master Builders.
      - 2) "Euco-NS"; Euclid Chemical Co.
      - 3) "Five Star Grout"; U.S. Grout Corp.

- F. Non-slip Aggregate Finish: Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rust-proof, and non-glazing, and is unaffected by freezing, moisture, and cleaning materials.
- G. Colored Wear-Resistant Finish: Packaged, dry, combination of materials, consisting of Portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, non-fading mineral oxides, interground with cement. Color as selected by Engineer, unless otherwise indicated.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Colorcron"; Master Builders.
    - b. "Surflex"; Euclid Chemical Co.
    - c. "Lithochrome"; L.M. Scofield Co.
- H. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- I. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
  2. Polyethylene film.
  3. Polyethylene-coated burlap.
- J. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg./sq. m. when applied at 200 sq ft./gal.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Masterkure"; Master Builders.
    - b. "Ecocure"; Euclid Chemical Co.
    - c. "Horn Clear Seal"; A.C. Horn, Inc.
- K. Underlayment Compound: Freeflowing, self-leveling, pumpable cementitious base compound for applications from 1 inch thick to feathered edges.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Flo-Top"; Euclid Chemical Co.
    - b. "Underlayment 110," Master Builders, Inc.
    - c. "Thoro Underlayment Self-Leveling"; Thoro System Products.

- L. Bonding Compound: Polyvinyl acetate or acrylic base.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Polyvinyl Acetate (Interior Only):
      - 1) "Euco Weld"; Euclid Chemical Co.
      - 2) "Weldcrete"; Larsen Products Corp.
      - 3) "Everweld"; L&M Construction Chemicals, Inc.
    - b. Acrylic or Styrene Butadiene:
      - 1) "Day-Chem AD Bond"; Dayton Superior Corp.
      - 2) "Everbond"; L & M Construction Chemicals.
      - 3) "SBR Latex"; Euclid Chemical Co.
- M. Epoxy Adhesive: 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. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Epoxite Binder 2390"; A.C. Horn, Inc.
    - b. "Sikadur 32 Hi-Mod"; Sika Chemical Corp.
    - c. "Euco Epoxy 452 or 620"; Euclid Chemical Co.

## 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 and ACI 211. If the trial batch method is 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 unless otherwise acceptable to Engineer.
1. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Engineer and Structural Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Engineer.
- C. Design mixes to provide normal weight concrete with the following properties, as indicated in Table I.:

TABLE 1

### CONCRETE REQUIREMENTS

| Concrete | Cement | Min. 28-Day | *Max. | Min. | Slump | Inch | Entrained |
|----------|--------|-------------|-------|------|-------|------|-----------|
|----------|--------|-------------|-------|------|-------|------|-----------|

| <u>Class</u> | <u>Type</u> | <u>Compressive<br/>Strength<br/>PSI</u> | <u>Water-<br/>Cement<br/>Ratio</u> | <u>Cement<br/>Content<br/>Sacks</u> | <u>Min.</u> | <u>Max.</u> | <u>Air %</u> |
|--------------|-------------|---|------------------------------------|-------------------------------------|-------------|-------------|--------------|
| A            | I           | 4000                                    | 0.45                               | 6                                   | -           | -           | 6±1          |
| B            | I           | 2000                                    | 0.74                               | 4-1/2                               | 2           | 6           | 5±1-1/2      |
| C            | I           | 4000                                    | 0.50                               | 6.38                                | 1           | 4           | 6±2          |
| D            | II or IP    | 4000                                    | 0.45                               | 6                                   | -           | -           | 6±1          |

\*Maximum Water - Cementitious Materials Ratio

1. All reinforced concrete shall be Class A, except as otherwise specified or shown on the drawings.
  2. Concrete used for mud mats, fill and channeling in manholes and chambers shall be Class B unless otherwise noted on the drawings.
  3. Class C concrete conforming to ODOT 499 (Class C) shall be used for all concrete pavement, curbing, driveways, and sidewalks, unless noted otherwise on the drawings.
  4. Class B concrete may be used for encasing pipelines, fill, and pipe bedding.
  5. Class B concrete shall be used as concrete fill in concrete tanks for shaping or sloping bottoms.
    - a. The following steps shall be taken for installation of the Class B concrete:
      - 1) Scrub concrete slabs and/or walls with a stiff wire brush and streams of clean water as a minimum, to remove laitance.
      - 2) Apply a bonding agent in accordance with the manufacturer's surface preparation and application recommendations.
      - 3) The Class B concrete shall then be placed and screeded to bring the surface to final grade.
  6. Class D concrete shall be used for sewerage treatment plants and sewerage pump stations, as noted on the drawings.
- D. **Lightweight Concrete:** Lightweight aggregate and concrete shall conform to ASTM C 330. Proportion mix to produce concrete with a minimum compressive strength of 3000 psi at 28 days and a calculated equilibrium unit weight of 110 pcf plus or minus 3 pcf as determined by ASTM C 567. Concrete slump at the point of placement shall be the minimum necessary for efficient mixing, placing, and finishing. Maximum slump shall be 6 inches for pumped concrete and 5 inches elsewhere. Air entrain concrete exposed to weather according to ACI 301 requirements.
- E. **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; at no additional cost to Owner and 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.
- F. **Admixtures:**

1. Use high range water-reducing admixture (super plasticizer) in Classes A and D concrete unless noted otherwise.
2. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
3. Use air-entraining admixture in all concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content within limits shown in Table I.
4. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.
5. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as shown in Table I:
  - a. Concrete containing HRWR admixture (super-plasticizer): Not more than 8" after addition of HRWR to site-verified 2"-3" slump concrete.

## 2.6 CONCRETE MIXING

- A. Job-Site Mixing: Mix materials for concrete in appropriate drum type batch machine mixer. For mixers of one cu. yd., or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd., or fraction thereof.
  1. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.
  1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.
    - a. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

### 3.2 FORMS

- A. Design, erect, support, brace, and maintain form work to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct form work so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain form work construction tolerances complying with ACI 347.
- B. Design form work to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- C. 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 back-up at joints to prevent leakage of cement paste.
- D. 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, to prevent swelling and for easy removal.
- E. Provide temporary openings where interior area of form work 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 on forms at inconspicuous locations.
- F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Provisions for Other Trades: Provide openings in concrete form work 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.
- H. 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. Retightening forms and bracing after concrete placement if required to eliminate mortar leaks and maintain proper alignment.

### 3.3 VAPOR RETARDER INSTALLATION

- A. Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6" and seal with manufacturer's recommended mastic or pressure-sensitive tape.

### 3.4 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute'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. Repair damages before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement by form work, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Place reinforcement to obtain at least minimum coverages 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 longest lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.
- F. Epoxy - Coated Reinforcing Steel:
  - 1. Epoxy-coated reinforcing bars supported from form work shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2 inches from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreader bars where specified by the Engineer, shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion-resistant material.
  - 2. Epoxy-coated reinforcing bars - Equipment for handling epoxy-coated bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pick-up points to minimize bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored on protective cribbing. Fading of the color of the coating shall not be cause for rejection of epoxy-coated reinforcing bars. Coating damage due to handling, shipment and placing need not be repaired in cases where the damaged area is 0.1 square inches or smaller. Damaged areas larger than 0.1 square inches shall be repaired in accordance with the epoxy material manufacturer's recommendations. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2 percent of the surface area in each linear foot of each bar.



### 3.5 JOINTS

- A. Construction Joints: Locate and install construction 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 1-1/2" deep in construction joints in walls, slabs, and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.
  - 2. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.
- B. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.
- C. Isolation Joints in Slabs-on-Ground: 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.
  - 1. Submit joint filler and sealant materials for approval.
- D. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4 of slab depth, unless otherwise indicated.
  - 1. Form contraction joints by inserting premolded plastic strips into fresh concrete until top surface of strip is flush with slab surface.
  - 2. Follow the directions of Insert Manufacturer for finishing the slab and joints.
- E. If joint pattern not shown, provide joints not exceeding 15' in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third-bays).
  - 1. Submit joint filler and sealant materials for approval.

### 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. Electrical conduit shall not be embedded in concrete.

- B. Install reglets to receive top edge of foundation sheet waterproofing, and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- C. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units to support screed strips using strike-off templates or compacting type screeds.

### 3.7 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. 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.
- D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel form work is not acceptable.

### 3.8 CONCRETE PLACEMENT

- A. Preplacement Inspection: Before placing concrete, inspect and complete form work 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. Moisten wood forms immediately before placing concrete where form coatings are not used.
  - 1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.
- B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.
  - 1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which 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 as nearly as practicable to its final location to avoid segregation.

- C. **Placing Concrete in Forms:** Deposit concrete in forms in horizontal layers not deeper than 24" 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. 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" 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.
- D. **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 strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
  3. Maintain reinforcing in proper position on chairs during concrete placement operations.
- E. **Cold Weather Placing:** Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (27 deg C) at point of placement.
    - a. The concrete shall be maintained within this temperature range for not less than seven (7) days.
  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 or against cold reinforcing steel.
  3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- F. **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 90 deg F (32 deg C). 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, as acceptable to Engineers.

### 3.9 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are 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 orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed; provide smooth rubbed finish to smooth form finish. Refer to "Concrete Surface Repairs."
- C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment.
  1. Scarify or roughen entire surface by grinding or similar effective means.
  2. Combined one part Portland cement to 1-1/2 parts fine sand by volume and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the 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.
  3. Thoroughly wet concrete surfaces and 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.
  4. Repeat the above process if necessary to fill voids or bug holes and obtain a consistent match to adjacent surfaces, subject to acceptance of the Engineer.
- D. Grout Cleaned Finish: Provide grout cleaned finish on scheduled concrete surfaces which have received smooth form finish treatment.
  1. Scarify or roughen entire surface by grinding or similar effective means.

2. Apply Thoroseal plaster mix coating by Thoro System Products or approved equivalent with an approximate thickness of 1/8-inch to 1/4-inch.
  3. Follow the manufacturer's recommendations and guidelines regarding surface preparation, application methods and curing.
  4. Repeat the above process if necessary to fill voids or bug holes and obtain a consistent match to adjacent surfaces, subject to acceptance of the Engineer.
- 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.

### 3.10 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated.
1. After placing slabs, plane surface to tolerances for floor flatness F(F) 15 and floor levelness F(L) 13, measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms, or rakes.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are 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 when surface water has disappeared or 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 tolerances of F(F) 18 F(L) 15. 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.
1. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of F(F), 20 and F(L) 17, measured according to ASTM E1155. Grind smooth surface defects which would telegraph through applied floor covering 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.
- F. Non-slip Aggregate Finish: Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and elsewhere as indicated.
  - 1. After completion of float finishing, and before starting trowel finish, uniformly spread 25 lbs. of dampened non-slip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.
  - 2. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose non-slip aggregate.
- G. Colored Wear-Resistant Finish: Provide colored wear-resistant finish to monolithic slab surface indicated.
  - 1. Apply dry shake materials for colored wear-resistant finish at rate of not less than 100 lbs. per 100 sq. ft., unless greater amount is recommended by material manufacturer.
  - 2. Immediately following first floating operation, uniformly distribute approximately 2/3 of required weight of dry shake material over concrete surface, and embed by means of power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material with overlapping applications, and embed by power floating.
  - 3. After completion of broadcasting and floating, apply trowel finish as herein specified. Cure slab surface with curing compound recommended by dry shake hardener manufacturer. Apply curing compound immediately after final finishing.

### 3.11 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Protect concrete from rapid moisture loss before and during finishing operations.
  - 1. The evaporation graph, Figure 1, of ACI 308 - Curing Concrete, shall be used to determine the evaporation rate during concrete placement. If the rate of evaporation equals or exceeds 0.2 lbs/sq.ft./hr., steps shall be taken to prevent excessive evaporation from the surface.
  - 2. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.

- a. Initial curing may be any of the methods listed herein that maintain a satisfactory moisture content and temperature.
  3. Begin final curing procedures, if they differ from initial curing, immediately following initial curing and before concrete has dried. Continue curing for at least seven (7) days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- B. Curing Methods: Perform curing of all structural concrete as herein specified.
1. Provide moisture curing by following methods.
    - a. Keep concrete surface continuously wet by covering with water.
    - b. Continuous water-fog spray.
    - c. Cover concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
  2. Provide moisture-cover curing as follows:
    - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- C. Provide curing and sealing compound to pavement, walks, and curbs only, as follows:
1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 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 (3) hours after initial application. Maintain continuity of coating and repair damage during curing period.
- D. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides 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.
- E. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by moist curing methods.
1. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

### 3.12 SHORES AND SUPPORTS

- A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.
- B. Extend shoring from ground to roof for structures four (4) stories or less, unless otherwise permitted.
- C. Extend shoring at least three (3) floors under floor or roof being placed for structures over four (4) stories. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.
- D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.
  - 1. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

### 3.13 REMOVAL OF FORMS

- A. 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 deg F (10 deg C) for five (5) days after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or 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. Lab cured cylinders will not be considered.
- C. Form facing material may be removed five (5) 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.

### 3.14 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used 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 form work.
- 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.

### 3.15 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 with template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
  - 1. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and finish concrete surfaces as scheduled. Cure concrete as herein specified.
- E. Reinforced Masonry: Provide concrete grout conforming to ASTM C476 for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

### 3.16 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. Saw-cut out honeycomb, rock pockets, voids over 1/4" in any dimension, down to solid concrete but, in no case to a depth of less than 1." Make edges of cuts slightly undercut to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar after 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 surrounding color. 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 Portland Cement patching mortar, or precast cement cone plugs secured in place with bonding agent. When other materials are used, apply them in accordance with manufacturer's recommendations.

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.
2. 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, in addition to smoothness using a template having required slope.
3. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.
4. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Engineer.
6. Repair defective areas, except random cracks and single holes not exceeding 1" 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 3/4" 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.
7. Repair isolated random cracks and single holes not over 1" in 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 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after 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.
8. Perform structural repairs with prior approval of Engineer or Structural Engineer for method and procedure, using specified epoxy adhesive and mortar.
9. Repair methods not specified above may be used, subject to acceptance of Engineer.
10. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material.

### 3.17 THROUGH SECTION CONCRETE CRACK REPAIRS

A. Sealing through wall or slab cracks.

1. Seal cracks for a water-tight or structurally bonded repair with epoxy or chemical grouting procedures.
  - a. The Contractor shall make proper repairs with epoxy injection or chemical injection with a moisture reactive hydrophilic polyurethane foam grout, as directed by the Engineer.

3.18 MUD MATS

- A. Where called for on the plans or as directed by the Engineer, the Contractor shall construct concrete mud mats immediately after cleaning the excavation bottom, to preserve the bearing surface condition. Concrete for mud mats shall be not less than 3 in. thick. Bottom of excavation shall be free of water, mud and loose material prior to mud mat placement. See Section 310000.
1. Mud mat concrete shall be cast against the side walls of all excavations to completely seal the bottom.

ADDENDUM  
EXAMPLE FORM A

CONCRETE SUPPLIER: \_\_\_\_\_

PROJECT: \_\_\_\_\_ CONTRACTOR: \_\_\_\_\_

MIXTURE ID: \_\_\_\_\_ SPECIFIED  $f_c$ : \_\_\_\_\_ PSI

MATERIAL MIXTURE PROPORTIONS lbs-mass/cu.yd. (pcy)

1.0 Cement Type \_\_\_\_\_ Source: \_\_\_\_\_

Sp. Gr. \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

1.1 Other Cementitious Materials: \_\_\_\_\_ Class: \_\_\_\_\_ Source: \_\_\_\_\_

Sp. Gr. \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

2.0 Aggregate (No. 1) Type: \_\_\_\_\_ Size: \_\_\_\_\_ Source: \_\_\_\_\_

SSD Sp. Gr. \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

Dry Rodded Unit Wt.: \_\_\_\_\_ pcf

Alternate (No. 1) Lightweight Aggregate Type: \_\_\_\_\_ Size: \_\_\_\_\_ Source: \_\_\_\_\_

Sp. Gr. Factor \_\_\_\_\_ over dry pcy \_\_\_\_\_ cu. ft.

Loose Unit Wt. \_\_\_\_\_ pcf Estimated Wet \_\_\_\_\_ pcf

2.1 Aggregate (No. 2) Type: \_\_\_\_\_ Size: \_\_\_\_\_ Source: \_\_\_\_\_

SSD Sp. Gr. \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

Dry Rodded Unit Wt.: \_\_\_\_\_ pcf (If Fine Sized - FM \_\_\_\_\_)

2.2 Aggregate (Nos. 3, 4, n) Type: \_\_\_\_\_ Size: \_\_\_\_\_ Source: \_\_\_\_\_

SSD Sp. Gr. \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

Dry Rodded Unit Wt.: \_\_\_\_\_ pcf

3.0 Water: \_\_\_\_\_ gal. \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

# EXAMPLE FORM A (CONTINUED)

## 4.0 Admixtures expressed as fluid ounces/cubic yard, and estimated range

Source: \_\_\_\_\_ Name: \_\_\_\_\_ Type \_\_\_\_\_ oz

Source: \_\_\_\_\_ Name: \_\_\_\_\_ Type \_\_\_\_\_ oz

Source: \_\_\_\_\_ Name: \_\_\_\_\_ Type \_\_\_\_\_ oz

Total Admixture Liquid Vol. \_\_\_\_\_ cu. ft.

(\*) Note: Show volume in 4.0 if not included in cubic feet of air or water.

## 5.0 Other Materials - fibers, color pigment or other additions

Sp. Gr. \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

Total Mixture Mass and Volume: \_\_\_\_\_ pcy \_\_\_\_\_ cu. ft.

### Fresh Concrete Properties

### Coarse & Fine Aggregate Gradation

#### Percent Passing

Slump \_\_\_\_\_ +/- \_\_\_\_\_ in.

Sieve Size

Aggregate No.

Unit Weight \_\_\_\_\_ pcf

2 in.

1 2 3 4 Combined

Air Content \_\_\_\_\_ +/- \_\_\_\_\_ %

1-1/2 in.

1 in.

3/4 in.

1/2 in.

If Trail Batch Data -

3/8 in.

Identify Batch No. \_\_\_\_\_

No. 4

Batch Date \_\_\_\_\_

No. 8

Concrete Temp. \_\_\_\_\_ °F

No. 16

Comp. Strength-Average \_\_\_\_\_ °F

No. 30

EXAMPLE FORM A (CONTINUED)

|                       |         |       |       |       |       |       |
|-----------------------|---------|-------|-------|-------|-------|-------|
| 7 day avg. _____ psi  | No. 50  | _____ | _____ | _____ | _____ | _____ |
| 28 day avg. _____ psi | No. 100 | _____ | _____ | _____ | _____ | _____ |
|                       | No. 200 | _____ | _____ | _____ | _____ | _____ |

Comments: \_\_\_\_\_

\_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Title: \_\_\_\_\_

Organization: \_\_\_\_\_

# EXAMPLE FORM B

CONCRETE SUPPLIER: \_\_\_\_\_

MATERIAL                      TRAIL BATCH NUMBER - proportions per cubic yard

1                      2                      3                      4

1.0    Cement Source: \_\_\_\_\_

Type \_\_\_\_\_ lb                      lb                      lb                      lb

1.1    Other Cementitious Material Sources: \_\_\_\_\_

Type \_\_\_\_\_ lb                      lb                      lb                      lb

2.0    Aggregate No. 1    Size \_\_\_\_\_                      Source: \_\_\_\_\_

SSD \_\_\_\_\_ lb                      lb                      lb                      lb

Alternate No. 1 Lightweight Aggregates Type \_\_\_\_\_                      Source: \_\_\_\_\_

Sp. Gr. Factor \_\_\_\_\_

Oven Dry \_\_\_\_\_ lb                      lb                      lb                      lb

Wet \_\_\_\_\_ lb                      lb                      lb                      lb

2.1    Aggregate No. 2    Size \_\_\_\_\_                      Source: \_\_\_\_\_

SSD \_\_\_\_\_ lb                      lb                      lb                      lb

2.2    Aggregate Nos. 3, 4, n)    Size \_\_\_\_\_                      Source: \_\_\_\_\_

SSD \_\_\_\_\_ lb                      lb                      lb                      lb

3.0    Water \_\_\_\_\_ lb                      lb                      lb                      lb

4.0    Admixtures Source: \_\_\_\_\_

\_\_\_\_\_ Type \_\_\_\_\_ oz                      oz                      oz                      oz

\_\_\_\_\_ Type \_\_\_\_\_ oz                      oz                      oz                      oz

\_\_\_\_\_ Type \_\_\_\_\_ oz                      oz                      oz                      oz

# EXAMPLE FORM B (CONTINUED)

## 5.0 Other Materials

\_\_\_\_\_ Type \_\_\_\_\_ lb \_\_\_\_\_ lb \_\_\_\_\_ lb \_\_\_\_\_ lb

Total Mass: \_\_\_\_\_ lb \_\_\_\_\_ lb \_\_\_\_\_ lb \_\_\_\_\_ lb

Total Mass/cy: \_\_\_\_\_ pcy \_\_\_\_\_ pcy \_\_\_\_\_ pcy \_\_\_\_\_ pcy

Relative Cubic Yard Volume: \_\_\_\_\_ cy \_\_\_\_\_ cy \_\_\_\_\_ cy \_\_\_\_\_ cy

Water-Cementitious Material Ratio:

## Fresh Concrete Properties

### TRAIL BATCH NUMBER

|  | <u>## -1</u> | <u>## -2</u> | <u>## -3</u> | <u>## -4</u> |
|--|--------------|--------------|--------------|--------------|
| Slump-inches   | _____        | _____        | _____        | _____        |
| Air-Content %  | _____        | _____        | _____        | _____        |
| Unit Wt. pcf   | _____        | _____        | _____        | _____        |
| Concrete Temp. °F  | _____        | _____        | _____        | _____        |
| Compressive Strength Results (ASTM C192, C39) or Other Specified Test Requirements |              |              |              |              |
| 7 days   | _____        | _____        | _____        | _____        |
|  | _____        | _____        | _____        | _____        |
|  | _____        | _____        | _____        | _____        |
| Average (7 day)  | _____        | _____        | _____        | _____        |



EXAMPLE FORM B (CONTINUED)

28 days

|       |       |       |       |
|-------|-------|-------|-------|
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |

Average (28 day)

|       |       |       |       |
|-------|-------|-------|-------|
| _____ | _____ | _____ | _____ |
|-------|-------|-------|-------|

Water-Cementitious Material Ratio:

|       |       |       |       |
|-------|-------|-------|-------|
| _____ | _____ | _____ | _____ |
|-------|-------|-------|-------|

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Title: \_\_\_\_\_

Organization: \_\_\_\_\_

END OF SECTION 030000

## SECTION 034000.02 - PRECAST CONCRETE MANHOLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Under this section, the Contractor shall furnish and construct precast concrete manholes, including drops and manhole stacks of types and at locations shown on the Drawings and/or scheduled.
- B. This section includes additional excavation to widen and deepen sewer trenches for manhole construction, furnishing and installing concrete of classes called for, brick, Portland cement mortar, reinforcing steel, precast concrete pipe, integral base sections, bottom riser sections, transition sections, riser sections, eccentric cones, flat slab tops and adjusting rings, flexible manhole connections, pipe for drop connections, plugging lifting holes, pointing joints, forming channels through manhole bottoms, making watertight connections to new and existing sewers, and other work incidental to manhole construction.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 DEFINITIONS

- A. The various types of manholes are as shown on the Drawings or in the Standard Details.

#### 1.5 SUBMITTALS

- A. Manufacturer's Shop Drawings and Certificates
  - 1. Precast Concrete Manhole Sections and Specials
  - 2. Flexible Joints
- B. Supplier's Certificates
  - 1. Reinforced Concrete Pipe Manhole Sections.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

#### A. Precast Concrete Pipe Manhole Sections

1. Precast concrete pipe manhole sections, transition sections, eccentric cones, flat slab tops, and adjusting rings shall conform to ASTM Specification C 478. Reinforcing in transition sections shall be equal to that specified for wall sections of the larger diameter.
2. Joints shall be O-ring type conforming to ASTM Specification C 443.
3. The standard length of riser sections shall be 48 in. Lengths of 32 in. or 16 in. shall be used to meet required dimensions and as specified.
4. Openings for connecting pipes in riser sections, bottom riser sections, and integral base sections, and for access in flat slabs shall be preformed or cored by the manufacturer. Cut-out openings shall be made immediately after the pipe is removed from the casting form. All cored openings for sewer pipe connections shall have flexible joints.
5. Specified manhole steps shall be factory installed to provide a continuous ladder of 16 in. c/c rung spacing. Steps shall be placed in the forms and cast in pipe wall or placed immediately after the pipe is removed from casting and carefully mortared in place with nonshrink mortar to insure a watertight joint. If the outer surface of the pipe wall is pierced, the patch shall be completely covered with a bituminous sealer.
6. Where pressure tight manhole frames and covers are called for, threaded inserts shall be cast in eccentric cones or flat slab tops and holes formed or cored in adjusting rings to match bolt size and spacing specified for manhole casting.

#### B. Manhole frames, covers, and steps utilized shall comply with their respective specification.

#### C. Mortar

1. Mortar used for the structures herein specified shall conform to Specifications for Mortar for Unit Masonry, ASTM Designation C 270 Type S, containing no masonry cement. The mortar shall be composed of one part Portland cement to two parts sand by volume.
2. Materials for nonshrinking grout shall conform to CRD-C "Corps of Engineers Specifications for Non- Shrink Grout". Approved products are "Sauereisen F-100 Grout" by Sauereisen Cements Co.; "Five Star Grout" by U.S. Grout Corporation; "Masterflow 713" by Master Builders; "Euco N-S" by Euclid Chemical Company.

#### D. All cast-in-place concrete used for forming channels in manhole bottoms shall be Class B as specified in the Section 030000.

#### E. Reinforcing steel used in cast-in-place concrete shall meet the requirements of Section 030000.

- F. Flexible joints for precast manhole pipe openings herein specified shall conform to ASTM designation C 923, "A-Lok" Type as manufactured by A-Lok Products; or an approved equivalent.
- G. The pipe and size for manhole drops shall conform to the Standard Details and its respective specification contained herein.
- H. Brick used for catch basin and manhole construction shall conform to Specifications for Sewer and Manhole Brick (made from clay or shale), ASTM Designation C 32, and shall be Grade "MS" unless otherwise specified.

## PART 3 - EXECUTION

### 3.1 LOCATION AND CONSTRUCTION

- A. Location and type of manhole installed shall be as shown on the Drawings or directed.
- B. Construction shall be in conformance with details shown on the Drawings and as specified under this section.

### 3.2 EXCAVATION

- A. Excavation for manhole construction shall be prepared as directed in the applicable paragraphs of Section 310000 – Earthwork.

### 3.3 INSTALLATION OF INTEGRAL BASE SECTIONS

- A. Class B concrete shall be poured so as to provide a minimum of 4-in. thick pad under the entire area of the manhole base. Place the manhole on the pad before the concrete is completely set so that final leveling adjustment can be made.
- B. 6" Granular backfill bedding can be used in lieu of Class B concrete.

### 3.4 CHANNELING MANHOLE BOTTOMS

- A. The bottoms of all manholes shall be channeled to conduct flow in the planned direction. Channels shall be the true shape of the lower half of the sewer pipe and shall match inverts of connecting pipe at the manhole wall.
- B. In integral base sections (only) channels may be constructed using brick and Portland cement mortar. Mortar shall be 3/4-in. thick minimum between bricks and between bricks and concrete and 1-in. thick minimum on all exposed surfaces.

### 3.5 PRECAST CONCRETE RISER SECTIONS

- A. The shortest length of riser section to be incorporated into the manhole shall be installed immediately below the flat slab top.
- B. Pipe section joints shall be pointed and lifting holes filled with nonshrinking mortar.

### 3.6 SPECIAL PROVISIONS

- A. The intent of this section is to identify requirements only associated with improvements, or rehabilitation of existing sewerage manholes.
- B. The installation of bottom riser sections shall be as follows:
  - 1. The base shall be of Class A concrete as specified in Section 030000 9 in. thick minimum placed on undisturbed earth.
  - 2. The cut-out riser section shall be blocked in place above the pipe and the concrete base poured in place. Concrete shall be extended above the lower rim of the riser wall as required to provide a watertight seal around the entire circumference of the riser section.
  - 3. On straight runs the Contractor may carry the sewer pipe through the manhole and break out the top half after the fill concrete has set. In all cases the sewer pipe shall extend through the manhole wall to the inside face.
- C. All manholes for sanitary sewers shall have an application of Thoro-Seal or other approved coating (any color but gray).

END OF SECTION 034000.02

## SECTION 099700 - SPECIAL COATINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

#### 1.2 SUMMARY

- B. Work covered by this Section includes the furnishing and application of paints, stains, primers, varnishes and other finish, decorative and protective coatings.
- C. Shop priming and factory pre-finishing are required on some, but not necessarily all, of the items described in other sections.
- D. Extent of work:
  - 1. All new process equipment and process piping.
  - 2. All building and room surfaces as indicated on the plans or as scheduled.
  - 3. All conduits, ducts, drains, etc. of other trades unless such product is deemed having an acceptable factory pre-finish, under the following conditions:
    - a. When exposed items are related to room surfaces scheduled to painting.
    - b. When specifically called out as requiring special coating protection.

#### 1.3 DEFINITIONS

- A. Special coating systems are defined as those types of materials and methods of application requiring more than normal skills and techniques for mixing, handling and application, as specified in the "Painting" section.
  - 1. The term "special coating systems" as used in this section includes applied materials used in prime, intermediate and finish coats.
  - 2. The word "paint", as applied in this and or other Sections shall apply to all special coatings required herein for the protection of materials from corrosive environment, weathering processes, or for aesthetic or other reasons.
  - 3. The term "exposed surfaces" is defined to include areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place in areas to be coated. Extend special coatings in these areas as required to maintain the coating system integrity and provide desired protection.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information including basic materials analysis and application instructions for each coating material specified.
1. List each material and cross-reference to the specific coating and finish system and application. Identify each material by the manufacturer's catalog number and general classification.
  2. In the event that the submittal requests a substitution then the following ASTM test results from an independent testing laboratory for the referenced products shall be included: Performance Criteria:
  3. ASTM B 117 Salt Fog
  4. ASTM D 3359 (Method A and B) Adhesion Test
  5. ASTM G8, Method A Cathodic Disbondment
  6. ASTM D 4541 (Elcometer)
  7. ASTM D 4060 Taber Abrasion
  8. ASTM D 522 (Conical Mandrel)
  9. ASTM D 3363 Pencil Hardness
  10. ASTM D 2794 Impact
  11. ASTM G 53 QUV Exposure
  12. ASTM D 2240 Durometer, Shore D
  13. ASTM D 870 Immersion (Potable Water)
  14. ASTM E 96 Moisture Vapor Transmission
  15. ASTM D 2370 Tensile Strength and Elongation
  16. ASTM D 638 Tear Strength
- B. Manufacturer's representative color and texture sample cards shall be submitted to the Engineer at least 30 days prior to paint application. Contractor shall coordinate work so as to allow sufficient time for paint to be delivered to the job site.

#### 1.5 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and other undercoat material produced by the same manufacturer as the finish coats. Use only thinners recommended by the manufacturer, and only within recommended limits.
- B. Coordination of Work: Review other sections of these specifications in which other coatings are to be provided to ensure compatibility of the total coatings systems for various substrates.

1. Upon request, furnish information on the characteristics of pre-primed materials, to ensure that provisions for specified finish coats can be appropriately applied.
2. Notify the Engineer of any anticipated problems involved in using the coatings systems as specified.

C. Job Mock-up:

1. Minimum 50 sq.ft. application of each specified coating system on each type of substrate. At Engineer's discretion.
2. Mock-ups will serve as standard for acceptance of work.
3. Leave approved mock-ups in place as part of completed project.
4. Manufacturer's representative shall be available to advise applicator on proper application techniques and procedures.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Name or title of material.
2. Federal Specification number, if applicable.
3. Manufacturer's stock number and date of manufacture.
4. Manufacturer's name.
5. Contents by volume, for major pigment and vehicle constituents.
6. Thinning instructions.
7. Application instructions.
8. Color name and number.
9. Handling instructions and precautions.

B. Store materials not in actual use in tightly covered containers at a minimum ambient temperature of 45 deg. F (7 deg. C) in a well ventilated area. Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.

1. Protect from freezing where necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all necessary precautionary measures to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of stains.

C. No material shall be applied unless the containers are opened in the presence of the Owner's Representative.



## 1.7 PROJECT CONDITIONS

- A. Apply coatings only when the temperature of surfaces to be coated and surrounding air temperatures are above 45 deg. F (7 deg. C), unless otherwise permitted by manufacturer's printed instructions.
- B. Do not apply coatings in snow, rain, fog or mist, or when the relative humidity exceeds 85%, or to damp or wet surfaces unless otherwise permitted by manufacturer's printed instructions. Allow wet surfaces to dry thoroughly and attain the temperature and conditions specified before proceeding with or continuing with the coating operation.
  - 1. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and the temperature within the area can be maintained within limits specified by the manufacturer during application and drying periods.
- C. Report to responsible person such as safety personnel, General Trades Superintendent, etc., any condition which may pose a threat to the health and welfare of employees.
- D. Keep working area clean and safe.
- E. Obey all job site rules and regulations.
- F. Surfaces not to be painted; unless specifically stated otherwise:
  - 1. Face brick
  - 2. Pre-finished wall panels, partitions and ceiling tile
  - 3. Items with acceptable factory-applied final finish
  - 4. Concealed ducts, pipes and conduit.
  - 5. Glass, Aluminum, Copper, Bronze, Stainless Steel

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
  - 1. Tnemec Company, Inc., North Kansas City, Missouri
  - 2. Carboline Company, St. Louis, Missouri
  - 3. Sherwin Williams Company, Cleveland, Ohio
- B. Material Quality: Provide the best quality grade of the various types of coatings as regularly manufactured by acceptable coating manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.

- C. Proprietary names to designate colors or materials are not intended to imply that products of named manufacturers are required to the exclusion of equivalent products of other manufacturers.
- D. Request for substitution shall include manufacturer's literature for each product giving the name, product number, generic type, descriptive information, solids by volume, recommended dry film thickness and certified test reports showing results to equal the performance criteria of the products listed herein.

## 2.2 COATING SYSTEMS

### A. Ferrous Metal:

#### 1. Submerged, Non-Potable

Surface Preparation: SSPC-SP10 Near White Blast

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 3.0-5.0 mils dry

Carboline Carboguard 890 @ 3.0 - 5.0 DFT

Sherwin Williams Dura-Plate 235 at 3.0-5.0 mils DFT

Second Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 6.0-8.0 mils dry

Carboline Carboguard 890 @ 4.0 - 6.0 DFT

Sherwin Williams Dura-Plate 235 at 5.0-8.0 mils DFT

NOTE: If shop primed, field surface preparation for weld seams and abraded areas is SSPC-SP-10 and spot prime with Series 161 @ 3-5 mils dry or Carboline Carboguard 890 @ 3.0 - 5.0 DFT or Sherwin Williams Dura-Plate 235 @3.0-5.0 mils DFT.

#### 2. Submerged, Potable

Surface Preparation: SSPC-SP10 Near White Blast

First Coat: Tnemec Series N140-1255 Pota-Pox Plus @ 4.0-6.0 mils dry

Carboline Carboguard 891 @ 4.0 - 6.0 DFT

Sherwin Williams Macropoxy 646 PW at 4.0-6.0 mils DFT

Second Coat: Tnemec Series N140-15BL Pota-Pox Plus @ 6.0-8.0 mils dry

Carboline Carboguard 891 @ 6.0 - 10.0 DFT

Sherwin Williams Macropoxy 646 PW at 6.0-8.0 mils DFT

NOTE: If shop primed, field surface preparation for weld seams and abraded areas is SSPC-SP-10 and spot prime with Series N140 @ 3-5 mils dry or Sherwin Williams Macropoxy 646 PW at 3.0-5.0 mils DFT.

#### 3. Non-Submerged, Interior Exposure

Surface Preparation: SSPC-SP6 Commercial Blast

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 3.0-5.0 mils dry

Carboline Carboguard 60 @ 3.0 - 5.0 DFT

Sherwin Williams Macropoxy 646 at 3.0-5.0 mils DFT

Second Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 4.0-6.0 mils dry  
Carboline Carboguard 60 @ 4.0 - 6.0 DFT  
Sherwin Williams Macropoxy 646 at 4.0-6.0 mils DFT

NOTE: If shop primed, field surface preparation for weld seams and abraded areas is SSPC-SP-10 and spot prime with Series N69 @ 3-5 mils dry or Carboline Carboguard 60 @ 3.0 - 5.0 DFT or Sherwin Williams Macropoxy 646 at 3.0-5.0 mils DFT.

4. Non-Submerged, Exterior Exposure

Surface Preparation: SSPC-SP6 Commercial Blast

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 3.0-5.0 mils dry

Carboline Carboguard 60 @ 3.0 - 5.0 DFT

Sherwin Williams Macropoxy 646 at 3.0-5.0 mils DFT

Second Coat: Tnemec Series 1075 Endura-Shield II @ 2.0-4.0 mils dry

Carboline Carbothane 133 LH @ 3.0 - 5.0 DFT

Sherwin Williams Acrolon 218 HS or Hi-Solids

Polyurethane at 3.0-5.0 mils DFT

NOTE: If shop primed, field surface preparation for weld seams and abraded areas is SSPC-SP-6 and spot prime with Series N69 @ 3-5 mils dry or Carboline Carboguard 60 @ 3.0 - 5.0 DFT or Sherwin Williams Macropoxy 646 at 3.0-5.0 mils DFT.

5. Galvanized Steel (including Bar Joist and Galvanized Steel)

Surface Preparation: SSPC-SPI Solvent Clean on galvanized surfaces.

SSPC-SP7 Brush-Off blast to lightly profile surface.

First Coat: N69 Hi-Build Epoxoline II @ 2.0-4.0 mils dry

Carboline Carboguard 888 @ 3.0 - 4.0 DFT

Sherwin Williams Macropoxy 646 at 3.0-4.0 mils DFT

B. Non-Ferrous Metals:

1. Interior Exposure

Surface Preparation: SSPC-SP1 Solvent Clean and Scarify per SSPC-SP 3

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 2.0-3.0 mils dry

Carboline Carboguard 60 @ 3.0 - 5.0 DFT

Sherwin Williams Macropoxy 646 at 3.0-5.0 mils DFT

Second Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 3.0-5.0 mils dry

Carboline Carboguard 60 @ 3.0 - 5.0 DFT

Sherwin Williams Macropoxy 646 at 3.0-5.0 mils DFT

2. Exterior Exposure

Surface Preparation: SSPC-SP1 Solvent Clean and Scarify per SSPC-SP 3

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 2.0-3.0 mils dry

Carboline Carboguard 60 @ 3.0 - 5.0 DFT

Sherwin Williams Macropoxy 646 at 3.0-5.0 mils DFT

Second Coat: Tnemec Series 1075 Endura-Shield @ 2.0-4.0 mils dry  
Carboline Carbothane 133 LH @ 3.0 - 5.0 DFT  
Sherwin Williams Acrolon 218 HS or Hi-Solids  
Polyurethane at 3.0-5.0 mils DFT

C. Concrete

1. Submerged, Non-Potable

Surface Preparation: SSPC-SP 13/NACE#6 "Surface Preparation of Concrete"

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 150 sq.ft. per gal.

Carboline Carboguard 890 @ 150 sq. Ft. per gal  
Sherwin Williams Dura-Plate 235 at 150 sqft per gal

Second Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 150 sq.ft. per gal.

Carboline Carboguard 890 @ 150 sq. Ft. per gal  
Sherwin Williams Dura-Plate 235 at 150 sqft per gal

2. Waterproofing - See Specification Section 071116

3. Non-submerged, poured in place or precast, Interior Exposure

Surface Preparation: Clean and dry

First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 150 sq. ft./gal.

Carboline Carboguard 60 @ 150 sq. Ft. per gal  
Sherwin Williams Macropoxy 646 at 150 sqft per gal

Second Coat: Series N69 Hi-Build Epoxoline II @ 150 sq. ft./gal.

Carboline Carboguard 60 @ 150 sq. Ft. per gal  
Sherwin Williams Macropoxy 646 at 150 sqft per gal

4. Non-submerged, poured in place or precast, Exterior Exposure

Surface Preparation: Clean and dry

First Coat: Tnemec Series 156 Envirocrete @ 150 sq.ft. per gal.

Carboline Flexxide Elastomer @ 150 sq. Ft. per gal  
Sherwin Williams Loxon XP at 6.0-8.0 mils dft

Second Coat: Tnemec Series 156 Envirocrete @ 150 sq.ft. per gal.

Carboline Flexxide Elastomer @ 150 sq. Ft. per gal  
Sherwin Williams Loxon XP at 6.0-8.0 mils DFT

5. Concrete block walls, Interior Exposure

Surface Preparation: Clean and dry

First Coat: Tnemec Series 130-6601 Envirofill @ 75 sq.ft. per gal

Carboline Sanitile 600 @ 75 sq. Ft. per gal.  
Sherwin Williams Cement Plex 875

NOTE: Material should be rolled, or sprayed and back rolled, then squeegeed to provide a smoother surface.

Second Coat: Tnemec Series N69 Hi-Build Epoxoline II @150 sq. ft./gal.

Carboline Carboguard 60 @ 150 Sq. Ft. per gal.  
Sherwin Williams Macropoxy 646 at 150 sqft per gal

- Third Coat: Tnemec Series N69 Hi-Build Epoxoline II @150 sq. ft/gal.  
Carboline Carboguard 60 @ 150 Sq. Ft. per gal.  
Sherwin Williams Macropoxy 646 at 150 sqft per gal
6. Concrete block walls, Exterior Exposure  
Surface Preparation: Clean and dry  
First Coat: Tnemec Series 156 Envirocrete @ 100 sq.ft. per gal.  
Carboline Flexxide Elastomer @ 100 sq. Ft. per gal.  
Sherwin Williams Loxon XP at 6.0-8.0 mils DFT  
Second Coat: Tnemec Series 156 Envirocrete @ 100 sq.ft. per gal.  
Carboline Flexxide Elastomer @ 100 sq. Ft. per gal.  
Sherwin Williams Loxon XP at 6.0-8.0 mils DFT
7. Floors, General  
Surface Preparation: SSPC-SP 13/NACE#6 "Surface Preparation of Concrete"  
First Coat: Tnemec Series 201 Epoxoprime @ 250 sq.ft. per gal.  
Carboline Carbotguard 1340 @ 3.0 - 4.0 DFT  
Sherwin Williams GP 3579 at 6.0-8.0 mils DFT  
Second Coat: Tnemec Series 280 Tneme-Glaze @ 150 sq.ft. per gal. If non-skid is desired then randomly broadcast with 30/50 mesh silica sand into wet epoxy intermediate  
Carboline Santile 944HB @ 6.0 - 8.0 DFT  
Sherwin Williams GP 3745 at 6.0-8.0 mils DFT  
Third Coat: Tnemec Series 291 CRU @ 250 sq. ft per gal.  
Carboline Sanitile 934 @ 2.0 - 3.0 DFT  
Sherwin Williams GP 4638 at 3.0-4.5 mils DFT
8. Floors, Chemical Rooms  
Surface Preparation: Mechanically abrade entire surface to completely remove existing coating and provide an anchor profile in the exposed concrete equal to ICRI CSP 3 or greater. Prepared substrate must be clean, dry, and free of contaminants.  
First Coat: Tnemec Series 282 Tneme-Glaze applied at 8.0 to 12.0 mils DFT  
Sherwin Williams General Polymers 3579 epoxy primer at 10 mils  
Carboline Semstone 110 primer applied at 8-10 mils  
Second Coat: Tnemec Series 282 Tneme-Glaze applied at 6.0 to 8.0 mils, DFT, 2 coats and broadcast with Series 211-0212 Glass Beads to achieve desired slip resistance in the final application  
Sherwin Williams General Polymers 3741 Novoflo epoxy at 17 mils per coat, 2 coats  
Carboline Semstone 140 applied at 17 mils, 2 coats
9. Foundations  
Surface Preparation: Clean and dry  
First Coat: Tnemec Series 46H-413 80 sq.ft. per gal.  
Carboline Bitumastic 300 M @ 80 sq. Ft. per gal.  
Sherwin Williams Hi-Mil Sher-Tar at 80- sqft per gal

D. Plaster and Gypsum Wallboard

Surface Preparation: Clean and dry  
First Coat: Tnemec Series 51-792 PVA Sealer @ 275 sq.ft. per gal.  
Carboline Carbocrylic 120 @ 1.0 - 2.0 DFT  
Sherwin Williams Pro Mar 200 Laztex Primer at 1.0-2.0  
mils DFT  
Second Coat: Tnemec Series 113 Tneme-Tufcoat @ 200 sq.ft. per gal.  
Carboline Sanitile 255 @ 200 sq. ft. per gal  
Sherwin Williams Pro Industrial Hi-Bild Waterbased  
Catalyzed Epoxy at 4.0-6.0 mils DFT  
Third Coat Tnemec Series 113 Tneme-Tufcoat @ 200 sq.ft. per gal.  
Carboline Sanitile 255 @ 200 sq. ft. per gal  
Sherwin Williams Pro Industrial Hi-Bild Waterbased  
Catalyzed Epoxy at 4.0-6.0 mils DFT

E. Wood

Surface Preparation: Clean and dry  
First Coat: Tnemec Series 36-603 Undercoater @ 300 sq.ft. per gal.  
Carboline Carbocrylic 120 @ 1.0 - 2.0 DFT  
Sherwin Williams Multi Purpose Primer at 1.0-2.0 mils  
DFT  
Second Coat: Tnemec Series 23 Enduratone @ 400 sq.ft. per gal.  
Carboline Carbocoat 8215 @ 400 sq. ft. per gal.  
Sherwin Williams Pro Mar 200 Alkyd at 400 sqft per gal  
Third Coat Tnemec Series 23 Enduratone @ 400 sq.ft. per gal.  
Carboline Carbocoat 8215 @ 400 sq. ft. per gal.  
Sherwin Williams Pro Mar 200 Alkyd at 400 sqft per gal

F. PVC Pipe

Surface Preparation: Lightly sand  
First Coat: Tnemec Series N69 Hi-Build Epoxoline II @ 200 sq.ft. per  
gal.  
Carboline Carboguard 60 @ 200 sq. ft. per gal.  
Sherwin Williams Macropoxy 646 at 200 sqft per gal

G. Insulated Pipe

Surface Preparation: Clean and dry  
First Coat: Tnemec Series 1029 Enduratone @ 300 sq.ft. per gal.  
Carboline Carbocrylic 3359 @ 300 sq. ft. per gal.  
Sherwin Williams DTM Acrylic at 2.5-4.0 mils DFT  
Second Coat: Tnemec Series 1029 Enduratone @ 300 sq.ft. per gal.  
Carboline Carbocrylic 3359 @ 300 sq. ft. per gal.  
Sherwin Williams DTM Acrylic at 2.5-4.0 mils DFT

#### H. Insulated Pipe

Surface Preparation: Clean and dry  
First Coat: Tnemec Series 27 F.C. Typoxy @ 400 sq.ft. per gal.  
Carboline Santile 120 @ 400 sq. ft. per gal  
Sherwin Williams Pro Industrial Pro Cryl Primer @ 400 sq.  
ft. per gal  
Second Coat: Tnemec Series 113 Tneme-Tufcoat @ 325 sq.ft. per gal.  
Carboline Carboguard 60 @ 325 sq. ft. per gal  
Sherwin Williams Pro Industrial Hi-Bild Waterbased  
Catalyzed Epoxy at 4.0-6.0 mils DFT

### 2.3 COLOR CODING AND PROCESS SYSTEM IDENTIFICATION

A. Color coding for processing piping, equipment and appurtenances is a suggested system unless otherwise specified or requested by Owner. Final coding to be determined in the field:

1. Equipment - light gray with O.S.H.A. orange coupling guards and O.S.H.A. yellow belt guards.
2. Pipe Supports - hangers to be same color as piping applied, floor post to be same as adjacent wall color, and fabricated racks to be manufacturer's standard protective finish or paint same as adjacent wall color if not having a suitable protective finish.
3. General process piping - exposed interior or exterior:
  - a. Submerged Pipe or Supports - Black
  - b. Intermittently Submerged Metals - Black (unless piping as defined otherwise)
  - c. Natural Gas - OSHA Red\*
  - d. Process/L.P. Gas - OSHA Orange
  - e. Potable (City) water - OSHA Blue\*
  - f. Well or Non-Potable Water — Aqua
  - g. Seal water, wash water — white plant effluent
  - h. Raw wastewater - Medium Grey\*
  - i. Equipment drains - Black
  - j. Sanitary drains - Black with tags
  - k. Chemical feed - Aqua
  - l. Vents Ivory
  - m. Compressed air - Green
  - n. Chlorine - OSHA Yellow w/Red Stripes\*
  - o. Raw Sewage - Light Gray
  - p. Grit Light Gray w/Yellow Stripes
  - q. Primary Sludge - Dark Brown
  - r. Return Sludge - Black w/Brown Stripes
  - s. Waste Sludge or Liquor - Dark Green\*
  - t. Supernatant - OSHA Green
  - u. Fuel Oil - Dark Gray
  - v. Sample Lines - Light Blue
  - w. Fire Protection System - OSHA Red Sprinkler Piping
  - x. Hoist and Trolleys - OSHA Yellow

\* These colors are recommended as standard by WEF.

4. Water Works Chemical Lines (Recommended 10-States Standards):
  - a. Alum or Primary Coagulant - Orange
  - b. Ammonia - White
  - c. Carbon Slurry - Black
  - d. Caustic - Yellow with Green Band
  - e. Chlorine (Gas and Solution) - Yellow
  - f. Chlorine Dioxide - Yellow with Violet Band
  - g. Fluoride Light Blue with Red Band
  - h. Lime Slurry - Light Green
  - i. Ozone - Yellow with Orange Band
  - j. Phosphate Compounds - Light Green with Red Band
  - k. Polymers or Coagulant Aids - Orange with Green Band
  - l. Potassium Permanganate - Violet
  - m. Soda Ash - Light Green with Orange Band
  - n. Sulfuric Acid - Yellow with Red Band
  - o. Sulfur Dioxide - Light Green with Yellow Band
5. Miscellaneous, non-process related items such as electrical conduit, duct work, roof drains, etc. are to be properly prepped and finished to match adjacent wall or ceiling color in rooms scheduled for finish wall and/or ceiling paint.
6. In situations where two colors do not have sufficient contrast to easily differentiate between them, a six (6) inch band of contrasting color shall be on one of the pipes at approximately thirty (30) inch intervals.

B. Signs and Labels

1. There shall be stenciled on each pipeline in each room a minimum of two legends describing the function of the pipeline, such as "natural gas", on each side of the pipe. It is intended that all pipelines shall bear legend at the most visible point and meet ANSI A13.1 Scheme for the identification of piping system for size, type and vantage point of legends.
2. Signs shall be furnished and securely fastened to each pipeline showing its destination such as "Aeration Tank No. 1".
3. Where the flow of a pipeline is in one direction only, then a flow arrow shall be stenciled in front of each legend on the pipe.
4. For pipes smaller than 1 in. in outside diameter, a white plastic tag with black lettering shall be used.
5. The legends and flow arrows shall be stenciled with approved stencil paint. Following the completion of other work under this Item, all stencils used shall remain the property of the Owner.



6. Each hydrant, hose bib, sillcock, and yard hydrant connected to plant water shall be stenciled with the words "Unsafe Water - Do Not Drink". The size of the stenciled letters shall be 1 inch. Stencil on the hydrants is to be on the nozzle section. The hose bibs shall have a 15" x 5" x 1/2" thick plaque made of marine plywood, where the stenciled letters are to be applied. The Plaque shall be fastened to the structure directly above the hose bib connection, (Plaques to have white letters with aqua background).
7. Preprinted plastic-coated adhesive labels may be used in lieu of stencils, on interior piping only.
8. All rooms in which equipment is operated automatically shall have signs mounted on the walls which are visible at entrances. The Contractor shall furnish twenty 14 in. x 20 in. black or yellow porcelain signs meeting OSHA requirements. Signs shall include mounting accessories. Each sign shall read:

**Warning: The equipment in this room operates automatically and may start or stop at any time.**

### PART 3 - EXECUTION

#### 3.1 PRE-WORK INSPECTION

- A. Examine surfaces to be coated and report conditions that would adversely affect appearance or performance of coating systems and which cannot be put into an acceptable condition by preparatory work specified in Paragraph 3.2.
- B. Do not proceed with surface preparation and application until surface is acceptable or authorization to proceed is given by the Owner's representative.

#### 3.2 SURFACE PREPARATION

- A. General:
  1. Dislodge dirt, rust, plaster nibs, mortar spatter and other dry material by scraping or brushing. Remove dust and loose material by brushing, sweeping, vacuuming or blowing with high-pressure air.
  2. Remove oil, wax and grease by scraping off heavy deposits and cleaning with mineral spirits or a hot trisodium phosphate solution followed by a water rinse.
  3. Verify that surfaces to be coated are dry, clean and free of dust, dirt, oil, wax grease or other contaminants.
- B. Non-Submerged Concrete, Masonry and Cement Stucco:
  1. Allow new concrete and masonry to cure 28 days.
  2. Scrape and grind fins and protrusions flush with surface.

3. Patch holes and cracks flush with surface.
  4. Rake mortar joints clean.
- C. Plaster:
1. Allow to cure for 28 days.
  2. Remove nibs and other protrusions by scraping flush with surface.
  3. Patch voids and cracks with spackling compound to match texture or surface.
- D. Gypsum Board:
1. Sand joint compound smooth and flush with surface using fine grit sand paper.
  2. Fill nicks, scratches, holes and uneven spots with spackling compound and after dry, sand flush with surface.
- E. E. Non-Ferrous Metal:
1. SSPC-SPI solvent cleaning to remove all contaminants.
- F. Ferrous Metal:
1. Enclosed: Remove loose rust, mill scale and other foreign matter by hand (SSPC-SP2) or power tool (SSPC-SP3) cleaning and apply specified coating before rusting occurs.
  2. Non-Submerged, Architecturally Exposed: Society of Protective Coatings, SSPC-SP6 Commercial Blast.
  3. Submerged Steel: Society of Protective Coatings, SSPC-SP10 Near White Blast.
- G. Galvanized Metal:
1. Remove contaminants and protective mill coating by SSPC-SP1 Solvent Cleaning or steam cleaning. All surfaces shall be prepared by light brush blasting to achieve a minimum 1.0 mil abrasive blast profile
- H. Wood:
1. Remove surface deposits of sap and pitch by scraping and cleaning with mineral spirits.
  2. Seal knots and pitch pockets with a product manufactured for this specific purpose.
  3. Sand rough spots of smooth siding and finish woodwork.
  4. After prime coat is dry, fill cracks, holes and scratches with suitable wood filler or spackling compound and when dry, sand flush with surface.
  5. Sand lightly between coats.

I. Concrete Floors:

1. Prepare concrete floors in accordance with SSPC-SP 13/NACE #6 "Surface Preparation of Concrete".

J. Submerged Concrete:

1. Prepare in accordance with SSPC-SP 13/NACE #6 "Surface Preparation of Concrete" to remove laitance and expose all cavities and honeycombs. If immersion service condition will have an exposure outside of neutral pH (6-9) then all cavities shall be filled using Tnemec Series 218 Mortarclad or Sherwin Williams Corobond 300. Product is trowel applied to all vertical walls with exposed cavities.

### 3.3 APPLICATION

A. General: Apply special coatings by brush, roller, spray, squeegee, or other applicators in accordance with the manufacturer's directions. brushes best suited for the type of material being applied. Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

1. Coating colors, surfaces treatments and finishes are indicated in the "Schedules" of the contract documents.
2. Provide finish coats that are compatible with the primers used.
3. The number of coats and coating film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the coating manufacturer. Sand between coating applications where sanding is required to produce an even smooth surface in accordance with the coating manufacturer's directions.
4. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces.
5. Coat the back sides of access panels, removable or hinged covers, and similar hinged items, to match exposed surfaces.

B. Minimum Coating Thickness: Apply each material at not thinner than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire coating system as recommended by the manufacturer.

C. Prime Coats: Before the application of finish coats, apply a prime coat, as recommended by the coating manufacturer, to material that is required to be painted or finished, and which has not been prime coated by others.

1. Recoat primed and sealed substrates where there is evidence of suction spots or unsealed areas in the first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.

- D. Brush Application: Brush-out and work brush coats into surfaces in an even film. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.
  - 1. Apply primers and first coats by brush unless the manufacturer's instructions permit use of mechanical applicators.
- E. Mechanical Applications: Use mechanical methods for coating application when permitted by the coating manufacturer's recommendations, governing ordinances, and trade union regulations.
  - 1. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double-back with spray equipment building-up film thickness of 2 coats in one pass, unless recommended by the coating manufacturer.
- F. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or recoat work not in compliance with specified requirements.
- G. Spray application will not be permitted for the Primary Clarifier Painting bid item.

### 3.4 INSPECTION

- A. Request acceptance of each coat before applying succeeding coats.
- B. The Contractor shall furnish the Engineer a suitable thickness detector of a type recommended by the paint manufacturer.
- C. Any field painting found to be defective shall be removed and the surfaces repainted as the Engineer may direct at no additional cost to the Owner.
- D. Before final approval of the work, all damaged surfaces of paint (field or factory applied) shall be cleaned and repainted or touched up as directed.

### 3.5 FIELD QUALITY CONTROL

- A. The Owner reserves the right to invoke the following material testing procedure at any time, and at any number of times during the period when coating operations are being conducted.
  - 1. The Owner will engage the services of an independent testing laboratory to sample the coating being used. Samples of material delivered to project site will be taken, identified and sealed, and certified in the presence of the Contractor.
  - 2. The testing laboratory will perform appropriate tests for any or all of the following characteristics as required by the Owner:
    - a. Quantitative materials analysis.
    - b. Absorption.
    - c. Accelerated weathering.

### 3.6 CLEANING

- A. Clean-Up: At the end of each work day during progress of work, remove rubbish, empty cans, rags and other discarded materials from the site.
  - 1. Upon completion of the work, clean window glass and other spattered surfaces. Remove spattered coatings by washing, scraping or other proper methods, using care not to scratch or otherwise damage adjacent finished surfaces.

### 3.7 PROTECTION

- A. Protect work of other trades, whether to be coated or not, against damage from coating operations. Correct damage by cleaning, repairing or replacing, and recoating as acceptable to the Engineer. Leave the work in an undamaged condition.
- B. Provide "Wet Paint" signs as required to protect newly-coated finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of coating operations.
  - 1. At completion of the work of other trades, touch-up and restore damaged or defaced coated surfaces.

### 3.8 SCHEDULE

- A. Piping, Equipment and Concrete Tank Surfaces:

| <u>Item</u>         | <u>Coating System</u> |
|---------------------|-----------------------|
| Fluoride Room Floor | 2.2.C.8.              |

- B. For new equipment, refer to individual specifications for extent of factory priming and/or painting.

END OF SECTION 099700

## SECTION 260500 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES:

- A. General
- B. Intent Of Drawings
- C. Interpretation Of Drawings
- D. Quality Control
- E. Submittals
- F. Location Environmental Considerations
- G. Products
- H. Coordination
- I. Demolition
- J. Electrical Installation
- K. Relocate or Make Modifications to Any Existing Electrical, Instrumentation or Control Systems Wiring
- L. Quality Assurance
- M. Examination
- N. Preparation And Storage
- O. Installation
- P. Field Quality Control
- Q. Painting
- R. Cleaning
- S. Operation - Maintenance And Spare Parts Data

#### 1.2 GENERAL

- A. The Electrical Contractor shall be responsible to check with the equipment manufactures of the physical size of the equipment that it will fit and that it can be moved into the indicated locations.
- B. Intent of Drawings – The Drawings are not intended to be used for construction purposes for the electrical work, but to supplement the Specifications as to the principal features of the electrical design. The intent of this section is that all equipment and electrical devices furnished and installed under this and other sections of the Specifications be properly interconnected to permit successful system operation regardless of whether all interconnections are specifically referenced in the Specifications and associated Drawings.
- C. Interpretation of Drawings
  - 1. The locations of equipment to which electrical connections are to be made are approximate as shown on the Drawings. It shall be the Electrical Contractor's responsibility to determine the exact conduit locations by reviewing shop drawings. The sizes of disconnect switches, motor starters, overload heaters, fuses or circuit breakers are approximate, and it shall be the Electrical Contractors responsibility to obtain the correct sizes based on the actual installed equipment or items. The conduit and wire sizes shown on the Drawings are the minimum sizes required and shall not be reduced.

- D. Quality Control
1. The Electrical Contractor shall maintain a level of quality of materials and installation means as to assure the completed electrical, instrumentation and control system will be completed in compliance with the Specifications.
- E. Submittals
1. Shop Drawings - Submit shop drawings under provision of Section 01061 for all electrical equipment and devices.
  2. Shop drawings shall include manufacturer's literature, specifications, schematic diagrams, field wiring interconnection diagrams and any other data necessary to indicate compliance with the Specifications
  3. Final "Record" Contract Drawings - Drawings and information required shall include but not be limited to the following:
    - a. Conduit runs shall be shown and identified at each end of run, include where conduit originates and the termination. Each conduit shall have a pull string attached and fastened at each end.
    - b. Power Distribution Schematics - Show actual installed switching details, cable size and type, conduit size, locations and runs, fuse size and type, circuit breaker frame size, trip setting and type.
    - c. Details and Diagrams
      - i. Elementary Wiring Diagrams – Show actual motor control wiring with wire numbers, telephone system cable routing and station identification with cable numbers.
      - ii. One-Line Diagrams - Show equipment names, fuse sizes and types, heater sizes, conduit and wire sizes, motor FLA and horsepower. Include wire and cable numbers or identification.
      - iii. Instrumentation and Control Diagrams - Show actual installed, wired instrumentation loop diagrams, include actual installed device Tag Nos, Model Nos, Scaling,
    - d. Lighting and Device Schedule
      - i. Show actual manufacturers and model numbers.
      - ii. Lighting panel layouts
      - iii. Actual circuit No. circuit description, breaker size and type.
  4. Payment for the Division 16 work and materials shall not exceed 90% of the total bid price until all Operations and Maintenance data and record as built drawings have been completed and received by the Owner.
- G. Location Environmental Considerations
1. Provide satisfactory operation and maintenance under the following conditions:
  2. Temperature:
    - a. Outside: - 20° to 110° F
    - b. Inside: +40° to 120° F
  3. Relative Humidity: 100 percent
  4. Process Temperature:
    - a. Liquid: 32° to 105° F
    - a. Air: - 32° to 200° F
  5. Atmosphere:
    - a. As indicated on the drawings
    - b. Corrosive atmosphere Hydrogen Sulfide
    - c. Wet Locations

- 1) As defined in NEC ART. 100
    - 2) Outside exposed areas, areas indoors near pumps, frequent washdown areas.
  - d. The interiors of conduits and raceways located in wet areas shall also be classified as wet areas.
  - e. Damp Locations
    - 1) As defined in NEC ART. 100
    - 2) Areas under covered enclosures
  - f. Wet and Corrosive areas
    - 1) Enclosures located in areas that are wet and corrosive shall be rated for NEMA 4X Stainless Steel or as noted on the drawings.
  - g. Hazardous Areas (Classified)
    - 1) Areas that are a hazardous area are indicated on the drawings. All new equipment and installation methods shall conform to the requirements in the NEC.
- H. Products
1. Electrical materials and equipment shall be new and shall be labeled by the Underwriters Laboratories, Inc. whenever standards have been established and the label service applies.
  2. Wire and Terminal Labeling - Tag all wire, cable and conduit at each end or termination with suitable permanent tags, printed, stamped, or engraved with the wire, cable or conduit number. The figures on the tags shall be clear and legible.
  3. Safety Signs - High voltage warning signs shall be provided and placed at all guarded locations as required by the N.E.C. The signs shall be permanent and conspicuous, and shall be plainly visible even when doors are open or panels removed from compartments.
  4. Engraved Nameplates - Identify all electrical enclosures with engraved phenolic nameplates. Engrave and mount nameplates for all switchgear, disconnect switches, and individual motor starter enclosures indicating equipment served. Nameplates shall be **white with black letters**. Minimum letter size shall be one-quarter inch.
- I. Demolition
1. Electrical Contractor shall disconnect power from existing equipment to be removed. General Contractor to remove and dispose of actual equipment.
  2. Electrical contractor shall perform the demolition of electrical equipment where indicated on the electrical contract drawings.
- J. Electrical Installation
1. Electrical Contractor shall furnish and install, adjust, connect, and put into satisfactory operation all electrical equipment, control components and instrumentation items as indicated on the Drawings and specified herein.
- K. Coordination
1. Electrical Contractor shall review all Specifications and Drawings for the electrical work included under these sections and coordinate this work. Investigate existing conditions in the field before submitting proposal. Become acquainted with the conditions under which the work of this section of the Specifications will be performed and accept all conditions as found.



2. Schedule and coordinate all relocations of, or modifications to electrical, instrumentation or control systems wiring, conduit equipment, or appurtenances to whatever extent is necessary and required in order to conform to structural and architectural conditions, duct work and piping interference's, etc., shall be included under this section of the Specifications.
3. Coordinate with other trades on the project so that all trades install their work to avoid interference with each other. Arrangements made among the trades which result in deviations from Drawings and Specifications are subject to the approval of the Owner.
4. The control panels and/or equipment are to be provided by the equipment supplier, General Contractor, and System Integrator. These items will require power and/or interconnections from the disconnect switch to the control panel and/or field mounted devices or junction boxes for power and control. Specific details to be determined by the shop drawings.

### 1.3 REFERENCES

- A. American National Standards Institute (ANSI)
- B. Factory Mutual Engineering Division (FM)
- C. Illumination Engineering Society (IES)
- D. Institute of Electrical & Electronics Engineers (IEEE)
- E. Insulated Cable Engineers Association (ICEA)
- F. Instrumentation, Systems and Automation Society (ISA)
- G. Joint Industrial Council (JIC)
- H. National Electrical Code (NEC)
- I. National Electrical Manufacturers Association (NEMA)
- J. International Electrical Testing Association (NETA)
- K. National Fire Protection Association (NFPA)
- L. Occupational Safety and Health Administration (OSHA)
- M. Ohio Building Code (OBC)
- N. Underwriters' Laboratories Incorporated (UL)
- O. ANSI/NEMA 1-2000 Standard Practices for Good Workmanship in Electrical Contracting.
- P. Quality Assurance
  1. Regulatory requirements
    - a. The Contractor shall obtain and pay for all fees for permits and inspections as required.
  2. Installation Standards
    - a. NEC – installation of electrical items shall be in accordance with the NEC.
    - b. Instrumentation and control – Installation of the instrumentation, control system shall be in accordance with standards of the ISA.

### PART 2 – PRODUCTS (NOT APPLICABLE)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Inspect all devices at delivery for damage.
- B. Confirm all devices at delivery are as required according to design and shop drawings.
- C. Examine the site and structures for any obstructions which may interfere with the electrical installation as planned.

### 3.2 PREPARATION AND STORAGE

- A. Provide a dry heated storage area for all electrical and electronic equipment and devices.
- B. Electrical and electronic equipment devices shall be stored and shall be heated to prevent condensation from forming. Electrical and electronic equipment found with condensation in the enclosure or condensation caused damage will not be accepted.

### 3.3 INSTALLATION

- A. The locations of equipment to which electrical connections are to be made are approximate as indicated on the Drawings.
- B. It shall be the Contractor's responsibility to check shop drawings relating to equipment requiring electrical connections and to determine the exact conduit locations.
- C. Electrical and electronic equipment installed but not energized shall continue to have a heat source to maintain the enclosure free of condensation. Electrical and electronic equipment found with condensation in the enclosure or condensation caused damage will not be accepted.
- D. Contractor shall perform all chasing, channeling, drilling and patching necessary. Repair any damage to the building or any equipment. Replace damaged equipment if, in the Engineer's judgment, the repair would not be satisfactory.
- E. No work shall be covered or hidden from view until it has been inspected and approved by the Owner.
- F. Any workmanship or materials not meeting the requirements of the Specifications or Drawings shall be immediately replaced by the Contractor without cost to the Owner and to the satisfaction of the Owner.
- G. All wiring shall have permanent labels at all terminations and junctions of the wires and on all field wiring terminal strips.
- H. Safety signs shall be furnished and installed on or around all electrical equipment.
- I. Permanent marking labels shall be installed on exposed sides of each piece of electrical equipment, pull boxes, junction boxes and terminal boxes stating the maximum voltage level involved with the associated equipment.
- J. Concrete equipment pads for electrical equipment shall be furnished and placed by the Electrical Contractor.

### 3.4 PAINTING

- A. All wood panel mounting boards shall be painted.
- B. All electrical enclosures shall undergo a phosphatizing prepainting treatment. Final paint coats shall be a polyester powder coating with ANSI 61 light gray color for enclosures mounted inside and with ANSI 24 medium gray color for enclosures mounted outside.
- C. Remove any rust and touch up any scratches on all new electrical devices or enclosures with matching touch-up paint as supplied by the manufacturer.

### 3.5 FIELD QUALITY CONTROL

- A. Major components of the Electrical System shall be tested per NETA standards. NETA's Standard Specification for Testing, Parts 1 to 5, shall govern all testing.
- B. The following tests are per NETA Acceptance Testing Specifications, Part 7, Inspection and Test Procedures. Visual and Mechanical Inspections shall be performed for all equipment.
  - 1. Cables - Low Voltage shall have the following tests: Insulation resistance, continuity.
  - 2. Circuit Breakers - Low Voltage (Molded Case) that are rated at over 100 amps shall have the following tests: Contact resistance, time-current characteristic, instantaneous pickup current, insulation resistance.
  - 3. Grounding Systems shall have the following test: Fall of potential.
  - 4. Surge Arresters shall have the following tests: 60 Hz sparkover, insulation power factor, ground continuity.
- C. After all testing has been completed to the satisfaction of the Owner, the entire Electrical (Power) System shall operate for a minimum test period of 30 days. Cumulative down time of all components furnished under Division 16 shall not exceed 1/2 hour as recorded by the Engineer during the test period. System documentation shall be delivered on the last day of test period. Test period shall not end until system documentation has been delivered. If the cumulative downtime limit is exceeded, the Engineer shall have the following options.
  - 1. Extend the test period as required until the cumulative downtime during the proceeding 30 days does not exceed 1/2 hour as recorded by the Engineer.
  - 2. Sub-systems which have no components contributing to the cumulative downtime will be approved as a partial acceptance.
- D. Sub-systems which have components that contributed to the cumulative downtime shall have their test period begin after all repairs and adjustments have been made.

### 3.6 OPERATION - MAINTENANCE AND SPARE PARTS DATA

- A. Submit specific data and information required under individual Division 16 Sections.
  - 1. Submit operation data as required.
  - 2. Submit maintenance data as required.
  - 3. Spare Parts Data - Submit as required. Include manufacturer's list of recommended spare parts.
  - 4. Parts and supplies judged to be necessary to keep equipment and control system operating successfully for first year of operation shall be furnished.

5. Review individual sections for required lists of spare parts to be furnished.

### 3.7 CLEANING

- A. All areas are to be cleaned of construction debris and wire. Electrical equipment is to be cleaned of all construction dirt, dust, etc.
- B. All electrical and electronic equipment shall be kept clean and free of all dust, dirt, and debris at all times.
- C. All electrical and electronic boxes and enclosures shall have the covers of these boxes and enclosures closed and sealed except when actually working in these boxes and enclosures.

END OF SECTION 260500

## SECTION 260519 – CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Building wire and cable.
- B. Wiring connectors and connections.

#### 1.2 RELATED SECTIONS

- A. Section 260553 - Electrical Identification.

#### 1.3 REFERENCES

- A. Quality Control: Follow requirements for references and standards.
- B. NECA Standard of Installation (National Electrical Contractors Association)
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association)
- D. NFPA 70 - National Electrical Code (NEC)

#### 1.4 SUBMITTALS FOR REVIEW

- A. Submittals: Follow procedures for submittals.
- B. Product Data: Provide for each cable assembly type.

#### 1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Contract Closeout Submittals – Follow as required.
- B. Project Record Documents: Record actual locations of components and circuits.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

#### 1.7 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories Inc., or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

## 1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as indicated.
- B. Conductor sizes are based on copper only.
- C. Wire and cable routing indicated is approximate unless dimensioned.

## 1.9 COORDINATION

- A. Coordinate Work under provisions of Section 260500.
- B. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

## PART 2 - PRODUCTS

### 2.1 BUILDING WIRE

- A. Manufacturers:
  - 1. Okonite Company
  - 2. Alpha Wire Company
  - 3. Southwire
  - 4. Substitutions: Follow as required for Material and Equipment.
- B. Description: Multi-stranded insulated copper wire, #12 AWG minimum for feeders and branch circuits and #14 AWG minimum for control circuits.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: NFPA 70; Type XHHW or THWN insulation for service, feeders and branch circuits and control circuits.

### 2.2 WIRING CONNECTORS

- A. Use split bolt connectors for copper conductor splices and taps, #6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
- B. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, #8 AWG and smaller. Buchanan crimp (Split cap and insulator) or Ideal crimp connector with wrap cap insulator.
- C. Use Adhesive-lined heat shrink tubing for watertight connections; T&B, 3M, or Raychem.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that mechanical work likely to damage wire and cable has been completed.

### 3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

### 3.3 INSTALLATION

- A. Quality Control: Follow as required by manufacturer's instructions.
- B. Route wire and cable as required to meet Project Conditions.
- C. Install cable in accordance with the NECA "Standard of Installation."
- D. Use stranded conductors for control circuits.
- E. Use conductor not smaller than #12 AWG for power and lighting circuits.
- F. Use conductor not smaller than #14 AWG for control circuits.
- G. Use #10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (25 m).
- H. Pull all conductors into raceway at same time.
- I. Use suitable wire pulling lubricant for building wire #4 AWG and larger.
- J. Protect exposed cable from damage.
- K. Use suitable cable fittings and connectors.
- L. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- M. Clean conductor surfaces before installing lugs and connectors.
- N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- O. Use split bolt connectors for copper conductor splices and taps, #6 AWG and larger. Tape un-insulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- P. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, #8 AWG and smaller.
- Q. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, #10 AWG and smaller.
- R. Identify and color code wire and cable under provisions of Section 16075. Identify each conductor with its circuit number or other designation indicated.
- S. Replace conductors damaged during installation.
- T. No splices are allowed in conduits or raceways.

### 3.4 FIELD QUALITY CONTROL

- A. Starting of Systems: Follow requirements for field inspection, testing, and adjusting.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION 260519

## SECTION 260520 – SHIELDED INSTRUMENTATION & VARIABLE FREQUENCY DRIVE CABLE

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Scope: Furnish all labor, materials, equipment and incidentals required to provide shielded cable as shown and specified.

#### 1.2 SUBMITTALS

- A. Shop Drawings:
  - 1. Comply with Section 013323.
- B. Product data:
  - 1. Submit for review, copies of manufacturer's engineering data and technical information for shielded instrumentation cables proposed for use.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Instrumentation Cable
  - 1. Single Shielded Pair or Triad: 300 volts
    - a. Tinned copper, #18 AWG or larger, stranded, polyethylene insulated conductors twisted with aluminum-polyester shield, stranded tinned #20 AWG copper drain wire and overall chrome vinyl jacket, 100 percent shield cover. Rated for 300 volts minimum.
    - b. Products and Manufacturers:
      - 1) Belden No. 8760, No. 8770, No. 9318, or No. 9365
      - 2) Alpha No. 2422, No. 2432.
  - 2. Multi-paired Shielded 300 volt:
    - a. Tinned copper, #18 AWG, stranded PVC insulated conductors, twisted in pairs with aluminum-polyester shield over each pair and its stranded drain wire (#20 AWG), overall chrome vinyl jacket, 100 percent shield cover.
    - b. Products and Manufacturers:
      - 1) 2 pairs - Belden No. 9368
      - 2) 3 pairs - Belden No. 9369
      - 3) 6 pairs - Belden No. 9389
      - 4) 9 pairs - Belden No. 9390
      - 5) 11 pairs - Belden No. 9391
      - 6) 15 pairs - Belden No. 9392
      - 7) Dekoron Poly-set
      - 8) Okonite type SP-OS



- B. Variable Frequency Drive Shielded Cable
  - 1. Four conductor shielded cable
    - a. Shielding to have an overall shield with an 85% tinned copper braided shield.
    - b. Cable to be Belden Variable Frequency Drive Cable Nos. 29502 through 29531, wire size as indicated or equal.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Delivery, Storage and Protection: Comply with Section 016600.

### 3.2 INSTALLATION

- A. Install in conduit separated from power cables unless otherwise shown on the Drawings.
- B. Install instrumentation cable conduits as far as possible from power cable conduit.
- C. Ground shield at one end only, as recommended by instrument manufacturer, and as approved by the Owner.
- D. Terminate stranded conductors with pre-insulated crimp type ring tongue terminals properly sized to fit fastening device and to fit wire size.
- E. Identification: Identify all conductors at each terminal and splice location. Identification number labels shall be Thomas & Betts type WSL cable markers or equal with clear heat shrink tubing over the marker.
- F. Install Category 5e and Category 6 cabling in accordance with Commercial Building Telecommunications Pathways and Spaces ANSI/TIA/EIA 569-A and Commercial Building Telecommunications Cabling Standard ANSI/TIA/EIA 568-A.

### 3.3 TESTING

- A. Test each circuit in the presence of the Owner after permanent cables are in place to demonstrate that the circuit and connected equipment perform satisfactorily and that they are free from improper grounds and short circuits.
- B. Maintain a written record of circuits being tested, marking down circuit number and descriptive function and results of each step in the test procedures including repeated tests.
- C. Any cable or a portion of the cable which fails when tested shall be replaced with a new cable for the full length and retested.

END OF SECTION 260520

## SECTION 260526 - GROUNDING AND BONDING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Grounding electrodes and conductors
- B. Equipment grounding conductors
- C. Bonding

#### 1.2 RELATED SECTIONS

- A. Section 033000 - Cast-In-Place Concrete

#### 1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code (NEC)

#### 1.4 GROUNDING SYSTEM DESCRIPTION

- A. The system shall consist of a series of driven ground rod electrodes interconnected with bare stranded ground conductor.
- B. All building footer and slab rebar greater than ½" shall be bonded to the ground conductor. Bond at 20 ft intervals and at each corner. In accordance with the NEC, connections to rebar may be made with suitably sized ground clamps.
- C. All connections shall be by exothermic welds (Cadweld or equal) installed according to the manufacturer's instructions.
- D. Tests shall be performed to determine the grounding grid resistance to ground. The test method shall be as described in NETA Standard ATS-1987, "Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems." A three-point fall-of-potential test shall be used using two auxiliary electrodes for the measurement. Test reports shall be provided describing the testing procedure and results. The grid-to-ground resistance shall be no greater than 5 ohms. If necessary, additional rods shall be added to achieve the 5-ohm ground. When the Contractor has obtained satisfactory results, he shall submit test reports to the Engineer for approval. After approval, the contractor shall bond the service entrance ground grid to the service entrance enclosure ground bus. The Owner or Owner's representative shall have the opportunity to inspect all exothermic welds.
- E. All ground cables shall have a minimum of 24" of ground cover.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms maximum

## 1.6 SUBMITTALS

- A. Product Data: Provide for grounding electrodes and connections.
- B. Test Reports: Indicate overall resistance to ground (and resistance of each electrode).
- C. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

## 1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 260500.
- B. Accurately record actual locations of grounding electrodes.

## 1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

# PART 2 - PRODUCTS

## 2.1 ROD ELECTRODE

- A. Manufacturers:
  - 1. ITT Blackburn Co.
  - 2. Copperweld, Bimetallic
  - 3. American Electric - Blackburn
- B. Material: Copper-clad steel
- C. Diameter: 3/4 inch
- D. Length: 10 feet

## 2.2 MECHANICAL CONNECTORS

- A. Manufacturers:
  - 1. Burndy Corp.
  - 2. O-Z/Gedney.
- B. Material: Bronze.

## 2.3 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
  - 1. Cadweld

## 2.4 WIRE

- A. Material: Stranded copper
- B. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.

### 3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground spaced at minimum 10 ft.
- C. Provide bonding to meet Regulatory Requirements.
- D. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

### 3.3 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

END OF SECTION 260526

## SECTION 260529 - SUPPORTING DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Conduit and equipment supports
- B. Anchors and fasteners
- C. Concrete equipment supports

#### 1.2 REFERENCES

- A. NECA - National Electrical Contractors Association
- B. ANSI/NFPA 70 - National Electrical Code

#### 1.3 SUBMITTALS

- A. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product Testing Agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### PART 2 - PRODUCTS

#### 2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- C. Anchors and Fasteners:
  - 1. Concrete block walls: Use expansion anchors.
  - 2. Steel Structural Elements: Use welded fasteners.
  - 3. Concrete Surfaces: Use expansion anchors.

## 2.2 CHANNEL SYSTEMS

- A. Manufacturer:
  - 1. Unistrut, B-Line, Allied Power -Strut
  - 2. Or approved equal
- B. Description:
  - 1. Galvanized steel - General locations
  - 2. Aluminum - Wet, damp areas
  - 3. Stainless steel - Wet, damp, corrosive areas where compatible with chemicals
  - 4. Fiberglass - Wet, damp, corrosive areas where compatible with chemicals
- C. Size: 1-5/8" x 1-5/8"

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not fasten supports to pipes and conduit except as shown on Drawings.
- D. Obtain permission from Engineer before drilling or cutting structural members.
- E. Fabricate supports from structural steel, galvanized steel, aluminum or stainless steel channel. Rigidly weld members or use stainless steel hex head bolts and hardware to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- F. Install surface-mounted cabinets and panel boards with minimum of four anchors.
- G. In wet and damp locations use stainless steel or aluminum channel supports with stainless steel fasteners.
- H. In wet and damp locations use stainless steel or aluminum spacers to stand cabinets and panel boards one inch off wall.
- I. Spray coat cut end of galvanized steel channel or rigid steel conduit with spray cold galvanizing.
- J. Galvanized pipe used as equipment supports are to have the open ends capped with galvanized end caps.
- K. Provide concrete equipment pad, housekeeping pads, for all equipment that will be floor mounted. Pads to be formed, chamfer edges, and have a troweled finish. Concrete shall be smoothed around conduits. Equipment panels shall be anchored using concrete anchors. Equipment pads for outdoor mounted panels shall extend from the front of the equipment panel 3'-6" min. to allow for opening and standing.

END OF SECTION 260529

## SECTION 260530 – ELECTRICAL DUCT BANK

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. PVC Conduit
- B. Pull Boxes/Handhole Enclosures

#### 1.2 MEASUREMENT AND PAYMENT

- A. Duct bank:
  - 1. Basis of Payment: Includes purchase, delivery, and installation of duct, fittings, supports, accessories, trenching, aggregate bedding or concrete encasement (where required), and backfill.
- B. Pull Boxes/Handhole Enclosures
  - 1. Basis of Payment: Includes purchase, delivery, and installation of pull box.

#### 1.4 REFERENCES

- A. Quality Control: Follow requirements for references and standards.
- B. ASTM C857 - Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
- C. ASTM C858 - Underground Precast Concrete Utility Structures
- D. STM C891 - Installation of Underground Precast Utility Structures
- E. ASTM C1037 - Inspection of Underground Precast Utility Structures
- F. IEEE C2 - National Electrical Safety Code
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
- H. NEMA TC 2 and TC3 - Schedule 40 PVC Conduit and PVC Fittings for Use with Rigid PVC Conduit and Tubing
- I. NFPA 70 - National Electrical Code
- J. UL 651A - Type EB and A PVC Conduit and HDPE Conduit
- K. ANSI/SCTE 77-2007 Specifications for Underground Enclosure Integrity

## 1.5 SUBMITTALS FOR REVIEW

- A. Submittals: Follow procedures for submittals.
- B. Product Data: Provide for handhole accessories.
- C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast handholes.

## 1.6 SUBMITTALS FOR INFORMATION

- A. Follow requirements for submittals in general project requirements.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

## 1.7 SUBMITTALS FOR CLOSEOUT

- A. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of handholes.

## 1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.9 FIELD SAMPLES

- A. Provide as required.

## 1.10 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.
- D. Pull box locations and quantity are shown in approximate locations. Locate as required to complete duct bank system.



## PART 2 - PRODUCTS

### 2.1 PLASTIC CONDUIT

- A. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, with fittings and conduit bodies to NEMA TC 3
- B. Rigid Plastic Underground Conduit: UL 651A, Type A PVC

### 2.2 DUCT BANK PULL BOXES

- A. Description: Pull boxes shall be as manufactured by Quazite.
  - 1. Load capacity of box to be as indicated on drawings or as indicated in ANSI SCTE-77-2007.
- B. Provide all necessary items for a complete installation.
- C. Pull boxes shown are approximate sizes. Size pull boxes as required for proper installation.
- D. Enclosure With Walls 48" or Shorter
  - 1. Enclosures, boxes and cover are required to conform to all test provisions of ANSI/SCTE 77 "Specifications for Underground Enclosure Integrity" for Tier as shown on Drawings. When multiple Tiers are specified, the boxes must physically accommodate and structurally support compatible covers while possessing the highest Tier rating. In no assembly can the cover design load exceed the design load of the box. All components in an assembly (box & cover) are manufactured using matched surface tooling. All covers are required to have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level embossed on the top surface. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.

### 2.3 ACCESSORIES

- A. Underground Warning Tape: 4 inch wide plastic tape, metal-backed, colored red or yellow with suitable warning legend describing buried electrical lines.
- B. Underground conduit PVC support chairs

## PART 3 - EXECUTION

### 3.1 DUCT BANK INSTALLATION

- A. Quality Control: Follow requirements in manufacturer's instructions.

- B. Install duct to locate top of duct bank at depths as indicated on drawings.
- C. Install duct with minimum slope of 4 inches per 100 feet. Slope duct away from building entrances.
- D. Cut duct square using saw or pipe cutter; de-burr cut ends.
- E. Insert duct to shoulder of fittings; fasten securely.
- F. Join nonmetallic duct using adhesive as recommended by manufacturer.
- G. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- H. Install no more than equivalent of three 90-degree bends between pull points.
- I. Use suitable separators and chairs installed not greater than 4 feet on centers.
- J. Conduit spacing shall be 12" minimum between 480/277 volt conduits and mA/communication signal conduits and 6" minimum between 120/240 volt conduits and mA/communication signal conduits.
- K. Provide suitable pull string in each empty duct.
- L. Swab duct with wire brush and mandrel. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- M. Backfill as required in Backfill Section. Aggregate bedding shall be placed and tamped in layers. Bedding shall be placed in trench bottom prior to installation of the bottom ducts.
- N. Concrete encasement required where indicated. Ensure that concrete totally encases conduits in duct bank to eliminate any voids.
- O. Interface installation of underground warning tape with backfilling as required in Backfill Section. Install tape 6" below finished surface.
- P. Install a vertical two-foot length of #8 rebar to extend to 6" below finished grade at each duct bank intersection, bend and at 100 ft intervals of straight duct bank run for locating the duct bank

### 3.3 PULL BOXES/HANDHOLE ENCLOSURES

- A. Quality Control: Follow requirements in manufacturer's instructions.
- B. Excavate for handhole installation under the provisions of Excavation Section.

- C. Excavate hole approximately 8" deeper than the depth of the pull box at finished grade and approximately 8" larger than the box. Provide minimum of 6 – 8 inches of gravel in the excavation bottom. Compact gravel to minimize settling.
- D. Set box on compacted gravel and backfill to finished grade.
- E. Install in accordance with NEC 314.30.

END OF SECTION 260530

## SECTION 260533 - CONDUIT

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Metal conduit
  - 1. Rigid Galvanized Steel
  - 2. Aluminum
- B. PVC coated rigid galvanized steel
- C. Nonmetallic conduit
- D. Flexible metal conduit
- E. Liquid-tight flexible metal conduit
- F. Fittings and conduit bodies

#### 1.2 RELATED SECTIONS

- A. Section 260529 - Supporting Devices
- B. Section 260553 - Electrical Identification
- C. Sections 260534 - Boxes

#### 1.3 REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated
- B. ANSI C80.5 - Rigid Aluminum Conduit
- C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
- D. ANSI/NFPA 70 - National Electrical Code
- E. NECA "Standard of Installation."
- F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

#### 1.4 DESIGN REQUIREMENTS

- A. Conduit Size: ANSI/NFPA 70

#### 1.5 SUBMITTALS

- A. Submit under provisions of Section 012333.
- B. Product Data: Provide for metallic conduit, flexible metal conduit, liquid-tight flexible metal conduit, nonmetallic conduit, flexible nonmetallic conduit, fittings, conduit bodies of each type planned to be used.

## 1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of project general requirements.
- B. Accurately record actual routing of all conduits exposed and concealed on record drawings.

## 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 016600.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

## 1.9 PROJECT CONDITIONS

- A. Verify routing and termination locations of conduit prior to rough-in.
- B. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

# PART 2 - PRODUCTS

## 2.1 CONDUIT REQUIREMENTS

- A. Minimum Size: 3/4 inch unless otherwise specified.
- B. Underground Installations:
  - 1. More than two feet from Foundation Wall: Use schedule 40 PVC conduit.
  - 2. Within two feet from Foundation Wall: Use plastic coated galv. rigid conduit.
  - 3. In or Under Slab on Grade: Use schedule 40 PVC conduit.
  - 4. When changing from underground to above ground, use PVC coated galv. rigid conduit to approximately two feet above finished grade.
  - 5. Conduits passing through poured concrete sidewalks, floating type slabs on grade shall be sleeved.
- C. Outdoor Locations, Above Grade: Use rigid galvanized steel conduit.
- D. In Slab Above Grade:
  - 1. Use schedule 40 PVC.
  - 2. Maximum Size Conduit in Slab: 3/4" for conduits crossing each other.
- E. Continuously Wet or Damp Locations: Use aluminum or PVC coated rigid steel conduit.
- F. Corrosive Location: Use PVC coated rigid steel or schedule 40 PVC.
- G. Dry Locations:

1. Concealed in framed wall or above suspended ceilings: Use steel electrical metallic tubing or schedule 40 PVC conduit.
  2. Exposed: Use rigid galvanized steel or aluminum conduit or as noted on drawings.
  3. Flexible metal conduit may be used for equipment connections. Maximum length of 3 ft.
- H. Classified hazardous Class I, Division 1 areas and Screen Rooms: PVC coated rigid steel conduit and explosion-proof flexible equipment connections.
- I. Equipment Connections:
1. Use liquid-tight flexible metal conduit.
  2. In corrosive or chemical rooms, use non-metallic flexible conduit and fittings.
- J. Flexible Conduit lengths shall be limited to three feet or less.

## 2.2 METAL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1 all steel fittings

## 2.3 PVC COATED METAL CONDUIT

- A. Manufacturers:
1. Robroy Industries "Plasti-Bond"
  2. Thomas & Betts – "OCAL Blue"
- B. Description: NEMA RN 1; rigid steel conduit with external PVC coating, 40 mil thick.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel fittings with external PVC coating to match conduit.

## 2.4 FLEXIBLE METAL CONDUIT

- A. Description: Interlocked aluminum construction.
- B. Fittings: ANSI/NEMA FB 1

## 2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
1. Sealtight VA - Anaconda Metal Hose Div.
  2. Liquidtight type L.A. - Electric Flex Co.
- B. Description: Interlocked aluminum construction with PVC jacket.
- C. Fittings: ANSI/NEMA FB 1.

## 2.6 NONMETALLIC CONDUIT

- A. Manufacturers:
  - 1. Carlon Electrical Products Div.
  - 2. LCP
  - 3. Quil.
- B. Description: NEMA TC 2; Schedule 40 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install conduit in accordance with NECA "Standard of Installation."
- B. Install nonmetallic conduit in accordance with manufacturer's instructions.
- C. Arrange supports to prevent misalignment during wiring installation.
- D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- E. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
- F. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.
- G. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports
- H. Do not attach conduit to ceiling support wires.
- I. Arrange conduit to maintain headroom and present neat appearance.
- J. Route exposed conduit parallel and perpendicular to walls.
- K. Route conduit in and under slab from point-to-point.
- L. Do not cross conduits in slab unless  $\frac{3}{4}$ " conduits.
- M. Maintain adequate clearance between conduit and piping.
- N. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104°F.
- O. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- P. Bring conduit to shoulder of fittings; fasten securely.
- Q. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- R. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- S. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.
- T. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- U. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.
- V. Conduits shall be sloped in such a manner that water may drain to the closest pull box if possible.

- W. Provide suitable pull string in each empty conduit except sleeves and nipples.
- X. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- Y. Ground and bond conduit under provisions of Section 260526.
- Z. Identify conduit under provisions of Section 260553.
- ZA. Flexible conduit, non-metallic, liquid-tight, and metallic shall not be used in lengths longer than 6 ft unless specifically approved. Flexible conduit is not to be used in place of neatly run rigid conduit.
- ZB. Where called out on plans provide cable terminators / sealing bushings, CRC by O-Z/Gedney or approved equal. Verify specific cable outside diameters and follow manufacturer's installation requirements.

END OF SECTION 260533



## SECTION 260534 - PULL, JUNCTION BOXES AND ENCLOSURES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pull Boxes
- B. Junction Boxes
- C. Accessories

#### 1.2 RELATED SECTIONS

- A. Section 260529 - Supporting Devices

#### 1.3 REFERENCES

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems
- C. ANSI/NFPA 70 - National Electrical Code

#### 1.4 SUBMITTALS

- A. Submit under provisions of general project requirements and Section 260500.
- B. Product Data: Provide manufacturer's standard data for boxes and enclosures.
- C. Junction box locations and details
  - 1. Terminal block layout
  - 2. Grounding

#### 1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Hoffman
- B. Saginaw
- C. Rittal
- D. Or Equal

## 2.2 PULL BOXES

### A. Construction:

1. Outdoors, Wet Damp areas, Corrosive areas: NEMA Type 4/4X, sunlight resistant fiberglass, polycarbonate or stainless steel (SS) as specified on Drawings; enclosure with continuous hinge covers.
  - a. Covers: Continuous SS hinge, held closed by SS screws
2. Indoors exposed: NEMA 12, 13 or as specified on Drawings.
3. Indoors flush wall mounted: NEMA 1 w/ flush covers
4. Indoors concealed: NEMA 1 w/ screw cover
5. Indoor wet and damp: NEMA 4X SS
6. Indoor corrosive areas: NEMA 4X SS or compatible with chemical
7. Hazardous locations: NEMA 7

## 2.3 TERMINAL HINGED COVER ENCLOSURES

### A. Construction:

1. Outdoor, Wet Damp areas, Corrosive areas. NEMA 4/4X, sunlight resistant fiberglass or polycarbonate or SS as specified on Drawings, Type 4/4X enclosure with continuous hinge cover.
    - a. Covers: Continuous SS hinge, held closed by flush latch operable by screwdriver.
  2. Indoors exposed: NEMA 12, 13
  3. Indoors flush wall mounted: NEMA 1 w/ flush covers
  4. Indoors concealed: NEMA 1 w/ screw cover
  5. Indoor wet and damp: NEMA 4X SS
  6. Indoor corrosive areas: NEMA 4X SS or compatible with chemical
  7. Hazardous locations: NEMA 7
- B. Provide white enamel interior metal panel for mounting terminal blocks and electrical components.

## 2.4 CABINETS

- A. Provide metal barriers to form separate compartments containing control wiring at less than 50 volts from power wiring.
- B. Provide accessory feet for freestanding equipment.

## 2.5 TERMINAL BLOCKS

### A. Manufacturers:

1. Weidmuller SAK 6, SAK 2.5, ASK 1
  2. Allen-Bradley
  3. Square-D
  4. Or equal
- B. Terminal Blocks: ANSI/NEMA ICS 4
- C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

- D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts. Ground terminal shall be green.
- E. Provide ground bus terminal block, with each connector bonded to enclosure.
- F. Provide a typed legend of cables and terminal numbers with origin and destination.
- G. Boxes where water may drain from the attached conduits shall have drains installed in the bottom or the lowest point of the box. Conduit penetration at such boxes shall be located along the sides or top of the box. Conduits shall not be installed in a manner that water can enter attached pull conduits.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- A. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- B. Do not attach boxes directly to masonry, concrete, or brick walls but provide a ¼ inch spacer of PVC, nylon, or stainless steel.
- C. Install enclosures and boxes using stainless steel fasteners.
- E. Provide supports where required when no wall or other adequate support is available.

END OF SECTION 260534

## SECTION 260553 - ELECTRICAL IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Nameplates and labels
- B. Wire and cable markers
- C. Conduit markers

#### 1.2 REFERENCES

- A. NFPA 70 - National Electrical Code

#### 1.3 SUBMITTALS

- A. Submit under provisions of Section 260500.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

### PART 2 - PRODUCTS

#### 2.1 NAMEPLATES AND LABELS

- A. Nameplates:
  - 1. Equipment Identification: Engraved three-layer laminated plastic, black letters on white background.
  - 2. Emergency Powered Equipment: Engraved three-layer laminated plastic, black letters on red background. As required by NEC.
  - 3. Equipment power source identification: Engraved three-layer laminated plastic, black letters on yellow background.
- B. Locations:
  - 1. Each electrical distribution and control equipment enclosure.
  - 2. Junction box.

- C. Letter Size:
  - 1. Use 1/8 inch letters for identifying individual equipment and loads.
  - 2. Use 1/4 inch letters for identifying grouped equipment and loads.
- D. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, and control device stations.

## 2.2 WIRE MARKERS

- A. Manufacturers:
  - 1. T & B Shrink-Kon HVM wire markers
  - 2. Panduit - Pan Code HSDL
  - 3. Brady
- B. Description: Tubing type wire markers
- C. Locations: Each conductor at panelboard gutters, outlet and junction boxes, terminal strip and each load connection.
- D. Legend:
  - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.
  - 2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings or on shop drawings.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.

### 3.2 APPLICATION

- A. Install nameplate parallel to equipment lines.
- B. Secure nameplate to equipment front using stainless steel screws, rivets, or adhesive.
- C. Identify underground conduits using foil backed underground warning tape. Install one tape per trench at 6 inches below finished grade.

END OF SECTION 260553

## SECTION 262213 - DRY-TYPE TRANSFORMERS (600 V AND LESS)

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
  - 1. Distribution transformers
  - 2. Control and signal transformers

#### 1.3 SUBMITTALS

- A. Product Data including rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Wiring and connection diagrams
- C. Source quality-control test reports
- D. Output Settings Reports: Record of tap adjustments specified in Part 3

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C 57.12.91.
- C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

## 1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of wall-mounting and structure-hanging supports.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square-D/ Schneider Electric
  - 4. Engineer Approved Equal

### 2.2 MATERIALS

- A. Description: Factory-assembled-and-tested, air-cooled units for 60 Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices, except for taps
  - 1. Internal Coil Connections: Brazed or pressure type
  - 2. Coil Material: Copper

### 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase
- C. Enclosure: Ventilated, drip-proof, NEMA 250, Type 2
- D. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "Indoor Corrosion Protection."
  - 1. Finish Color: Gray
- E. Insulation Class: 220°C, UL-component-recognized insulation system with a maximum of 150°C rise above 40°C ambient temperature.
- F. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- I. Select features from six paragraphs and associated subparagraphs below. Coordinate with Drawings.
- J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  - 2. Include special terminal for grounding the shield.
  - 3. Shield Effectiveness:
    - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz
    - b. Common-Mode Noise Attenuation: Minus 120 dBA minimum at 0.5 to 1.5 kHz; minus 65 dBA minimum at 1.5 to 100 kHz.
    - c. Normal-Mode Noise Attenuation: Minus 52 dBA minimum at 1.5 to 10 kHz.
- K. Wall Brackets: Manufacturer's standard brackets.

## 2.4 CONTROL AND SIGNAL TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.
- B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls and floors for suitable mounting conditions where transformers will be installed.



- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Brace wall-mounting transformers as specified in Division 16 Section "Electrical Supports."
- B. Install floor-mounting transformers level on concrete bases not less than 2 inches larger in both directions than supported unit and 4 inches high.
  - 1. Anchor transformers to concrete bases according to manufacturer's written instructions.

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.4 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 262213

## SECTION 262416 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Lighting and Distribution Panelboards
- B. Power Distribution Panelboards
- C. Surge Protective Device (SPD)

#### 1.2 REFERENCES

- A. NECA Standard of Installation (published by the National Electrical Contractors Association)
- B. NEMA PB 1 - Panelboards
- C. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association)
- E. NFPA 70 - National Electrical Code

#### 1.3 SUBMITTALS FOR REVIEW

- A. Section 013300 - Submittals: Procedures for submittals
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.

#### 1.4 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- B. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

#### 1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc.

## 1.6 MAINTENANCE MATERIALS

- A. Furnish two of each panelboard key.

## PART 2 - PRODUCTS

### 2.1 LIGHTING AND DISTRIBUTION PANELBOARDS

- A. Manufacturers:
  - 1. Eaton
  - 2. Square-D
  - 3. General Electric
  - 4. Substitutions: Engineer Approved Equal.
- B. Description: NEMA PB1, circuit breaker type, lighting and distribution branch circuit panelboard.
- C. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated copper neutral bus. Provide copper line lugs.
- D. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical rating for 120/208V panelboard, or as indicated on drawings.
- E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter or equipment protection circuit breakers where scheduled. Do not use tandem circuit breakers.
- F. Enclosure: NEMA PB 1, Type 1 cabinet box, or NEMA 12 as indicated.
- G. Cabinet Front: Surface type, hinged door with flush lock, finished in ANSI 61 light gray enamel.

### 2.2 SURGE PROTECTIVE DEVICE (SPD)

- A. For each panelboard provide surge protection device in accordance with section 264313.

### 2.3 POWER DISTRIBUTION PANELBOARDS

- A. Manufacturers:
  - 1. Eaton
  - 2. Square-D
  - 3. Siemens Energy and Automation
  - 4. General Electric
  - 5. Substitutions: Engineer Approved Equal

- B. Description: NEMA PB1, circuit breaker type, Power distribution branch circuit panelboard.
- C. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus, provide copper neutral bus. Provide copper line lugs.
- D. Minimum Integrated Short Circuit Rating: 22,000 amperes rms symmetrical overall series rating for 480V panelboard or as indicated on drawings.
- E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.
- F. Cabinet: Cabinet to be NEMA 1 gasketed

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb.
- C. Height: 6 feet (1800 mm) to top of panelboard; install panelboards taller than 6 feet (1800 mm) with bottom no more than 4 inches (100 mm) above floor.
- D. Provide filler plates for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- F. Provide engraved plastic nameplates under the provisions of Section 260553.
- G. Ground and bond panelboard enclosure according to Section 260526.

### 3.2 ADJUSTING

- A. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 262416

## SECTION 262419 - MOTOR CONTROL CENTERS

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

##### A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install motor control centers.

##### B. Coordination:

1. Obtain motor nameplate data on existing equipment or new equipment being furnished for properly sizing circuit breakers, starters and overloads.
2. Obtain data on motor space heater and other accessories for properly sizing control power transformers.

##### C. Related Sections:

1. Section 260553, Electrical Identification
2. Section 264313, Surge Protection Device

#### 1.2 REFERENCES

##### A. Standards referenced in this Section are:

1. NEMA ICS 18-2001, Motor Control Centers
2. International Electrical Testing Association, (NETA) Acceptance Testing Specification
3. UL 845, Motor Control Centers
4. ANSI C37.2, Standard Electrical Power System Device Function Numbers

#### 1.3 QUALITY ASSURANCE

##### A. Regulatory Requirements

1. NEC Article 430, Motors, Motor Circuits, and Controllers

##### B. Field Quality Control: Field acceptance testing of motor control centers will be manufacturer service tests.

##### C. Test Equipment, Calibration and Reporting: All test equipment, instrument calibration and test reports shall be in accordance with latest edition of NETA Acceptance Testing Specifications.

## 1.4 SUBMITTALS

### A. Shop Drawings: Submit the following:

1. Product Data: Manufacturer specifications, cut sheets, dimensions, and technical data for all components, materials, and equipment proposed
2. Outline and summary sheets with schedules of equipment in each unit
3. One-line diagrams indicating circuit breaker sizes, bus rating, motor controller ratings, and other pertinent information to demonstrate compliance with the Contract Documents
4. Unit control schematic and elementary wiring diagrams showing numbered terminal points and interconnections to other units

### B. Test Plans and Reports: Thirty days in advance of actual factory and field testing, submit proposed testing methods, procedures, and apparatus. Submit reports of completed factory and field testing, including procedures and test results.

### C. Operation and Maintenance Data:

1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
3. Furnish operation and maintenance manuals per Section 01781, Operation and Maintenance Data.

## 1.5 DELIVERY, STORAGE AND HANDLING

### A. Delivery:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Shipping containers shall be designed to be shipped by truck, rail, or ship. Indoor containers shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
3. Inspect motor control centers for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.

### B. Handling:

1. Lift, roll or jack motor control center equipment into locations shown.
2. Motor control centers shall be equipped to be handled by crane. Where cranes are not available equipment shall be suitable for placement on rollers using jacks to raise and lower the groups.

### C. Storage:

1. Store motor control center equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

## 1.6 MAINTENANCE

### A. Spare Parts:

1. Furnish, tag, and box for shipment and long term storage the following spare parts and special tools for each motor control center lineup:

| <b>Item</b>   | <b>Quantity<br/>per Switchgear Lineup</b>                             |
|---|---|
| a. Starters and feeder breakers   | Quantities and sizes as shown   |
| b. Fuses  | Six of each type and size used  |
| c. Auxiliary control relays   | Two, with at least two normally open and two normally closed contacts |
| d. Control power transformers   | Two of each size used   |
| e. Indicating lamps   | Twelve  |
| f. Covers for indicating lamps  | Six of each color used  |
| g. Starters: Contact kits for Size 1 motor starter                      | Five sets   |
| h. Starters: Contact kits for Size 2, Size 3, and Size 4 motor starters | One set of each size  |

- B. Furnish a list of additional recommended spare parts for an operating period of one year. Describe each part, the quantity recommended and current unit price.
1. Package spare parts in suitable containers bearing labels clearly indicating the contents and equipment with which they are to be used. Deliver spare parts at the same time as the motor control centers.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

#### A. Manufacturers: Provide products of one of the following:

1. Square-D Company
2. Eaton
3. ABB
4. Or engineer approved equal

### 2.2 MATERIALS

A. General: Motor Control Center lineups shall be provided as shown with the following ratings:

1. Service: Voltage rating and number of wires shall be as shown on Drawings. Motor control center shall operate from a three-phase, 60 Hertz system.
2. Wiring: NEMA Class II, Type B.
3. Enclosure: NEMA 1.
4. Interrupting Capacity Rating: Motor control center shall have an interrupting capacity rating above available fault current, as noted on the drawings. Devices shall be suitable for minimum rating noted.
5. Motor Control Center lineups shall be UL rated as suitable for service entrance where shown on Drawings and as required.

B. Construction:

1. Totally enclosed structure, dead front, consisting of nominal 20-inch deep, 20-inch wide, 90-inch high vertical sections bolted together to form a unit assembly.
2. Vertical sections shall have side sheets extending the full height and depth of section.
3. Removable lifting angles for each shipping section.
4. Two removable floor sills for mounting.
5. Horizontal wireways top and bottom, isolated from horizontal bus and readily accessible.
  - a. Wireway openings between sections shall have rounded corners and rolled edges.
6. Isolated vertical wireways with cable supports, accessible through hinged doors, for each vertical section.
  - a. Wireway shall be separate from each compartment and remain intact when compartment is removed.
7. All metal non-conducting parts electrically continuous.

C. Bus System:

1. Rating: Bus bracing and bus current capacities above available fault current, as noted on drawings.
2. All bus bars tin plated copper rated UL heat rise standards.
3. Bus bar connections easily accessible with simple tools.
4. Main Horizontal Bus:
  - a. Continuous edge mounted, and isolated from wireways and working areas.
  - b. Bus shall be mounted in vertical center of motor control center to provide easy access and even heat distribution.
  - c. Bus shall be supported, braced, and isolated by a high strength, non-tracking, glass-filled polyester material.



5. Vertical Bus:
  - a. Continuous, and isolated by a glass polyester barrier.
  - b. Rated for 300 amperes continuous minimum, and at least equal to the full load rating of all installed units in the associated stack.
6. Grounding Bus: Full length mounted across the bottom, drilled with lugs of appropriate capacity as required.

D. Unit Compartments:

1. Provide individual front door for each unit compartment. Door shall be fastened to stationary structure, not the unit itself, so that door can be closed when unit is removed.
2. Starter and feeder unit doors interlocked mechanically with unit disconnect device to prevent unintentional opening of door while energized and unintentional application of power while door is open, with provisions for releasing interlock for intentional access and application of power.
3. Padlocking arrangement permitting locking disconnect device in the "OFF" position with at least three padlocks with door closed or open.
4. Compartments shall be equipped as indicated on the Drawings:
  - a. Blank compartments, unused space, and compartments shown on Drawings as "SPACE" shall have bus covers and be complete with all necessary hardware for future installation of a plug-in unit.
  - b. Provide shutters for each compartment that automatically open when unit is inserted and automatically close when unit is removed.
5. Provide wiring and device identification:
  - a. Identify compartment doors, devices, and field wiring in accordance with Section 16075, Electrical Identification.
  - b. Identify all internal control conductors with permanent type wire markers. Each wire shall be identified by a unique number attached to wire at each termination point.
  - c. Identify all internal control devices with permanent type markers. Each device shall be identified by a unique number attached to each device.
  - d. Numbering system for each wire and control device shall be identified on the wiring diagrams and shall reflect the actual designations used in the Work.
6. NEMA 1 minimum motor starter size. Starter units completely draw out type in Sizes 1 and 2 and draw out type after disconnecting power leads only in Sizes 3 and 4.
7. Motor starters shall be NEMA rated and include a magnetic contactor, with encapsulated magnet coils. Wound coils are unacceptable. All control shall be 120 volts AC unless noted otherwise.
  - a. Starters shall be full voltage non-reversing unless shown otherwise on Drawings.
  - b. Reduced Voltage Solid-State Starter:
    - 1) General:
      - a) Provide solid-state, step-less, current limiting, soft-start, motor controllers (RVSS) as shown on Drawings.
      - b) RVSS shall include an overload relay and an isolation contactor.

- c) Provide subsystems that will protect RVSS from damage due to over-current and over-voltage.
  - d) Current Rating: 115 percent of motor nameplate rated current, continuous, minimum
- 2) Required Features:
  - a) Adjustable current limit of not more than 250 percent of motor nameplate full load current throughout entire motor acceleration period including first three cycles of voltage waveform from instant start signal is engaged
  - b) Adjustable voltage acceleration, from 2 to 30 seconds
  - c) Adjustable voltage deceleration, from 2 to 30 seconds
  - d) Phase loss detection
  - e) LED diagnostic indicators
  - f) Static over-current and over-voltage trip
  - g) Phase reversal, line or fuse loss, and under-voltage protection
  - h) Power unit over temperature protection
  - i) Motor inverse time overload protection
  - j) Input line transient over-voltage protection
- 3) Enclosure:
  - a) Cooling fans, if required, shall incorporate anti-friction bearings and internal impedance type motor protection.
  - b) If cooling fans are used, the enclosure for that section shall be NEMA 12 FVF, or NEMA 12 EFVFF force ventilated with filters, per NEMA Standard ICS1-110, installed by motor control center manufacturer.
- 4) On start-up, start driven equipment at zero current and allow driven equipment to accelerate to maximum speed without exceeding the set current limit.
- 5) On normal shutdowns, ramp driven equipment down at set deceleration rate that is non-regenerative for motor prior to shutdown.
- 6) On emergency shutdowns, remove power to motor.
- 7) Diagnostic LEDs: Provide LEDs on unit front that indicate the following:
  - a) Control power on
  - b) Motor power on
  - c) Motor starting
  - d) Motor fault.
  - e) RVSS fault
- 8) Control Outputs:
  - a) Control output shall be electrically isolated, dry, normally open SPDT contacts, rated 10 amps at 120 volts AC.
  - b) Provide the following control outputs:
    - (1) Motor running.
    - (2) Motor fault.
    - (3) RVSS fault.

8. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with the following:
  - a. Electronic Overload Relays: Relays shall be electronic type. Electronic relays shall be multi-function, adjustable, current sensing type and include overload, phase-unbalance, phase-loss, and equipment type ground fault in one package.
  - b. Each overload relay shall be manual reset type and shall include provisions for resetting by an insulating button on front of starter unit door.
  - c. Each overload relay shall include a normally open auxiliary contact for remote alarm purposes.
  - d. Each overload relay shall be sized for full-load amperes and service factor of actual motors installed.
9. Individual control power transformers for all starters capacity as required for all control circuit devices, 100 VA minimum, Class A insulation, two primary fuses, 120 volt secondary, one secondary fuse, and the other secondary leg grounded.
10. Separate Control: Where control power to starter is provided by a separate power source, a control power fuse shall be provided in unit and main disconnect shall be equipped with a normally open contact to isolate control circuit from source when controller disconnect is open.
11. Motor horsepower shown are per existing available documentation and shall be verified in field by Electrical Contractor to insure proper construction of new control units. Circuit breaker trips and starter overload heaters to be coordinated with the actual equipment installed.
12. Auxiliary contacts, relays, timers as required for specified control functions shall be verified in field by the Electrical Contractor's review of the existing starter units to insure new starter units construction offer the same operation of equipment.
13. Current Sensing Devices:
  - a. Current Switch:
    - 1) Produces a dry contact output when load current exceeds set point.
    - 2) Suitable for use of measuring current on motor leads of 480-volt, 60 Hertz, up to 150-amp continuous.
    - 3) Variable trip point and time delay. Trip point settable via calibrated dial.
    - 4) Monitors currents from 10 mA to 150 AC Amps
    - 5) Output relay (Form C) rated up to 20 amps
    - 6) LED trip status indicator
    - 7) Dead band prevents relay chatter
    - 8) Contact Material: Silver-cadmium oxide
    - 9) Mechanical Life: 10 million operations, typical at rated load
    - 10) Electrical Life: 100,000 operations, typical at rated load
  - b. Current Transducer:
    - 1) Produces 4 – 20 mA DC output current proportional to the input average RMS AC motor load current.
    - 2) Loop powered
14. All starter devices, including spare contacts, wired to numbered terminal blocks.

15. Terminal blocks for field connections to unit compartments shall be plug-in/pull apart type. Terminals shall be fully accessible from the front. Terminals shall be mounted near the front of vertical wireway.
16. Control devices shall be 600-volt heavy duty, NEMA A600. Relays shall have convertible contacts. Pilot devices shall be oiltight. Pilot lights shall be transformer type with six-volt secondary. .
17. Feeder Circuit Breakers: Thermal magnetic type.
  - a. Circuit breakers of 100 amp frame or less shall be mounted in a dual mount compartment (two breakers in one space factor) or shall mount in one-half space factor, unless otherwise indicated on Drawings.
18. Motor Starter Circuit Breakers: Magnetic trip only motor circuit protectors.
19. Provide the following diagrams and tables inside of door for each compartment:
  - a. Elementary wiring diagram.
  - b. Table of overload heater sizes with correct heater highlighted.
  - c. Table of motor circuit protector settings with correct setting highlighted.
20. Where shown on Drawings, incorporate a solid state protective relaying package (SSPRP) into motor starter for motor protection. Unit shall incorporate the following ANSI C37.2 device function numbers and selectable indications and communication modules:
  - a. Product and Manufacturer:
    - 1) GE MultiLin SR469
    - 2) Or equal
  - b. Motor Protection Device Functions:
    - 1) Stator winding over-temperature (Device 49)
    - 2) Short circuit (Device 50)
    - 3) Motor overload (Device 49/50/51)
    - 4) Locked rotor - multiple start (Device 48)
    - 5) Phase reversal (Device 46)
    - 6) Ground fault (Device 50G/51G)
    - 7) Mechanical jam
    - 8) Unbalance/negative sequence currents (Device 46)
    - 9) Undercurrent (Device 37)
    - 10) Motor bearing over-temperature (Device 38)
    - 11) Thrust bearing over-temperature (Device 38)
    - 12) Over-voltage (Device 59)
    - 13) Undervoltage (Device 27)
    - 14) Voltage sequence (Device 47)
    - 15) Main trip and lockout output relay (Device 86)
    - 16) Alarm output relay (Device 74)
  - c. Selectable Indications:
    - 1) Average motor current
    - 2) Average motor temperature
    - 3) Motor current for each of the three phases
    - 4) Motor temperature readout for six winding RTDs
    - 5) Motor thrust-bearing temperature readout for two bearing RTDs
    - 6) Ground fault current
    - 7) Percent of motor capacity used
    - 8) Line-to-line and line-to neutral voltages, all three phases
    - 9) Average 15-minute kVA

- 10) Average 15-minute kW
  - 11) Average 15-minute kVAR
  - 12) Maximum percent full load current since initial startup
  - 13) Hottest RTD and temperature since initial startup
  - 14) Highest percent current unbalance since initial startup
  - 15) Highest ground fault current since initial startup
  - 16) Highest motor bearing temperature since initial startup
  - 17) Highest load bearing temperature since initial startup
  - 18) Maximum line voltage since start
  - 19) Minimum line voltage since start
  - 20) Number of motor starts attempted
  - 21) Number of motor starts completed
  - 22) Hours of operation
  - 23) Number of trips from each of ten protective functions
  - 24) All measured values at the time of a motor trip
  - 25) Values that have been loaded for system inputs and trip points
- d. Communication Module: RS232 capable of uploading all the above protective function attitudes and all the above listed selectable indications upon being queried by a host PLC hooked up through RS232 communication port.
21. Main and Tie Circuit Breakers: Thermal magnetic, molded case type, unless shown otherwise. Where shown, main and tie breakers shall be equipped with key interlocking. Interlocking shall allow only two of the three breakers to be closed at a time. Provide all locks and keys as required. Main circuit breakers shall be 100 percent amperage rated. Circuit breakers with frame ratings 800 amps and greater shall be electronic type with adjustable parameters and ground fault protection.

E. Surge Protection Device (SPD) Unit:

1. Provide an integral SPD unit for each motor control center. SPD unit shall comply with Section 16282, Surge Protection Device.

## 2.3 MAIN METERING DEVICE

A. Provide a main meter device as shown on Drawings.

1. Microprocessor based monitoring device shall provide complete electrical metering in one package. Device shall include self-contained potential transformers and self-protected internal fuses.
2. Device shall be mounted on compartment door to allow operator access to meter menu and display.
3. Device shall include trend analysis, event logging, and recording. Device shall also include the following direct reading metered values:
  - a. Volts: 0.2 percent accuracy
  - b. Amperes: 0.2 percent accuracy
  - c. Watts, Vars and VA: 0.5 percent accuracy
  - d. Power Factor: 1.0 percent accuracy
  - e. Frequency: 0.05 percent accuracy

- f. Watt, and VA Hours: 0.5 percent accuracy
  - g. Var Hours: 1.0 percent accuracy
  - h. Watt, Var and VA Demand: 0.4 percent accuracy
  - i. THD-Voltage: 50<sup>th</sup> harmonic
  - j. THD-Current: 50<sup>th</sup> harmonic
  - k. Individual Ampere Harmonics: 50<sup>th</sup> harmonic
  - l. Individual Voltage Harmonics: 50<sup>th</sup> harmonic
4. Metering device shall have the following additional features:
- a. Trend analysis that shall display minimum and maximum values for each metered parameter with date and time of each occurrence.
  - b. Input range of device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential transformers from a ratio of 120:120 to 500,000:120. Three current transformers suitably rated shall be included.
  - c. Alarm contacts rated five amps at 120 VAC.
  - d. Three analog outputs programmable to reflect the metered parameters, except kilowatt hours and kilovar hours.
  - e. Communication capability, using RS-485, Modbus RTU Protocol.
5. Control power shall be drawn from monitored incoming AC line. Device shall have non-volatile memory and not require battery backup. During a power failure, device shall retain preset parameters.

## 2.4 SOURCE QUALITY CONTROL

- A. Perform factory tests on individual motor control units prior to shipment. Tests shall include manufacturer's standard tests, including:
  - 1. Physical inspection and checking of all components.
  - 2. Mechanical operation and device function tests.
  - 3. Primary, control, and secondary wiring hi-pot tests.
- B. Factory tests as outlined above shall be witnessed by the OWNER's representative:
  - 1. The manufacturer shall notify the OWNER two (2) weeks prior to the date the tests are to be performed.
  - 2. The manufacturer shall include the cost of transportation and lodging for up to three (3) OWNER's representatives.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine conditions under which Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- B. Electrical Contractor shall verify and document all existing components and wiring terminations of each Motor control unit to be replaced within existing Motor Control Centers as shown on Drawings for proper construction of replacement control units.

### 3.2 INSTALLATION

- A. Install motor control centers on concrete bases in accordance with the Contract Documents and manufacturer's recommendations and instructions.
- B. Do not provide openings in top or side of motor control centers not required for conduit.
- C. Cable circuits together within enclosures and identify with durable tag secured to cabling twine.
- D. Set motor circuit protectors at lowest setting that allows motor starting without nuisance tripping.
- E. Verify that wiring diagrams on inside of door of each compartment reflect the circuitry actually provided and that correct overload heater size and motor circuit protector setting are noted.
- F. Install in conformance with the manufacturer's recommendations, governing codes, and the Contract Documents.
- G. Connections to existing facilities shall be coordinated with Owner's operations.
- H. Verify that all conductors, power and control, have been properly identified per specification section 16075.

### 3.3 FIELD QUALITY CONTROL

- A. Perform field testing and inspection of motor control centers. Inspect and test each motor control center after installation. All testing and inspection shall be in accordance with the manufacturer's recommendations and be performed by manufacturer's factory-trained representative, who shall inform OWNER and ENGINEER when equipment is correctly installed. Do not energize equipment without permission of OWNER.
- B. Perform the following minimum tests and checks before energizing equipment:
  - 1. Verify all overload and device settings.
  - 2. Inspect all mechanical and electrical interlocks and controls for proper operation.
  - 3. Check tightness of bolted connections.
  - 4. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
  - 5. Measure insulation resistance of each starter, phase-to-phase and phase-to-ground.
  - 6. Measure insulation resistance of each control circuit with respect to ground.
  - 7. Perform other tests recommended by equipment manufacturer.

### 3.4 MANUFACTURER SERVICES

#### A. Manufacturer Services:

1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of the equipment and installation in the equipment's final location. Representative shall train installing personnel in advance in the proper handling and rigging of the equipment.
2. Manufacturer's factory-trained representative shall test the system as specified in Article 3.3 of this Section. Representative shall operate and test the system in the presence of ENGINEER and verify that the equipment conforms to requirements.
3. Manufacturer's factory-trained representative shall adjust the system to initial settings as specified in Article 3.5 of this Section.
4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
5. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the Correction Period specified in the General Conditions as amended by the Supplementary Conditions.
6. Replacement parts or equipment installed during the Correction Period shall be equal to or better than the original.

- B. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of the products.

### 3.5 ADJUSTING

- A. Calibrate, set, and program all protective devices. Coordinate protective devices furnished under this Specification section and provide proper settings of all devices

END OF SECTION 262419



## SECTION 262816 - ENCLOSED SWITCHES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fusible switches
- B. Safety Disconnect switches

#### 1.2 RELATED SECTIONS

- A. Section 260553 – Electrical Identification

#### 1.3 REFERENCES

- A. NECA - Standard of Installation (published by the National Electrical Contractors Association)
- B. NEMA FU1 - Low Voltage Cartridge Fuses
- C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association)
- E. NFPA 70 - National Electrical Code

#### 1.4 SUBMITTALS FOR REVIEW

- A. Follow requirements for submittals, procedures for submittals, in general project requirements.
- B. Product Data: Provide switch ratings and enclosure dimensions.

#### 1.5 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations of enclosed switches in project record documents.

#### 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Follow requirements for material and equipment in general project requirements.  
Product options and substitutions:
  - 1. Cutler Hammer
  - 2. Eaton
  - 3. Square-D
  - 4. Siemens Energy and Automation
  - 5. General Electric
  - 6. Substitutions: Engineer Approved Equal

### 2.2 FUSIBLE SWITCH ASSEMBLIES

- A. Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position
- B. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses
- C. Short Circuit rating: 200,000 amps

### 2.3 ENCLOSURES

- A. Fabrication: NEMA KS 1
  - 1. Interior Dry Locations: Type 1 or 12 as indicated on Drawings
  - 2. Exterior Locations: Type 4X SS

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation"
- B. Install fuses in fusible disconnect switches.
- C. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

### 3.2 FIELD QUALITY CONTROL

- A. Follow requirements for Starting of Systems in general project requirements: Field inspection, testing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 262816

## SECTION 262913.06 - SOFT-START MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Scope:
  - 1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install soft-start motor controllers, complete and operational.
  - 2. Soft-start motor controllers required under this Section are low-voltage, voltage source inverter, pulse width modulated. Soft-start motor controllers shall be customized.
- B. Where soft-start motor controllers are being provided by the vendor of the associated driven equipment, costs for soft-start motor controllers shall be included in the lump sum price for said equipment. Where soft-start motor controllers are not being provided by the vendor of the associated driven equipment, costs for soft-start motor controllers shall be included in the general contract price
- C. Related Sections:
  - 1. Section 260529 - Supporting Devices
  - 2. Section 260534 - Boxes and Enclosures
  - 3. Section 260553 - Electrical Identification

#### 1.2 SUMMARY

- A. Section includes soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.
  - 1. Enclosed soft-start controllers
  - 2. Enclosures
  - 3. Accessories
  - 4. Identification

#### 1.3 DEFINITIONS

- A. FLA: Full-load current.
- B. OCPD: Overcurrent protective device.
- C. SCR: Silicon-controlled rectifier.

#### 1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
  - 1. Product Data: For each type of product.
    - a. Technical specifications
    - b. Catalog cuts and product literature.

2. Shop Drawings: For each type of controller.
  - a. Include plans, elevations, sections, and mounting details.
  - b. Indicate dimensions, weights, required clearances, and location and size of each field connection.
  - c. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
  - d. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

**B. Informational Submittals**

**1. Certificates:**

- a. Certification letters from soft-start motor controller manufacturer and motor manufacturer that the approved driven equipment has been reviewed and that soft-start motor controller units and motors are compatible, and shall be provided in accordance with the Contract Documents and requirements of the driven equipment.

**2. Source Quality Control Submittals:**

- a. Within 14 days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.

**3. Field Quality Control Submittals:**

- a. Within 14 days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.

**4. Manufacturer Reports:**

- a. Preliminary and final harmonic analysis.
- b. Within 14 days of each visit to the Site by manufacturer's representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.

**5. Qualifications Statements:**

- a. Manufacturer.

**C. Closeout Submittals: Submit the following**

1. Operation and Maintenance Data: For soft-start controllers to include in operation and maintenance manuals.
  - a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - 1) Routine maintenance requirements for soft-start controllers and installed components.
    - 2) Manufacturer's written instructions for testing and adjusting circuit-breaker trip settings.

- 3) Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage soft-start controllers.
- 4) Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate FLAs.
- 5) Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected

D. Maintenance Material Submittals

1. Furnish, tag, and box for shipment and long term storage, spare parts and special tools for soft-start motor controllers. Each spare part set shall include manufacturer's recommended spare parts inventory for one year and include, at minimum, the following:
  - a. Indicating Lights: Two of each type and color installed
  - b. Elapsed Time Monitor: One of each type installed
2. Furnish a list of recommended spare parts for an operating period of one year. Describe each part, the quantity recommended, and current unit price.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Shipping containers shall be designed to be shipped by truck, rail, or ship. Indoor containers shall be bolted to skids.
3. Inspect soft-start motor controller equipment for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.

B. Handling:

1. Lift, roll or jack soft-start motor controller equipment into locations shown.
2. Soft-start motor controllers shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer's requirements.

C. Storage:

1. Store soft-start motor controller equipment in a clean, dry location with controlled, uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

## PART 2 - PRODUCTS

### 2.1 MOTOR CONTROLLER PERFORMANCE REQUIREMENTS

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

- B. UL Compliance: Fabricate and label enclosed controllers to comply with UL 508.
- C. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2.

## 2.2 ENCLOSED SOFT-START MOTOR CONTROLLERS

- A. Description: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop. The controller shall be an integrated unit with power SCRs, heat sink, microprocessor logic board, , and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
  - 1. Internal Bypass Structure: Integral bypass contacts in parallel with the SCRs of the soft-start controller, bypassing the SCRs when full voltage is achieved, rated for AC1 current levels.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton
  - 2. General Electric Company
  - 3. Rockwell Automation, Inc.
  - 4. SIEMENS Industry, Inc.; Energy Management Division
  - 5. Square D; by Schneider Electric
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Standard duty
  - 1. At least two SCRs per phase to control the starting and stopping of the motor.
  - 2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
  - 3. Integral Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
- E. Control Power:
  - 1. For on-board control power, obtain from line circuit per project drawings.
- F. Controller Diagnostics and Protection:
  - 1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller over-temperature and motor-overload alarm and trip; settings selectable via DIP switches and a rotary dial.
  - 2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
- G. Cover mounted-controller status panel with LED lights to show the following:
  - 1. Starter Status: "Running"
  - 2. Motor runtime in hours

- 3. Faults:
  - a. Motor overcurrent trip
  - b. Motor thermal overload
  - c. Starter thermal fault
  - d. Low line voltage
  - e. Loss of a phase
  - f. Phases reversed
  - g. Shorted SCR

- H. Interface Panel: Devices mounted on controller door
  - 1. Manual operators and displays per the project drawings

- I. Remote Output Features. All outputs shall be prewired to terminal blocks.
  - 1. Form C status contacts that change state when controller is running
  - 2. Form C alarm contacts that change state when a fault condition occurs

- J. Remote Input Features. All inputs shall be prewired to terminal blocks.
  - 1. Form C command contacts that change state to stop motor

## 2.3 ENCLOSURES

- A. Comply with NEMA 250, Type designations as indicated on Drawings, to comply with environmental conditions at installed location.
- B. Construction of the enclosures shall comply with NEMA ICS 6.
- C. System to include one single enclosure to contain two separate soft-starter motor controllers and all associated devices and accessories.

## 2.4 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
    - a. Push Buttons: As indicated in the controller schedule.
    - b. Pilot Lights: As indicated in the controller schedule.
  - 2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable

## 2.5 IDENTIFICATION

- A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with adhesive backing to maintain enclosure NEMA rating.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work. Notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems," and bolted to wall.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Install all terminations, lugs, and required appurtenances necessary to properly terminate power supplies.
- G. Install control wiring terminations and appurtenances necessary to complete installing control and monitoring devices
- H. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.



B. Tests and Inspections:

1. Comply with provisions of NFPA 70B, Chapter "Testing and Test Methods."
2. Visual and Mechanical Inspection:
  - a. Compare equipment nameplate data with Drawings and the Specifications.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage, alignment, and grounding.
  - d. Verify that the unit is clean.
  - e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.
  - f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
  - g. Motor-Running Protection:
    - 1) Verify that motor FLA is at, or under, the controller current rating.
    - 2) Verify that overload element setting is correct for its application.
    - 3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
    - 4) If motor-running protection is provided by fuses, verify correct fuse rating.
  - h. Inspect bolted electrical connections for high resistance using one of the following two methods:
    - 1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
3. Electrical Tests:
  - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS, Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than this table or manufacturer's written instructions shall be investigated and corrected.
  - b. Test motor protection devices according to manufacturer's published data.

- c. Act on inspection results, recommended action, and considering recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
- C. Motor controllers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.5 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.
  - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
  - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
  - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Motor controllers will be considered defective if they do not pass the system function tests and inspections.
- C. Prepare test and inspection reports.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train OWNER'S maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION 262913.06

## SECTION 262923 - VARIABLE FREQUENCY DRIVES

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

##### A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install variable frequency drives, complete and operational.
2. Variable frequency drives required under this Section are low-voltage, voltage source inverter, pulse width modulated. Variable frequency drives shall be customized.

##### B. Where variable frequency drives are being provided by the vendor of the associated driven equipment, costs for variable frequency drives shall be included in the lump sum price for said equipment. Where variable frequency drives are not being provided by the vendor of the associated driven equipment, costs for variable frequency drives shall be included in the general contract price.

##### C. Related Sections:

1. Section 260553 - Electrical Identification
2. Section 260520 - Shielded Cable

#### 1.2 REFERENCES

##### A. Standards referenced in this Section are:

1. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
2. NEMA AB 1, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures
3. NEMA ICS 2, Industrial Control and Systems, Controllers, Contactors and Overload Relays Rated 600 Volts
4. NEMA ICS 7, Industrial Control and Systems Adjustable Speed Drives
5. NEMA MG 1, Motor and Generator Standard
6. UL 508, Industrial Control Equipment
7. ISO 9000, Quality Management Systems, Fundamentals and Vocabulary
8. ISO 9001, Quality Management Systems, Requirements
9. ISO 9002, Quality Systems, Model for Quality Assurance in Production, Installation and Servicing

### 1.3 QUALITY ASSURANCE

#### A. Qualifications:

##### 1. Manufacturer:

- a. Variable frequency drive manufacturer shall have at least five years of experience designing and regularly manufacturing and servicing substantially similar equipment to that specified, and shall submit documentation upon request of at least five installations in satisfactory operation for at least five years.
- b. Manufacturer shall be certified under ISO 9000, ISO 9001, or ISO 9002 for materials and equipment specified.
- c. For all required factory tests, variable frequency drive manufacturer shall use a factory test facility that has calibrated its testing apparatus in the previous twelve months, and is staffed by qualified, experienced technicians.

#### B. Component Supply and Compatibility:

1. Drives specified under this Section shall employ a low switching frequency or pattern to minimize instantaneous rate of voltage change over time (dv/dt), and the adverse effects of potential bearing currents. Where alternate manufacturers are proposed, obtain manufacturer recommendations regarding bearing currents and provide equipment required at no additional cost to OWNER.
2. Each variable frequency drive shall be totally compatible with associated driven equipment and motors. Variable frequency drives shall be matched to specific load requirements for each system. Operation of variable frequency drive shall not overstress motor insulation.
3. Similar components of drives associated with each system shall be products of a single manufacturer.

### 1.4 SUBMITTALS

#### A. Action Submittals: Submit the following:

##### 1. Shop Drawings:

- a. Dimensional information and construction details of enclosures. Enclosure details shall consist of exterior and interior front door with nameplate legends, interior door front and rear views, and terminal block layout.
- b. Three-line power and control schematic diagrams
- c. Wiring diagrams showing the interconnection of conductors to all devices with terminal assignments for remote devices
- d. Functional description of system operation
- e. VFD heat dissipation at full load, including heat rejection/cooling system
- f. Preliminary Harmonic analysis shall utilize:
  - 1)  $I_L$  shall be 80% of the connected load.
  - 2) The point of common coupling (PCC) shall be the first main breaker of the motor control center which the VFD is powered from.

- 3) The level of harmonics, at the PCC described above, shall not exceed IEEE 519 limits.
2. Product Data:
  - a. Technical specifications
  - b. Catalog cuts and product literature
3. Testing Plans:
  - a. At least thirty days prior to source quality control testing, submit descriptions of proposed shop testing methods, procedures, and apparatus.
  - b. At least thirty days prior to field quality control testing, submit descriptions of proposed field testing methods, procedures, and apparatus.

B. Informational Submittals: Submit the following:

1. Certificates:
  - a. Certification letters from variable frequency drive manufacturer and motor manufacturer that the approved driven equipment has been reviewed and that variable frequency drive units and motors are compatible, and shall be provided in accordance with the Contract Documents and requirements of the driven equipment.
2. Source Quality Control Submittals:
  - a. Within 14 days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
3. Field Quality Control Submittals:
  - a. Within 14 days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
4. Manufacturer Reports:
  - a. Preliminary and final harmonic analysis.
  - b. Within 14 days of each visit to the Site by manufacturer's representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.
5. Qualifications Statements:
  - a. Manufacturer.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:

- a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, list of recommended spare parts, and spare parts ordering information.
- b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
- c. Comply with Section: Operation and Maintenance Data.
- d. Field report of final harmonic testing

**D. Maintenance Materials Submittals: Submit the following:**

**1. Spare Parts and Extra Stock Materials:**

- a. Furnish, tag, and box for shipment and long term storage, spare parts and special tools for variable frequency drives. Each spare part set shall include manufacturer's recommended spare parts inventory for one year and include, at minimum, the following:

| <b>Item</b>                                      | <b>Quantity<br/>per Four VFDs per HP Rating</b> |
|--|---|
| 1) Transistor and diode modules with accessories | One set   |
| 2) Power supply module                           | One   |
| 3) Fans  | One set   |
| 4) Power fuses                                   | One set of each size and type used              |
| 5) Control power fuses                           | Two sets of each size and type used             |
| 6) Pilot lights                                  | Two per ten of each type used                   |

2. Furnish a list of recommended spare parts for an operating period of one year. Describe each part, the quantity recommended, and current unit price.

**1.5 DELIVERY, STORAGE, AND HANDLING**

**A. Delivery:**

1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Shipping containers shall be designed to be shipped by truck, rail, or ship. Indoor containers shall be bolted to skids.
3. Inspect variable frequency drive equipment for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.

**B. Handling:**

1. Lift, roll or jack variable frequency drive equipment into locations shown.
2. Variable frequency drives shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer's requirements.

C. Storage:

1. Store variable frequency drive equipment in a clean, dry location with controlled, uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT PERFORMANCE

A. System Performance:

1. Driven equipment to be controlled by a variable frequency drive shall be provided with a customized variable frequency drive. Each drive unit shall include an adjustable frequency controller with associated controls for continuous speed adjustment and protection of the driven equipment. Output speed control of motor shall be continuous throughout speed range of 2 to 60 Hertz under variable torque load or constant torque as specified for the driven equipment.
2. Variable frequency drives associated with each set of driven equipment shall be similar to each other.
3. Variable frequency drives shall be UL-listed or ETL-listed and designed, built, and tested in accordance with NEMA AB 1, NEMA ICS 2, NEMA ICS 7, and UL 508.
4. The VFD shall not emit harmonics that exceed IEEE 519 limits at the point of common coupling (PCC).
5. The PCC for all VFDs to be tested and conform to IEEE 519 harmonic limits will be considered the first point of connection to the electrical system, be that the motor control center that the VFD power is being supplied from and not the utility connection point.

### 2.2 MANUFACTURERS

A. Provide variable frequency drives by one of the following:

1. Schneider Electric
2. ABB
3. Allen-Bradley
4. Eaton
5. Toshiba
6. Danfoss
7. Or approved equal

### 2.3 APPROVED EQUAL: OTHER MANUFACTURERS MUST BE PRE-QUALIFIED BEFORE ONE (1) WEEK PRIOR TO BID OPENING. PREQUALIFICATION SHALL CONSIST OF SUBMITTING INFORMATION LISTED IN PARAGRAPHS 1.3 AND 1.4 ABOVE TO THE ENGINEER A MINIMUM OF TWO (2) WEEKS PRIOR TO THE BID OPENING DATE. APPROVAL OF EQUAL MANUFACTURERS (IF ANY) WILL BE MADE BY ADDENDUM PRIOR TO THE BID OPENING.

- A. Provide each variable frequency drive with freestanding or wall hanging, front-access, NEMA 1, filtered and gasketed enclosure. Enclosure shall house all components required for the associated variable frequency drive.
- B. Enclosure shall provide adequate cooling for components within and include positive ventilation.
- C. Enclosure shall include circuit breaker disconnect switch. Circuit breakers shall be in accordance with NEMA AB 1. Switch handle shall be suitable for padlocking and be through-the-door type with handle height not exceeding six feet. Operation of switch shall remove the service supply from all internal components. Power devices shall be suitable for interrupting capacity matching that of the upstream Power source in symmetrical amperes. Include current limiting semi-conductor fuses where required for protection of solid-state components.
- D. Enclosure door shall include an operator interface for access to controller's digital keypad and display.
- E. Equip enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 16075 - Electrical Identification.
- F. Equip enclosure with phenolic type terminal blocks suitably labeled for all internal and remote wiring requirements, plus twenty percent spare.
- G. Data shall be formatted as required to communicate with the plant SCADA system. The VFD's shall communicate via-Ethernet TCP/IP. The manufacturer shall coordinate with the plant integrator to map data for SCADA interface.

## 2.4 ADJUSTABLE FREQUENCY CONTROLLER

### A. General:

- 1. Adjustable frequency controller shall be microprocessor-based, pulse width modulated design, suitable for operation on a 480-volt, three-phase supply. Controller shall produce an adjustable AC voltage/frequency output to vary speed of driven equipment. Controller shall consist of the following sections:
  - a. The drive shall be a PWM (Pulse Width Modulated) inverter using IGBT transistors.
- 2. Controller switching frequency shall be adjustable and allow operation at 5,000 Hertz or less. Controller technology shall include a switching scheme that reduces the dv/dt of output supply.
- 3. Equip controller with a DC bus reactor or input line reactor as required to keep equipment line harmonics to a minimum.
- 4. Controller's solid-state converter input section switching devices shall have 1600 volt PIV rating.
- 5. Overload rating of 110 percent variable torque, 150 percent constant torque for one minute.
- 6. RMS harmonic content of output current shall be less than five percent of fundamental current.



7. Able to withstand output terminal line-to-line short circuits without component failure.

B. Operating Criteria:

1. Operating criteria shall be in accordance with the following:
  - a. Ambient temperature range of zero to 40°C
  - b. Operational humidity of up to 90 percent non-condensing
  - c. Altitude up to 3,300 feet above sea level
  - d. Nominal voltage of 480-volts plus or minus ten percent, three-phase, three-wire. Include an undervoltage feature to allow trip-free operation down to 35 percent undervoltage.
  - e. Nominal frequency of 60 Hertz plus or minus 3 Hertz.
  - f. Input power factor of 95 percent displacement power factor at all operating speeds.
  - g. Efficiency of 96 percent at full speed and full load.

C. Features:

1. Controller shall have the following features:
  - a. Digital keypad and display module shall provide parameter setting, adjustments, and monitoring of control functions and faults. Display messages shall be in English.
  - b. Serial communication port shall allow connecting to programmable controller interface using manufacturer standard protocol.
  - c. Independent acceleration/deceleration rates shall provide 2 to 600 seconds minimum. When called to stop, motor shall decelerate to minimum speed before stopping.
  - d. Power loss feature shall allow five cycle ride through capability for input supply interruptions.
  - e. Time delay automatic restart shall allow restart after controller fault conditions have been cleared with programmable attempts.
  - f. Coasting motor restart shall allow controller to restart into a coasting motor without damage or tripping. Coasting motor restart feature shall allow switching from bypass mode to variable frequency drive mode while operating, without shutdown.
  - g. Isolated control inputs and outputs

D. Protection:

1. Controller shall have protective functions as follows:
  - a. Input line metal oxide varistor transient protection
  - b. Electronic over-current trip, instantaneous and inverse time overload protection with thermal memory retention
  - c. Over-temperature trip temperature protection
  - d. Current limit trip protection
  - e. Input line over- and under-voltage trip protection
  - f. Ground fault trip protection

## 2. Power Line Considerations:

- a. The drive shall be designed to operate in accordance with all performance requirements of the contract documents from a power source which contains a maximum of 5% total voltage harmonic distortion, meet current distortion as defined by IEEE-519-1992.
- b. Each VFD or multiple sets of VFDs shall be designed and installed such that: the total voltage harmonic distortion reflected back to the power source is a maximum of 5%.
- c. When line reactors and harmonic filters are required, they shall be provided by the VFD supplier and shall be rated for, and compatible with, each VFD. They shall function as a complete system. Additional harmonic filters beyond those shown on drawings may be required in order to comply with the above parameters. The line reactors and harmonic traps shall be mounted inside the respective VFD enclosures. Traps shall be fuse-protected as a minimum and shall protect internal wiring and components on each phase and shall be current limiting. Data on these items shall be included with VFD shop drawings.
- d. The VFD supplier shall perform a computer simulated power system study to verify compliance with the parameters as stated herein. The results of this study shall be submitted to the engineer. At a minimum the submitted results of this study shall include:
  - 1) A results summary sheet which briefly describes the power system configuration analyzed and which states the calculated values of total harmonic distortion.
  - 2) Detailed list of the amplitude of harmonic currents and voltages to the 50th harmonic.
  - 3) This report must show if IEEE 519 is met and where on the power distribution it is.
- e. The contractor shall provide the VFD supplier with all power system data required to perform the above described study. These data may include but are not limited to:
  - 1) A complete one-line diagram of the subject electrical distribution system.
  - 2) Complete electrical data on all equipment shown on the one-line diagram is required. At a minimum this data shall consist of:
    - a) Transformers: kVA, Primary voltage, Secondary voltage, Short circuit capacity or impedance
    - b) Motors: Horsepower, Base speed, Full load RMS current (FLA)
    - c) Generators: Short circuit capacity or Subtransient reactances ( $X_d$ ), Power factor, kW, X/R Ratio
  - 3) If the distribution system can function in more than one configuration, the configuration(s) to be analyzed shall be clearly defined. Any other information which may affect the behavior of the distribution system shall also be provided.

## 2.5 OUTPUT FILTER

### A. General:

1. Provide output filter to prevent overstressing motor insulation system. Provide output filter with each variable frequency drive, when cable length between motor and variable frequency drive exceeds the following based on noted switching frequencies.
  - a. One KHZ switching frequency, 200 feet cable length.
  - b. Three KHZ switching frequency, 175 feet cable length.
2. Provide output filters in all other cases, based on recommendations of variable frequency drive and motor manufacturers, when actual voltage peaks at motor terminals exceed NEMA MG 1 limits.

### B. Features and Criteria:

1. Filter shall be three-phase, 600-volt class motor-protecting type consisting of suitable values of inductance, capacitance and resistance to form a damped, low pass filter.
2. Filter shall be low-loss type specifically designed to reduce voltage wave form  $dV/dt$ . Filter shall allow cable lengths, at a minimum, exceeding actual application distances with waveforms resulting in voltage spikes at motor terminals that are within NEMA MG 1 Part 31 voltage stress levels.
3. Filter shall be suitable for mounting within the variable frequency drive enclosure.

## 2.6 CONTROLS

### A. General:

1. Equip each variable frequency drive control system with relays, switches, fuses, indicating lights, and components required for a complete, functional system.
2. Variable frequency drive control shall be powered from a suitably sized and protected control power transformer.
3. Variable frequency drive control shall include status indicators, controller, and system fault condition displays and operating controls. Provide status indicators and operating controls associated with drive control on front door of enclosure.
4. Control arrangement shall be such that variable frequency drive internal electronic supply voltage is isolated from field wiring.

### B. Control and Pilot Devices:

1. Relays shall be standard, latching type, and pneumatic or solid-state time delay type. Provide relays with contacts rated ten amps, quantity as required.
2. Pilot devices shall be heavy duty type, rated 10 amps continuous. Indicating lights shall be push-to-test transformer type with 12-volt secondaries.

### C. Operation:

1. Controls for each variable frequency drive shall consist of all devices necessary for the following:

- a. Stop/Start and Speed Control: Stop/start and speed control shall respond to drive-mounted selector switch. With switch in "REMOTE" position, stop/start and speed control shall be based on a stop/start contact and 4–20 mA DC speed signal from remote process control panel. With switch in "LOCAL" position, stop/start control shall be based on remote stop/start pushbuttons located adjacent to driven equipment, and speed control shall be based on drive-mounted speed potentiometer.
- b. Emergency Stop Control: Emergency stop control shall respond to remote stop pushbutton located adjacent to driven equipment. When activated, driven equipment shall stop immediately in all operating modes.
- c. Motor Over-temperature Shutdown: Motor over-temperature control shall respond to remote contact that activates on motor over-temperature. When over-temperature is detected, driven equipment shall stop. Include provisions to remotely supply 120-volt power to thermistor control module located at motor.
- d. Seal water control (required for pumps and other equipment that require seal water): Seal water control shall include provisions to supply 120-volt power to remote seal water solenoid. Seal water solenoid shall energize when equipment requiring seal water is enabled. Equipment requiring seal water start shall be delayed until remote-located pressure switch verifies seal water flow. Upon loss of seal water, after an adjustable period of time, an alarm shall be initiated but equipment requiring seal water shall not shut down. When equipment requiring seal water is stopped, seal water solenoid shall remain energized for an adjustable period of time.

#### D. Auxiliary Features:

1. Provide each variable frequency drive with the following:
  - a. Status Indicators: Status indicators shall include separate pilot lights for indication of motor run (green), and bypass mode (blue).
  - b. Shutdown Indicators: Shutdown indicators shall include separate pilot lights (red) for each shutdown condition. Arrange shutdown indication circuitry so that, when activated, indicator requires manual reset.
  - c. Contact Outputs: Contact outputs shall include separate dry contacts for remote indication of motor run, seal water alarm for equipment with seal water systems, each shutdown condition, and controller faults.
  - d. Speed Output: Speed output shall include 4–20 mA DC signal for remote indication of motor speed.

#### E. Wiring and Device Identification:

1. Provide control wiring and device identification for each variable frequency drive:
  - a. Identify all control conductors with permanent type wire markers. Each wire shall be identified by a unique number that shall be attached to the wire at each termination point.
  - b. Identify each control device with permanent type marker. Each device shall be identified by a unique number attached to each device.
  - c. Numbering system for each wire and control device shall be identified on wiring diagrams and shall reflect actual designations used in the Work.

## 2.7 SOURCE QUALITY CONTROL

### A. Tests:

1. Perform factory tests on each variable frequency drive prior to shipping. Test shall consist of simulating expected load to be driven by operating load through speed ranges specified for driven equipment, for minimum of two hours per drive unit.
2. Provide factory control and alarm tests on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
3. Perform specified tests in addition to standard factory tests typically performed.

### B. Factory tests as outlined above shall be witnessed by the OWNER's representative:

1. The manufacturer shall notify the OWNER two (2) weeks prior to the date the tests are to be performed.
2. The manufacturer shall include the cost of transportation and lodging for up to three (3) OWNER's representatives.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

### 3.2 INSTALLATION

- A. Install equipment in accordance with manufacturer's recommendations and instructions and in conformance with Laws and Regulations, and the Contract Documents.
- B. Unless otherwise shown or indicated, install equipment at existing location of drive unit being replaced.
- C. Install equipment with sufficient access and working space provided for ready and safe operation and maintenance.
- D. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between equipment and wall for corrosion protection. Trim board neatly within outline of equipment.
- E. Install all terminations, lugs, and required appurtenances necessary to properly terminate power supplies.
- F. Install control wiring terminations and appurtenances necessary to complete installing control and monitoring devices.

### 3.3 FIELD QUALITY CONTROL

#### A. Site Tests:

1. After installation, inspect, adjust, and test each variable frequency drive at the Site. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Through CONTRACTOR, manufacturer's factory-trained representative shall inform OWNER and ENGINEER when equipment is correctly installed and ready to be energized. Do not energize equipment without permission of OWNER.
2. Perform the following equipment inspection and testing and provide reports documenting procedures and results.
  - a. Verify all device settings and drive adjustments.
  - b. Inspect all mechanical and electrical interlocks and controls for proper operation.
  - c. Test each drive through specified speed ranges and loads for a minimum of two hours per drive unit.
  - d. Test each drive by using actual control signal for remote and local operation.
  - e. Test each drive alarm function.
  - f. Perform other tests recommended by equipment manufacturer.
  - g. Perform Harmonics testing to confirm compliance with IEEE 519 limits.
    - 1) Testing of the Harmonic limits shall be per a VFD system as operating under natural conditions.
    - 2) Utilize the recorded maximum current recorded for the operating VFD system as  $I_{Load}$ .
    - 3) Submit all calculations, all collected field data and graphs for review to Engineer.
    - 4) If the VFD system fails to be at or below any or all of the IEEE 519 Harmonic acceptable levels, the VFD manufacturer shall incur all costs associated with retesting, additional harmonic mitigation equipment, equipment installation and retesting expenses including costs associated with Engineer travel to witness any and all testing.

#### B. Manufacturer Services:

1. Services by manufacturer's representative under this paragraph shall be at least 2 eight-hour days at the Site.
2. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of equipment and installation at equipment's final location. Representative shall train installing personnel in advance in the proper handling and rigging of equipment.
3. Manufacturer shall calibrate, set and program variable frequency drives provided.
4. Post-Installation Check – Manufacturer's factory-trained representative shall:
  - a. Check and approve the installed equipment before initial operation.
  - b. Adjust the system to final settings as specified in Article 3.5 of this section.
  - c. Test the system as specified in section 3.3.A of this section.

- d. Operate and test the system in presence of ENGINEER and verify that equipment is in conformance with the Contract Documents.
  - e. Revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
  - f. Provide services to correct defective Work within 72 hours of notification by OWNER during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
- 5. Replacement parts or equipment provided during the correction period shall be equal to or better than original.
  - 6. Training: Provide services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment.

### 3.4 ADJUSTING

- A. Following Substantial Completion, when inspection and testing are complete and variable frequency drives are operating, manufacturer's representative shall return to the Site and make final adjustments as required to each variable frequency drive furnished under this Section.

END OF SECTION 262923

## SECTION 263213 - PACKAGED ENGINE GENERATOR

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for standby power supply with the following features:
  - 1. Diesel engine
  - 2. Unit-mounted cooling system
  - 3. Unit-mounted control and monitoring
  - 4. Performance requirements for sensitive loads
  - 5. Load banks
  - 6. Outdoor enclosure
- B. Related Sections include the following:
  - 1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

#### 1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. Diesel #2 fuel

#### 1.4 SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
  - 1. Thermal damage curve for generator
  - 2. Time-current characteristic curves for generator protective device
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.



1. Wiring Diagrams: Power, signal, and control wiring
  - C. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Supporting Devices." Include the following:
    1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
    2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
    3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - D. Qualification Data: For installer, manufacturer and testing agency
  - E. Source quality-control test reports
    1. Certified summary of prototype-unit test report
    2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit
    3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
    4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements
    5. Report of sound generation
    6. Report of exhaust emissions showing compliance with applicable regulations
    7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
  - F. Field quality-control test reports
  - G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
    1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
  - H. Warranty: Special warranty specified in this Section.
- 1.5 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours normal travel time from Installer's place of business to Project site.
  2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with ASME B15.1.
- G. Comply with NFPA 37.
- H. Comply with NFPA 70.
- I. Comply with NFPA 110 requirements for Level 2 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- 1.6 PROJECT CONDITIONS
- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
  2. Do not proceed with interruption of electrical service without Construction Manager's written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: -20 to +40°C
  2. Relative Humidity: 0 to 95 percent
  3. Altitude: Sea level to 1000 feet

#### 1.7 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: 5 years or 3000 hours whichever occurs first to guarantee from defective material/workmanship from date of initial startup. Warranty is comprehensive including labor travel and parts.

#### 1.9 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, provide (1) visit in the initial year for planned maintenance by service technician of manufacturer's designated local service organization. Provide oil and fuel filters parts as part of these visits and supplies same items as those used in the manufacture and installation of original equipment.

#### 1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
  2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
  3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Caterpillar; Engine Division
  2. Generac Power Systems, Inc.
  3. Kohler Co.; Generator Division
  4. Cummins Power Generation; Industrial Business Group
  5. MTU Detroit Diesel

### 2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics: 250 kW / 313 kVA, 0.8 PF, 277/480 volt, 3-phase 4-wire, alternator capable of supplying 900 SkVA for motor starting loads with maximum instantaneous voltage dip of 35%.
1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
  2. Output Connections: Three-phase, four wire.
  3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth:  $\pm 3$  percent of rated output voltage from no load to full load.
  2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

## 2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 1950 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
  1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
  1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
  2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
  3. Retain paragraph below where required by NFPA 110, which prescribes engine water-jacket temperature requirements. Coordinate with Drawings for electrical supply.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump. Design for peak ambient air temperature of 110°F.
  1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    - a. Rating: 50-psig maximum working pressure with coolant at 180°F, and not collapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. (See Sound enclosure for sound requirements for total system)
- J. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 12 or 24 -V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
  2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  3. Cranking Cycle: As required by NFPA 110 for system level specified.
  4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
  5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10°C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
  7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
  8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
    - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower

float-charging mode and shall continue to operate in that mode until battery is discharged again.

- b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40°C to plus 60°C to prevent overcharging at high temperatures and undercharging at low temperatures.
- c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to  $\pm 10$  percent.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## 2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Double Wall Secondary Containment Sub-base Fuel Tank Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
  - 1. Tank level indicator.
  - 2. Capacity: Fuel for 24 hours (minimum) continuous operation at 100 percent rated power output (or 500 gallons minimum).
  - 3. Vandal-resistant fill cap.
  - 4. Containment Provisions: Comply with requirements of authorities having jurisdiction.
- C. State of Ohio Fire Marshall Requirements – Include required components below; obtain permits and arrange inspection from State of Ohio Fire Marshall for tank pressure test. Tank pressure test by generator supplier.
- D. Fuel fill option – The fuel fill is equipped with a 5 gallon above ground fill/spill container that contains fuel over spills that may occur during fill-ups and the normal vent will be extended to 12' above the grade
- E. Decal – The fuel tank will be equipped with a combustible liquids decal and NFPA 704 marker decal.
- F. High fuel level switch – A fuel level switch will be installed in the tank and the contacts will close when the fuel level reaches 90%.

## 2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator

set. When mode-selector switch is switched to the "On" position, generator set starts. The "Off" position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the "On" position starts generator set. The "Off" position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- D. Indicating and Protective Devices and Controls:
  - 1. AC voltmeter
  - 2. AC ammeter
  - 3. AC frequency meter
  - 4. DC voltmeter (alternator battery charging)
  - 5. Engine-coolant temperature gage
  - 6. Engine lubricating-oil pressure gage
  - 7. Running-time meter
  - 8. Ammeter-voltmeter, phase-selector switch(es)
  - 9. Generator-voltage adjusting rheostat
  - 10. Start-stop switch
  - 11. Overspeed shutdown device
  - 12. Coolant high-temperature shutdown device
  - 13. Coolant low-level shutdown device
  - 14. Oil low-pressure shutdown device
  - 15. Fuel tank derangement alarm
  - 16. Fuel tank high-level shutdown of fuel supply alarm
  - 17. Generator overload
- E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.



## 2.6 ACCESSORIES

- A. Battery Charger – An automatic float to equalize battery charger with the following features:
  - 1. 12 or 24 VDC output
  - 2. Voltage regulation of 1% from no to full load over 10% AC input line voltage variations
  - 3. Ammeter and voltmeter with 5% full-scale accuracy
  - 4. LED lamp for power indication
  - 5. Current limited during engine cranking, short circuit, and reverse polarity conditions
  - 6. Temperature compensated for ambient temperatures for -40°C to 60°C
  - 7. UL Listed
- B. Battery, Rack and Cables – Battery, battery rack and battery cables capable of holding the manufacturer's recommended batteries shall be supplied
- C. Rodent Guards – Generator rodent guards shall prevent intrusion and protect internal components
- D. Block Heater – The block heater shall be thermostatically controlled and sized to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements of NFPA 99 and NFPA 110, Level 1.
- E. Dry Contacts – 2 Input/5 Output Module kit provides two additional analog inputs and 5 additional dry contact outputs. The analog inputs can be used for analog or digital input functions. They can be set up for 0-5VDC,  $\pm 3$ VDC resistive or relay contact sensor devices
- F. Remote emergency generator stop button – generator shall be furnished with an externally mounted, recessed, emergency stop switch, Pilla model GS series with clear protective cover # PILCLHCOV1 or equal, NEMA 4X rated.
- G. Supply flexible fuel lines to provide a flexible connection between the engine fuel fittings and the fuel supply tank piping and for the fuel return lines from the injector pump per engine manufacturer's recommendations. Flex line shall have a protective steel wire braid to protect the hose from abrasion.
- H. Remote annunciator panel

## 2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: 400A; 100% rated; electronic trip; complying with NEMA AB 1 and UL 489.
  - 1. Tripping Characteristic: Designed specifically for generator protection.
  - 2. Trip Rating: Matched to generator rating.
  - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Mounting: Adjacent to or integrated with control and monitoring panel.

## 2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

## 2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof aluminum or steel housing, wind resistant up to 150 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure. The generator set shall be supplied with a Sound Attenuated Enclosure, providing a sound pressure of 80 dB(A) while the generator is operating at 100% load at 7 meters (23 feet).
- B. Description: Prefabricated enclosure with the following features:
  1. Construction: Galvanized-steel, metal-clad, or aluminum, integral structural-steel-framed building erected on concrete foundation.
  2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
  3. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
  4. Hinged Doors: With padlocking provisions.
  5. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.

6. Thermal Insulation: Manufacturer's standard materials and thickness selected to maintain winter interior temperature within operating limits required by engine-generator-set components.
- C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
  1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
- D. Convenience Outlets: GFCI. Arrange for external electrical connection.

## 2.10 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil-and-water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

## 2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## 2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
  1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  2. Full load run
  3. Maximum power
  4. Voltage regulation
  5. Transient and steady-state governing
  6. Single-step load pickup
  7. Safety shutdown
  8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
  9. Report factory test results within 10 days of completion of test.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with elastomeric isolator pads on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Supporting Devices."
- D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### 3.3 CONNECTIONS

- A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- B. Connect engine exhaust pipe to engine with flexible connector.
- C. Connect fuel piping to engines with a gate valve and union and flexible connector.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."
- E. Connect wiring according to Division 26 Section "Conductors and Cables."

### 3.4 IDENTIFICATION

- A. Identify system components according to Division 26 Section "Electrical Identification."

### 3.5 FIELD QUALITY CONTROL

#### A. Non-Conforming Work

1. To ensure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and/or local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.
  - a. Design Prototype Tests. Components of the emergency system, such as the engine/generator set, transfer switch, and accessories, shall not be subjected to prototype tests because the tests are potentially damaging. Rather, similar design prototypes and preproduction models shall be subject to the following tests:
    - i. Maximum power (kW)
    - ii. Maximum motor starting (kVA) at 35% instantaneous voltage dip.
    - iii. Alternator temperature rise by embedded thermocouple and/or by resistance method per NEMA MG1-32.6
    - iv. Governor speed regulation under steady-state and transient conditions
    - v. Voltage regulation and generator transient response
    - vi. Harmonic analysis, voltage waveform deviation, and telephone influence factor
    - vii. Three-phase short circuit tests
    - viii. Alternator cooling air flow
    - ix. Torsional analysis to verify that the generator set is free of harmful torsional stresses
    - x. Endurance testing
  - b. Final Production Tests. Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
    - i. Single-step load pickup
    - ii. Safety shutdown device testing
    - iii. Rated Power @ 0.8 PF
    - iv. Maximum power
    - v. Upon request, a witness test, or a certified test record sent prior to shipment
  - c. Site Tests. The manufacturer's distribution representative shall perform an installation check, startup, and building load test. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:
    - i. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
    - ii. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery chargers, alternator strip heaters, remote annunciators, etc.

- iii. Generator set startup under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during operation, normal and emergency line-to-line voltage and frequency, and phase rotation.
- B. Automatic start by means of a simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator set voltage, amperes, and frequency shall be monitored throughout the test
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.
- B. Load Bank test: 2-hour resistive load bank test shall be performed. Data shall be recorded every 15 minutes for the first hour with 25%, 50%, 75% and last hour 100% load. The temporary portable load bank will be provided by generator manufacturer.
- C. Tank testing: Electrical installer shall obtain permits and arrange inspection from State of Ohio Fire Marshall for tank pressure test. Tank pressure test to be included with generator supplier.

END OF SECTION 263213

## SECTION 263600 - ENCLOSED TRANSFER SWITCH

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Automatic transfer switch

#### 1.2 RELATED SECTIONS

- A. Section 263213 - Packaged Engine Generator Systems

#### 1.3 REFERENCES

- A. NFPA 70 - National Electrical Code
- B. NEMA ICS 1 - General Standards for Industrial Control and Systems
- C. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies
- D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- E. UL 1008 - Standard for Transfer Switch Equipment

#### 1.4 SUBMITTALS

- A. Submit under provisions of Section 013323.
- B. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

#### 1.5 OPERATION AND MAINTENANCE DATA

- A. Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions when engine generator is running.
- B. Maintenance Data: Include routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

## 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.

## 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 016600.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

## 1.9 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Russelectric
- B. ASCO
- C. Kohler
- B. Cummins
- C. Cutler – Hammer
- D. Siemens



E. Lake Shore Electric

## 2.2 AUTOMATIC TRANSFER SWITCH

- A. Description: NEMA ICS 2, automatic transfer switch.
- B. Configuration: Electrically operated, mechanically held transfer switch.
- C. Type: Dual mechanism, with off position, adjustable transfer delay, and manual operation of both sets of contacts using a handle.

## 2.3 RATINGS

- A. Voltage: 480 volts, three phase, four wire, 60 Hz.
- B. Switched Poles: 3. Refer to NEC Article 250 for proper generator grounding.
- C. Load Inrush Rating: Combination.
- D. Continuous Rating: 600 amperes.
- E. Withstand Current Rating: A minimum of 22 kA rms symmetrical amperes.
- F. Non-service Entrance Rated without overcurrent protection

## 2.4 PRODUCT OPTIONS AND FEATURES

- Microprocessor logic
- Adjustable time Delay Normal to Emergency
- Adjustable time Delay Engine Start Adjustable 5-15 sec
- Adjustable time Delay Emergency to Normal
- Adjustable time Delay Engine Cooloff
- Emergency Source Sensing
- Test pushbutton
- Electrical Operator Isolation Switch
- Single Phase Under Voltage/Under Frequency
- Indication / Pilot Light: Normal Position
- Indication / Pilot Light: Emergency Position
- Indication / Pilot Light: Normal Tripped
- Indication / Pilot Light: Emergency Tripped
- Aux. Contacts: Normal Source Available - 4NO/4NC
- Aux. Contacts: Emergency Source Available - 4NO/4NC
- Normal and Emergency Over current protection
- Auto. Plant Exer.: Selectable Load/No Load w/Failsafe

- A. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- B. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.
- C. Transfer Switch Auxiliary Contacts: 2 normally open, 2 normally closed.
- D. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.
- E. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.
- F. Open transition transfer.

## 2.5 AUTOMATIC SEQUENCE OF OPERATION

- A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
- B. Time Delay To Start Alternate Source Engine Generator: 0 to 15 seconds, adjustable.
- C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
- D. Time Delay Before Transfer to Alternate Power Source: 0 to 3 minutes, adjustable.
- E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
- F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.
- G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.
- H. Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.
- I. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

## 2.6 ENCLOSURE

- A. Enclosure: NEMA Type 4
- B. Finish: Painted Steel.
- C. Free Standing, to be bolted to concrete below
- D. Front Access only.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install transfer switches in accordance with manufacturer's instructions.
- B. Provide engraved plastic nameplates under the provisions of Section 260553.
- C. Include startup by authorized technician and coordinate with generator manufacturer.

### 3.2 WARRANTY – Provide 5-year comprehensive warranty with parts, labor and travel

### 3.3 DEMONSTRATION

- A. Provide systems demonstration under provisions of Section 017900.
- B. Demonstrate operation of transfer switch in normal and emergency modes.

END OF SECTION 263600

## SECTION 264313 - TRANSIENT VOLTAGE SUPPRESSION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes TVSSs for low-voltage power, control, and communication equipment.

#### 1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications
- B. SVR: Suppressed voltage rating
- C. TVSS: Transient voltage surge suppressor

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:
  - 1. UL 1283
  - 2. UL 1449
- C. Qualification Data: For testing agency
- D. Field quality-control test reports, including the following:
  - 1. Test procedures used
  - 2. Test results that comply with requirements
  - 3. Failed test results and corrective action taken to achieve requirements
- E. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals
- F. Warranties: Special warranties specified in this Section

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

- B. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- E. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
- F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

## 1.6 PROJECT CONDITIONS

- A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Replaceable Protection Modules: One of each size and type installed.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advanced Protection Technologies, Inc.
2. Atlantic Scientific
3. Current Technology, Inc.
4. Cutler-Hammer, Inc.; Eaton Corporation
5. Entrelec International
6. General Electric Company
7. Innovative Technology, Inc.
8. Intermatic, Inc.
9. LEA International
10. Leviton Mfg. Company Inc.
11. Liebert Corporation; a division of Emerson
12. Northern Technologies, Inc.
13. Siemens Energy & Automation, Inc.
14. Square D; Schneider Electric
15. Surge Suppression Incorporated
16. Sutton Designs Inc.
17. Transtector Systems, Inc.
18. Tycor; Cutler-Hammer, Inc.
19. United Power Corporation
20. Zero Surge Inc.

## 2.2 SERVICE ENTRANCE SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
  1. LED indicator lights for power and protection status
  2. Audible alarm, with silencing switch, to indicate when protection has failed
  3. One set of dry contacts rated at 5 A, 250 VAC for remote monitoring of protection status
- B. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
  1. Fuses, rated at 200 kA interrupting capacity
  2. Fabrication using bolted compression lugs for internal wiring
  3. Integral disconnect switch
  4. Redundant suppression circuits
  5. Redundant replaceable modules
  6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus
  7. Arrangement with wire connections to phase buses, neutral bus, and ground bus
  8. LED indicator lights for power and protection status
  9. Audible alarm, with silencing switch, to indicate when protection has failed
  10. One set of dry contacts rated at 5 A, 250 VAC for remote monitoring of protection status. Coordinate with building power monitoring and control system.
  11. Surge-event operations counter
- C. Peak Single-Impulse Surge Current Rating: 240 kA per phase.
- D. Connection Means: Permanently wired
- E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 480/277, 3-phase, 4-wire circuits shall be as follows:
  1. Line to Neutral: 800V for 480/277.

2. Line to Ground: 800V for 480/277.
3. Neutral to Ground: 800V for 480/277.

## 2.3 PANELBOARD SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
  1. LED indicator lights for power and protection status
  2. Audible alarm, with silencing switch, to indicate when protection has failed.
  3. One set of dry contacts rated at 5 A, 250 VAC for remote monitoring of protection status
- B. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
  1. Fuses, rated at 200 kA interrupting capacity
  2. Fabrication using bolted compression lugs for internal wiring
  3. Integral disconnect switch
  4. Redundant suppression circuits
  5. Redundant replaceable modules
  6. Arrangement with wire connections to phase buses, neutral bus, and ground bus
  7. LED indicator lights for power and protection status
  8. Audible alarm, with silencing switch, to indicate when protection has failed
  9. One set of dry contacts rated at 5 A, 250 VAC for remote monitoring of protection status. Coordinate with building power monitoring and control system.
  10. Surge-event operations counter.
- C. Peak Single-Impulse Surge Current Rating: 120 kA per phase
- D. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
  1. Line to Neutral: 400V for 208Y/120.
  2. Line to Ground: 400V for 208Y/120.
  3. Neutral to Ground: 400V for 208Y/120.
- E. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
  1. Line to Neutral: 400 V
  2. Line to Ground: 400 V
  3. Neutral to Ground: 400 V
- F. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
  1. Line to Neutral: 400 V, 800 V from high leg
  2. Line to Ground: 400 V
  3. Neutral to Ground: 400 V

## 2.4 ENCLOSURES

- A. NEMA 250, with type matching the enclosure of panel or device being protected.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard, Motor Control Center, and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
  - 1. Provide multi-pole, 30A circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

### 3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect panelboards, Motor Control Centers to their sources until surge protection devices are installed and connected.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust equipment installation, including connections, and to assist in field testing. Furnish all test results.
  - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Perform the following field tests and inspections and prepare test reports:
  - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
  - 2. Complete startup checks according to manufacturer's written instructions.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 264313



## SECTION 265100 - LIGHTING FIXTURES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Interior luminaires and accessories
- B. Luminaire accessories

#### 1.2 REFERENCES

- A. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns
- B. ANSI C82.1 - Ballasts for Fluorescent Lamps - Specifications
- D. NEMA WD 6 - Wiring Devices-Dimensional Requirements
- E. NFPA 70 - National Electrical Code
- F. NFPA 101 - Life Safety Code

#### 1.3 SUBMITTALS FOR REVIEW

- A. Section 013323 - Submittals: Procedures for submittals
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: Provide dimensions, ratings, and performance data.

#### 1.4 SUBMITTALS FOR INFORMATION

- A. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

#### 1.5 SUBMITTALS FOR CLOSEOUT

- A. Submit manufacturer's operation and maintenance instructions for each product.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Conform to requirements of NFPA 101.
- C. Products: Listed and classified by Underwriters Laboratories, Inc.

## PART 2 - PRODUCTS

### 2.1 LUMINAIRES

- A. Furnish Products as listed in Lighting Fixture Schedule in the Specification Drawings. Refer to Section 012513 for substitutions and product options.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- B. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- C. Install wall mounted luminaires, emergency lighting units at height as scheduled.
- D. Install accessories furnished with each luminaire.
- F. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- G. Bond products and metal accessories to branch circuit equipment grounding conductor.
- H. Install specified lamps in each emergency lighting unit, and luminaire.

### 3.2 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

### 3.3 CLEANING

- A. Section 017719 - Contract Closeout
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosures.
- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.

END OF SECTION 265100

## SECTION 310000 - EARTHWORK

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. The Work covered by this Section shall include all excavation, trenching and related work for the construction of the designated structures and pipelines, backfill and other incidental work.
- B. The Work covered by this Section consists of:
  - 1. making all necessary excavations for the construction of all Work;
  - 2. preparing subgrade for foundations, slabs, walks, and pavements;
  - 3. doing all pumping, fluming, and dewatering necessary to keep the trenches and other excavation free from water;
  - 4. providing for uninterrupted flow of existing drains and sewers, and the disposal of water from any sources during the progress of the Work;
  - 5. supporting and protecting all trench walls, structures, pipes, conduits, culverts, posts, poles, wires, fences, buildings and other public property adjacent to the Work;
  - 6. removing and replacing existing sewers, culverts, pipelines and bulkheads where necessary;
  - 7. removing after completion of the Work all sheeting and shoring or other soil support materials not necessary to support the sides of trenches;
  - 8. removing and disposing all surplus excavated material;
  - 9. doing all backfilling and grading, of compacting backfill to limits specified or ordered by the Engineer;
  - 10. restoring all property damaged as a result of the Work involved in this Contract.
- C. The Work includes transporting surplus excavated materials not needed for backfill at the location where the excavation is made, to other parts of the Work where filling is required, and disposal of all types of surplus material off the site.
- D. The Work includes:
  - 1. constructing a structure of soil or granular material in layers to a predetermined elevation and cross section;
  - 2. supporting and protecting all structures, pipes, conduits, culverts, posts, poles, wires, fences, buildings and other public property adjacent to the Work;
  - 3. placing all fill and performing rough grading;
  - 4. compacting fill to limits specified or ordered by the Engineer;
  - 5. restoring all property damaged as a result of the Work involved in this Contract.

### 1.3 DEFINITIONS

- A. Backfill: Soil or granular materials used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, not including haunches to support sides of pipe.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding: Layer placed over the excavated subgrade in a trench before laying pipe.
- C. Borrow: Satisfactory soil imported for use as fill or backfill.
- D. Excavation: Removal and disposal of material encountered above subgrade or foundation elevations.
  - 1. Additional Excavation: Excavation below subgrade or foundation elevations as directed by Engineer.
  - 2. Trench: Narrow linear excavation
  - 3. Unauthorized Excavation: Excavation below subgrade or foundation elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
  - 4. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface or subsurface conditions encountered, including rock, soil materials and obstructions.
- E. Embankment: A structure consisting of soil, granular material, shale, rock, or other approved material, constructed in layers to a predetermined elevation and cross-section.
- F. Granular materials: Natural aggregate, such as broken or crushed rock, gravel, or sand that can be readily incorporated into an 8-inch layer, and in which at least 65% by weight of the grains or particles are retained in a No. 200 sieve.
- G. Laboratory Dry Weight: The maximum laboratory dry weight shall be the weight provided by the laboratory when the sample is tested in accordance with ASTM D-698 Method A, C, or D.
- H. Optimum Moisture: The water content at which the maximum density is produced in a soil by a given compaction effort (ASTM D-698).
- I. Pavement Prism: Also referred to as the zone of influence. The area below a line drawn 45 degrees to the horizontal from the surface at the edge of pavement, sidewalk or curb.
- J. Pipe Embedment: The material placed in a trench surrounding a pipe or conduit consisting of the foundation, bedding, haunching, and initial backfill.

- K. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material one (1) cu. yd. or more in volume that when tested by an independent geotechnical testing agency, according to ASTM D 1586, exceeds a standard penetration resistance of 100 blows/2 inches.
- L. Shale: Laminated material, formed by the consolidation in nature of soil, having a finely stratified structure. For the purpose of these specifications, the following bedrock types shall also be considered shale: mudstone, claystone, siltstone and hard clay.
- M. Soil: All earth materials, organic or inorganic, which have resulted from natural processes such as weathering, decay, and chemical reaction.
- N. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, pavement, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- O. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage course, or topsoil materials.
- P. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

#### 1.4 SUBMITTALS

- A. Comply with all provisions of Section 01061CT, Shop Drawings and Submittals.
- B. Product Data: For the following:
  - 1. Source-locations of all materials shall be identified to the Engineer.
  - 2. Source quality laboratory test of all fill materials as required to show compliance with material specifications.
- C. Shop Drawings: Submit information for the following items:
  - 1. Sheeting and bracing (*prepared and stamped by a professional engineer, registered in the State of Ohio*).
  - 2. Dewatering system and standby equipment (*prepared and stamped by a professional engineer, registered in the State of Ohio*).
  - 3. Cofferdams (*prepared and stamped by a professional engineer, registered in the State of Ohio*).
  - 4. Protection methods anticipated (*prepared and stamped by a professional engineer, registered in the State of Ohio*).
  - 5. Underpinning (*prepared and stamped by a professional engineer, registered in the State of Ohio*).
  - 6. Excavation procedures (*prepared and stamped by a professional engineer, registered in the State of Ohio*).

## 1.5 REFERENCES

- A. AASHTO M 43 Standard Specification for Size of Aggregate for Road and Bridge Construction
- B. ASTM C-150 Standard Specification for Portland Cement
- C. ASTM C-618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- D. ASTM D-698 Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop
- E. ASTM D-1586 Standard Method for Penetration Test and Split-Barrel Sampling of Soils
- F. ASTM D-2487 Standard Test Method for Classification of Soils for Engineering Purposes
- G. ASTM D-2940 Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
- H. ASTM D-4253 Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- I. ASTM D-4254 Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- J. State of Ohio - Department of Transportation - Construction and Material Specifications, Item 304, Aggregate Base.
- K. State of Ohio - Department of Transportation - Construction and Material Specifications, Material Detail 703.16, Suitable Materials for Embankment Construction.
- L. State of Ohio - Department of Transportation - Construction and Material Specifications, Material Detail 703.02.A.2, Fine Aggregate for Portland Cement Concrete

## 1.6 QUALITY ASSURANCE

- A. Qualifications
- B. Regulatory Requirements
- C. Certifications
- D. Field Samples
- E. Mock-ups
- F. Pre-Construction Conference

## 1.7 PROJECT CONDITIONS

### A. Environmental Requirements

### B. Existing Conditions

1. Existing ground elevations of the site are shown by figures and/or by contours on the Drawings. The contours and elevations of the present ground are believed to be reasonably correct, but do not purport to be absolutely so, and, together with any schedule of quantities, are presented only as an approximation. The Contractor shall satisfy himself, however, by actual examination on the site of the Work, as to the existing elevations and contours, and the amount of work required.

### C. Existing Utilities

1. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
2. Notify Engineer not less than two days in advance of proposed utility interruptions.
3. Do not proceed with utility interruptions without Engineer's written permission.
4. Contact utility-locator service for area where Project is located before excavating.

## 1.8 DELIVERY, STORAGE AND HANDLING

### A. Deliver products to the site, store and protect under provisions of Section 016600, Product Handling and Protection.

### B. Comply with all provisions of Section 013543, Environmental Protection.

## 1.9 SEQUENCING AND SCHEDULING

### A. Refer to 013319 for testing laboratory service scheduling.

## 1.10 PROHIBITION OF EXPLOSIVES

### A. The use of explosives is not permitted.

## 1.11 FIELD MEASUREMENTS

### A. The Contract Drawings may indicate locations where certain utilities, structures or facilities might possibly interfere with the installation of new improvements. The Contractor shall dig such exploratory test pits as may be necessary to determine the exact location and elevation of the indicated subsurface structure and shall make acceptable provision for their protection, support and maintenance in operation.



The Engineer shall be provided advance notification when and where excavation for test pits will take place. The Contractor shall provide the Engineer a record of field locations of all listed utilities, structures or facilities a minimum of five (5) days prior to initiating construction of the project. Locations and elevations are to be provided by a Surveyor registered in the State of Ohio.

## PART 2 - PRODUCTS

### 2.1 GRANULAR PIPE EMBEDMENT

- A. Crushed gravel or crushed limestone meeting AASHTO M 43 gradation shall be used for bedding, haunching, and initial backfill as shown on the Drawings.

### 2.2 SAND PIPE EMBEDMENT

- A. Fine aggregate consisting of natural sand meeting the gradation requirements of ODOT Item 703.02.A.2 or shown on the Drawings. The material shall not be lumpy or frozen, and shall be free from slag, cinders, ashes, rubbish, and other deleterious or objectionable material. Sand shall not contain a total of more than 10% by weight of loam and clay.

### 2.3 ONSITE BACKFILL

- A. Excavated soil material, capable of meeting specified compaction, and approved by the Engineer for use as backfill in designated locations.
- B. Based upon subsurface investigation, the Owner does not guarantee the onsite soils in its present state consists of the proper moisture content to achieve the specified compaction without drying or adding water.
- C. Unsuitable Backfill Material
  - 1. Onsite materials that are unsuitable for backfill, unless otherwise specifically shown in the Drawings, include rock or other materials greater than six (6) inches in their largest dimension, pavement, rubbish, debris, wood, metal, plastic, frozen earth, and the following soils classified per ASTM D-2487:

| Symbol | Description   |
|--------|---|
| OL     | Organic silts and organic silty clays of low plasticity                       |
| MH     | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts |
| CH     | Inorganic clays of high plasticity, fat clays                                 |
| OH     | Organic clays of medium to high plasticity                                    |
| PT     | Peat, muck, and other highly organic soils                                    |

## 2.4 SPECIAL BACKFILL MATERIAL (ODOT Item 304)

- A. Special backfill material shall meet the gradation requirements of ODOT Item 304 and shall consist of crushed gravel or crushed limestone in combination with natural sand or stone. The aggregate shall meet the following gradation requirements:

| <u>Sieve</u> | <u>Total Percent Passing</u> |
|--------------|------------------------------|
| 2 inch       | 100                          |
| 1 inch       | 70-100                       |
| ¾ inch       | 50-90                        |
| No. 4        | 30-60                        |
| No. 40       | 9-33                         |
| No. 200      | 0-15                         |

## 2.5 LOW STRENGTH MORTAR BACKFILL

- A. Cement shall conform to ASTM C-150, Type 1
- B. Fly ash shall be Class F, ASTM C-618.
- C. Aggregate
1. Fine Aggregate shall be natural sand consisting of mineral aggregate particles. The gradation of the sand shall be as follows:

| <u>Sieve Size</u> | <u>Percent Passing</u> |
|-------------------|------------------------|
| ¾"                | 100                    |
| 200               | 0 - 10                 |

2. It is intended that the sand be fine enough to stay in suspension in the mixture to the extent required for proper flow. The Engineer reserves the right to reject the sand if a flowable mixture cannot be produced.
- D. Mortar Mix Proportioning
1. The initial trial mixture shall be as follows:

### Quantity of Dry Materials per Cubic Yard

|             |           |
|-------------|-----------|
| Cement      | 100 lbs.  |
| Fly Ash     | 250 lbs.  |
| Sand (SSD)* | 2700 lbs. |
| Water       | 500 lbs.  |

\* saturated-surface dry

2. These quantities of materials are expected to yield approximately 1 cubic yard of mortar of the proper consistency. Adjustments of the proportions may be made providing the total absolute volume of the materials is maintained.

## 2.6 EMBANKMENTS

- A. Soils suitable for use in an embankment must conform to ODOT 703.16 and are restricted as follows:
1. Maximum laboratory dry weight shall not be less than 90 pounds per cubic foot, except that soils having maximum dry weights of less than 100 pounds per cubic foot shall not be used in the top 12 inches of embankment.
  2. Soil having a liquid limit in excess of 49 are considered as unsuitable for use in an embankment.
  3. Silt from excavation or borrow identified as Ohio Classification A-4b shall be considered suitable for use in an embankment only when placed at least 3 feet below the surface of the subgrade.
  4. No slag, recycled Portland cement concrete or recycled asphaltic concrete products are suitable for use in an embankment.
  5. Do not use any suitable material that cannot be incorporated in an 8-inch lift in the top 2 feet of the embankment.
  6. Do not use shale, hard shale, or siltstone in the top 2 feet of embankment.
  7. Do not use materials that cannot be satisfactorily placed and compacted to a stable and durable condition.
  8. Material excavated in the work that contains excessive moisture is unsuitable for embankment construction unless dried. Dry or aerate such material before incorporating in the work. The Contractor may elect to waste this material, instead of drying it.
  9. Granular material Type E as specified in ODOT 703.16.C, is not allowed.
  10. No petroleum contaminated soils are suitable for use in an embankment.

## 2.7 ENGINEERED FILL

- A. Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940. The aggregate shall meet the following gradation requirements:

| <u>Sieve</u> | <u>Total Percent Passing</u> |
|--------------|------------------------------|
| 2 inch       | 100                          |
| 1½ inch      | 95-100                       |
| ¾ inch       | 70-92                        |
| 3/8 inch     | 50-70                        |
| No. 4        | 35-55                        |
| No. 30       | 12-25                        |
| No. 200      | 0-8                          |

## 2.8 ACCESSORIES

- A. Warning Tape
1. Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

- a. Red: Electric.
- b. Yellow: Gas, oil, steam, and dangerous materials.
- c. Orange: Telephone and other communications.
- d. Blue: Water systems.
- e. Green: Sewer systems.

B. Detectable Warning Tape

- 1. Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
  - a. Red: Electric.
  - b. Yellow: Gas, oil, steam, and dangerous materials.
  - c. Orange: Telephone and other communications.
  - d. Blue: Water systems.
  - e. Green: Sewer systems.

## PART 3 - EXECUTION

### 3.1 PROTECTION

A. Excavation; Temporary Sheet piling, Shoring, and Bracing

- 1. All excavation shall be in accordance with the Occupation Safety and Health Administration (OSHA) regulations.
- 2. The Contractor shall furnish and install adequate sheet piling, shoring, and bracing to maintain safe working conditions, and to protect newly built work and all adjacent neighboring structures from damage by settlement.
- 3. Bracing shall be arranged so as not to place a strain on portions of completed work until construction has proceeded enough to provide ample strength. Sheet piling and bracing may be withdrawn and removed at the time of backfilling, but the Contractor shall be responsible for all damage to newly built work and adjacent and neighboring structures.
- 4. All sheet piling shall be removed unless specifically authorized in writing by the Engineer to be left in place.

B. Construction Sheet piling Left in Place

- 1. The Contractor shall furnish, install, and leave in place construction sheet piling and bracing when specified or when indicated or shown on the Drawings.
- 2. Any construction sheet piling and bracing which the Contractor has placed to facilitate his work may be ordered in writing by the Engineer to be left in place. The right of the Engineer to order sheet piling and bracing left in place shall not be construed as creating an obligation on his part to issue such orders. Failure of the Engineer to order sheet piling and bracing left in place shall not relieve the Contractor of his responsibility under this Contract.

### 3.2 REPLACING, MOVING AND REPAIRING OF EXISTING UTILITIES

- A. The Contractor shall:
  - 1. replace, move, repair and maintain all utilities and all other structures encountered in the work
  - 2. coordinate and communicate with applicable utility companies
  - 3. repair all damage done to any of the said structures and appurtenances through his acts or neglect and shall keep them in repair during the life of this contract. The Contractor shall in all cases leave them in as good condition as they were previous to the commencement of the work and to the satisfaction of the Engineer.

### 3.3 DEWATERING

- A. Drainage and Removal of Water
  - 1. The Contractor shall dispose of water from the Work in a suitable manner without damage to adjacent property or structures.
  - 2. The Contractor shall, when ordered by the Engineer, construct tight bulkheads across trench and provide pumps suitable for the removal of any water which may be encountered or which may accumulate in the trenches. Unless otherwise provided for in the Contract Documents, drainage water will not be permitted to flow through the conduit.
  - 3. The trench shall be kept free from sewage and storm, surface, and subsurface water to at least 2 feet below the bottom of the excavation.
  - 4. Where open water courses, ditches, or drain pipes are encountered during the progress of the Work, the Contractor shall provide protection and securing of the continuous flow in such courses or drains and shall repair any damage that may be done to them.

### 3.4 EXCAVATION CLASSIFICATION

- A. All excavated materials are unclassified as defined in Article 1.3.

### 3.5 GENERAL EXCAVATION

- A. All necessary excavation for buildings, structures, pavements, and site improvements shall be performed to accommodate the completion of all related Contract Work.
- B. The Drawings show the horizontal and the lower limits of structures. The methods and equipment used by the Contractor when approaching the bottom limits of excavation shall be selected to provide a smooth surface and to prevent disturbing the soil below the bottom limits of excavation. All soil loosened during excavation shall be removed from the bottom of the excavation.

- C. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
- D. Excavation which is carried below the bottom limits of structures shall be classified as Unauthorized Excavation, unless said excavation below bottom limits of structures has been authorized by the Engineer prior to each occurrence.
- E. Unauthorized Excavation shall be filled with Class B concrete to the bottom limits of structures. Under circumstances where structural integrity is not a factor, the Engineer may authorize the filling of Unauthorized Excavation with Low Strength Mortar Backfill or Special Backfill material compacted to 100% density as specified under the compaction requirements in this Section. Such work shall be at the cost of the Contractor.

### 3.6 TRENCH EXCAVATION

- A. Excavation for trenches in which pipelines, sewers, and conduits are to be installed shall provide adequate space for workmen to space and joint pipe properly, but in every case the trench shall be kept to a minimum width. The width of trench shall not exceed the limits shown on the Drawings.
- B. Excavation shall be to the depth necessary for placing of granular bedding material under the pipe as shown on the Drawings. If over-excavation occurs, the trench bottom shall be filled to grade with compacted granular bedding material.
- C. Trenching operations shall not be performed beyond the distance that will be backfilled and compacted the same day.
- D. In general, backfilling shall begin as soon as the conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.

### 3.7 EXCAVATION OF UNSUITABLE MATERIALS

- A. Unsuitable materials existing below the Contract bottom limits for excavation shall be removed as directed by the Engineer. Such excavation shall not exceed the vertical and lateral limits as prescribed by the Engineer.
- B. In utility trenches, the voids left by removal of unsuitable excavated material shall be filled with AASHTO M 43 No. 1 and No. 2 aggregate conforming to the material requirements of Article 2.1 of this Section.

- C. In excavations other than utility trenches, the voids left by removal of unsuitable excavated material shall be filled with material consisting of either: (1) Special Backfill Material; (2) Class B concrete; or (3) Low Strength Mortar Backfill, whichever is ordered by the Engineer.
- D. Removal of unsuitable excavated material and its replacement as directed will be paid on basis of Contract Conditions relative to Changes in Work unless specific unit prices have been established for excavation of unsuitable material.

### 3.8 DISPOSAL OF UNSUITABLE AND SURPLUS MATERIAL

- A. It shall be the responsibility of the Contractor to dispose of all surplus material that cannot be used in backfill or embankments at his expense outside the limits of the project. Unsuitable excavated material, including rock or large boulders, shall be disposed of outside the limits of the project.
- B. Surplus material may be wasted adjacent to or incorporated in the regular construction only when ordered in writing by the Engineer.

### 3.9 BACKFILL

- A. Pipelines, Sewers and Conduits
  - 1. All pipe shall have bedding extending the width of the trench with depth in conformance with the Drawings. The bedding material shall be thoroughly compacted by tamping until no further densification is possible.
  - 2. Pipe cover material shall be used for filling above the pipe bedding along the sides of the pipe and to a height of twelve (12) inches over the top of the pipe. The pipe cover material shall be brought up evenly on both sides of the pipe to eliminate the possibility of lateral displacement of the pipe and shall be thoroughly compacted by tamping until no further densification is possible. Care shall be taken to spade the aggregate under the pipe haunch below the spring line.
  - 3. All trenches and excavations shall be backfilled immediately after pipe is laid therein, unless otherwise directed by the Engineer.
  - 4. After the pipe cover has been placed and compacted around the pipe as specified above, the remainder of the trench may be backfilled by machine. The backfill material shall be deposited in eight (8) inch horizontal layers, and each layer shall be thoroughly compacted to the specified density by approved methods before a succeeding layer is placed. In no case will backfilling material from a bucket be allowed to fall directly on a pipe and in all cases the bucket must be lowered so that the shock of the falling earth will not cause damage.

B. Structures

1. Backfilling shall not commence before concrete has attained specified strength. Do not use equipment for backfilling and compaction operations against structures that will overload the structure.
2. Backfilling around and over structures shall be carefully placed and tamped with tools of suitable weight to a point one (1) foot above the top of same. Additional backfill may be required to protect the structure from damage from heavy equipment. Backfill shall be placed in uniform layers not exceeding eight (8) inches in depth. Each layer shall be placed, then carefully and uniformly compacted to the specified density so as to eliminate the possibility of displacement of the structure.
3. After the backfill has been placed and compacted around the structure to the height specified above, the remainder may be backfilled by machine. The backfill material shall be deposited in eight (8) inch horizontal layers, and each layer shall be thoroughly compacted to the specified density by approved methods before a succeeding layer is placed. In no case will backfilling material from a bucket be allowed to fall directly on a structure, and in all cases the bucket must be lowered so that the shock of the falling earth will not cause damage.

C. Where any new, proposed, or future pavement, driveway, parking lot, curb, curb and gutter, or walk is to be placed over a backfilled area, Special Backfill material shall be used for any portion of the trench falling within the pavement prism.

D. Where it is necessary to undercut or replace existing utility conduits and/or service lines, the excavation beneath such lines shall be backfilled the entire length with approved Granular Pipe Embedment Material compacted in place in eight (8) inch layers to the required density. The approved Granular Pipe Embedment Material shall extend outward from the spring line of the conduit a distance of two (2) feet on either side and thence downward at its natural slope.

### 3.10 LOW STRENGTH MORTAR BACKFILL

- A. Low strength mortar backfill shall be discharged from the mixer as recommended by the supplier and approved by the Engineer.
- B. Low strength mortar backfill may be placed in the trench in as few lifts as may be practical.
- C. Secure conduit or pipelines before placing low strength mortar backfill to prevent conduits and pipelines from floating during backfilling.
- D. For low strength mortar backfill placed against existing structures of unknown strength, backfill material shall be brought up uniformly in maximum 12 inch lifts and allowed to cure for a minimum of 24 hours or until it can carry a person's weight without leaving imprints before the next lift is placed.



- E. Low strength mortar backfill shall be brought up to subgrade elevation or the pavement prism, whichever may be applicable.

### 3.11 EMBANKMENT

- A. In making fill for embankment, the surface of the existing ground shall be cleared, grubbed, stripped of organic material, plowed, compacted according to the requirements specified in this Section, and stepped on slopes so as to enable bond or firm bearing for the new fill. The materials for these fills shall be selected of approved materials free from organic matter and placed in horizontal layers not exceeding eight (8) inches in thickness when loose, each layer being thoroughly compacted. Materials shall not be placed when fill or foundation is frozen.
- B. Where fill is to be placed on side slopes steeper than one (1) vertical to six (6) horizontal, steps shall be formed into the slope before any embankment is placed. These steps shall be cut at vertical intervals at no more than two (2) feet and shall have a horizontal dimension of not less than three (3) feet.
- C. As fill progress, the top shall be kept crowned or sloped for drainage. No pavement shall be placed upon embankment until it meets compaction testing requirements.
- D. Fills that abut or contain concrete or masonry structures shall be placed with care to avoid undue or unbalanced loads on these structures.
- E. Following the completion of embankment, all slopes shall be neatly and evenly dressed to proper elevation, grade and dimension.

### 3.12 SUBGRADE

- A. All soil subgrade shall be prepared in accordance with this subsection.
- B. Drainage
  - 1. The surface of the subgrade shall be maintained in a smooth condition to prevent ponding of water after rains to insure the thorough drainage of the subgrade surface at all times.
- C. Unsuitable Subgrade
  - 1. Where unsuitable subgrade or subgrade not meeting the required bearing capacity is encountered in cuts, due to no fault or neglect of the Contractor, in which satisfactory stability cannot be obtained by moisture control and compaction, the unstable material shall be excavated to the depth required by the Engineer.
  - 2. Suitable material required for the embankment to replace the undercut will be paid on basis of Contract Conditions relative to changes in Work.

3. Where soft subgrade in cuts is due to the failure of the Contractor to maintain adequate surface drainage as required in this article, or is due to any other fault or neglect of the Contractor, the unstable condition shall be corrected as outlined above at no expense to the Owner.

### 3.13 CONSTRUCTION WITH MOISTURE AND DENSITY CONTROL

- A. All backfill and embankments, except rock embankments, shall be constructed using moisture and density control. All subgrade, except rock and shale in cut sections, shall be constructed using moisture and density control.
- B. Backfill, embankment and subgrade material which does not contain sufficient moisture to be compacted in accordance with the requirements of Article 3.17 of this Section shall be sprinkled with water as directed by the Engineer to bring the moisture content to within the range of optimum plus or minus three (3) percent. Water shall be thoroughly incorporated into the material by means of discs or other approved equipment.
- C. Backfill, embankment and subgrade material containing excess moisture shall be dried, prior to installation, to a moisture content not greater than three (3) percentage points above optimum, except that for material within the moisture content range specified herein that displays pronounced elasticity or deformation under the action of loaded construction equipment, the moisture content shall be reduced to optimum or below if necessary to secure stability. For subgrade material, these requirements for maximum moisture shall apply at the time of compaction of the subgrade and also at the time of placing pavement or subbase. Drying of wet soil shall be expedited by the use of plows, discs, or by other approved methods when so ordered by the Engineer.

### 3.15 COMPACTION REQUIREMENTS

- A. The bottom of excavations upon which concrete foundations or structures are to be placed shall be compacted so as to obtain 100% of maximum dry density per ASTM D-698 in the top twelve (12) inches.
- B. The top twelve (12) inches of stripped original subgrade and final subgrade shall be compacted to not less than 100% of maximum dry density per ASTM D-698.
  1. Subgrade under new, proposed, or future pavement shall be compacted 18 inches beyond the edge of pavement, paved shoulders or paved medians.
- C. Compaction of subgrade for sidewalks (regardless of paving material) shall be 100% of maximum dry density per ASTM D-698 in the top six (6) inches.
- D. Compaction of non-paved areas shall be 90% of maximum dry density per ASTM D-698.
- E. Aggregate pipe embedment and aggregate backfill around structures shall be compacted to not less than 100% of maximum dry density per ASTM D-4253 and ASTM D-4254.

- F. Final backfill shall be compacted to not less than 100% of maximum dry density per ASTM D-698.
- G. Fill placed within the interior of structures shall be compacted to not less than 100% of maximum dry density per ASTM D-698.
- H. Embankment shall be placed and compacted in layers until the density is not less than the percentage of maximum dry density indicated in the following table determined by ASTM D-698.

#### **EMBANKMENT SOIL COMPACTION REQUIREMENTS**

| Maximum Laboratory<br>Dry Weight<br><u>Pounds/Cubic Foot</u> | Minimum Compaction<br>Requirements,<br>Percent Laboratory<br><u>Maximum</u> |
|--|---|
| 90-104.9   | 102   |
| 105-119.9  | 100   |
| 120 and more   | 98  |

- I. Test Sections
  - 1. If it is determined by the Engineer that the composition of the material is such that it cannot be tested for density using a nuclear densometer or other methods; or where, in the opinion of the Engineer, in-place compaction testing is not feasible; and if approved by the Engineer, the Contractor may construct a test section to demonstrate acceptable compactive effort in lieu of in-place compaction testing. Test sections shall be constructed at no additional cost to the Owner.
  - 2. The test section shall be completed by repeatedly compacting the material until no further density is achieved. This value shall be the Minimum Test Section Density (MTSD). The compaction equipment used to complete the test section shall be of suitable size to compact the material and shall be the same equipment used to compact the in-place material.
  - 3. The test section shall be constructed with moisture density control as specified in this Section.
  - 4. The material shall be compacted to at least 98% of the MTSD.
  - 5. Each lift of in-place fill or backfill shall be densified using a compactive effort equal to or greater than the effort applied to achieve the MTSD; i.e., if six passes were required to achieve MTSD, then each lift of material shall be compacted using six or more passes.
  - 6. Construct a new test section when, in the opinion of the Engineer, the fill or backfill material has changed character or when the supporting material has changed character.

### 3.18 GRADING

- A. Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading
  - 1. Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
    - a. Lawn or unpaved areas shall be graded to plus or minus (*1 inch*) (*insert tolerance*).
    - b. Walks shall be graded to plus or minus (*1 inch*) (*insert tolerance*).
- C. Grading inside Building Lines
  - 1. Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

END OF SECTION 310000

## SECTION 312323.13 – COMPACTED BACKFILL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish, place and compact all the materials needed from select excavated materials or furnish additional suitable material if the excavated material is deemed unsuitable or the moisture content is not or can not be made to be within acceptable tolerances of optimum moisture to achieve the specified compaction.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Suitable excavated material as specified in ODOT Item 203.

### PART 3 - EXECUTION

#### 3.1 PLACING

- A. Compacted backfill shall be properly placed in layers sufficient to meet the compaction requirement of 95% of maximum laboratory dry density per ASTM D 698 throughout the entire layer and thoroughly compacted with mechanical compaction equipment with moisture adjustment as needed. Should after settlement occur, the Contractor must add and compact additional material, and he must maintain the backfill at the required finished grade or sub-grade until the project is satisfactorily completed and during the correction period.
- B. Approved mechanical compaction equipment shall be used for tamping backfill. Flooding, jetting or puddling of backfill will not be permitted.

END OF SECTION 312323.13

## SECTION 312323.14 – COMPACTED GRANULAR BACKFILL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish, place and compact all the materials needed.

### PART 2 - PRODUCTS

#### 2.1 MATERIAL

- A. Aggregate shall be ODOT 304 crushed limestone. Crushed gravel or slag products are unacceptable.
- B. Contractor shall submit current test reports for the lot(s) of the material to be supplied.

### PART 3 - EXECUTION

#### 3.1 PLACING AND COMPACTING

- A. Compacted granular backfill shall be properly placed in layers sufficient to meet the compaction requirement of 100% of maximum laboratory dry density per ASTM D 698 throughout the entire layer and thoroughly compacted with mechanical compaction equipment with moisture adjustment as needed. Should after settlement occur, the Contractor must add and compact additional material, and he must maintain the backfill at the required finished grade or sub-grade until the project is satisfactorily completed and during the correction period.
- B. Approved mechanical compaction equipment shall be used for tamping backfill. Flooding, jetting or puddling of backfill will not be permitted.

END OF SECTION 312323.14

## SECTION 312323.33 - LOW STRENGTH MORTAR BACKFILL MATERIAL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division - 1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This work shall consist of the placement of a flowable low strength mortar for backfilling conduits or at other locations as shown on the plans or as specified. The work shall be in accordance with ODOT Item 603 and 499 unless otherwise specified.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Cement

- 1. ODOT 701.01 or ODOT 701.04.

- B. Fly Ash

- 1. Fly Ash shall come from a source approved by the Engineer.

- C. Fine Aggregate

- 1. Fine Aggregate shall be natural sand consisting of mineral aggregate particles. The gradation of the sand shall be as follows:

| <u>Sieve Size</u> | <u>Percent Passing</u> |
|-------------------|------------------------|
| 3/4"              | 100                    |
| 200               | 0 - 10                 |

2. It is intended that the sand be fine enough to stay in suspension in the mixture to the extent required for proper flow. The Engineer reserves the right to reject the sand if a flowable mixture cannot be produced.

## 2.2 MORTAR MIX PROPORTIONING

- A. The initial trial mixture shall be as follows:

### Quantity of Dry Materials per Cubic Yard

|             |           |
|-------------|-----------|
| Cement      | 100 lbs.  |
| Fly Ash     | 250 lbs.  |
| Sand (SSD)* | 2700 lbs. |
| Water       | 500 lbs.  |

\* saturated-surface dry

- B. These quantities of materials are expected to yield approximately 1 cubic yard of mortar of the proper consistency. Adjustments of the proportions may be made providing the total absolute volume of the materials is maintained.

## PART 3 - EXECUTION

### 3.1 TRIAL BATCH

- A. To expedite consolidation of the mortar, it will be necessary for bleed water to appear on the surface immediately after the mortar is struck off.

A delay in bleeding indicates there are too many fines in the mixture, so the fly ash quantity shall be reduced in increments of 50 lbs. until mixture is bleeding freely. Approximately 60 lbs. of sand shall be added to replace each 50 lbs. of fly ash to maintain the original yield.

- B. Fluidity of the mortar mixture shall be measured by the Corps. of Engineers' Flow Cone Method according to CRD-C611. Prior to filling the flow cone with mortar, the mixture shall be passed through a 1/4-inch screen. Time of efflux shall be approximately 12 seconds.
- C. Prior to the first placement, the Contractor shall make one or more trial batches of mortar of the size to be hauled to job site and shall cast one or more test samples equivalent to the approximate dimensions of the trench to be backfilled (either in a form or trench). Amount of bleeding, settlement rate and time required to support pavement replacement shall be determined from these full-size tests. The Contractor shall furnish the required materials and samples.



### 3.2 MIXING EQUIPMENT

- A. Sufficient mixing capacity of mixers shall be provided to permit the mortar to be placed without interruption.

### 3.3 PLACING MORTAR

- A. Flowable mortar shall be discharged from the mixer by any reasonable means into the space to be filled. The fill material shall be brought up uniformly to the fill line shown on the plans or as directed by the Engineer.

END OF SECTION 312323.33

## SECTION 331113.10 - PIPE JOINTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The installation of all piping, fittings, valves, hydrants, etc. in the performance of pipeline construction work shall include the making of one or more types of pipe joints as specified herein.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

### PART 2 - PRODUCTS

#### 2.1 PUSH-ON TYPE JOINTS

- A. Push-on type of joints for cast iron and ductile iron pipe shall be made where shown on the plans and as specified herein in strict accordance with the manufacturer's recommendations.
- B. No more than one joint at a time shall be "pushed home". In the event that two (2) or more joints are "pushed home" simultaneously, the Contractor shall remove all pipe which was not pushed home "one at a time" and remove and discard the "used" gaskets and relay the pipe "one at a time".
- C. Rubber gaskets shall be a rubber O-ring type shaped to fit the particular inside configuration of the bells of the pipe being installed and shall produce a leak-free piping system.
- D. Immediately prior to assembly, thoroughly clean all pipe surfaces which the rubber gasket contacts, insert the gasket properly and lubricate the joint surfaces.
- E. All ends shall be beveled and square to the pipe barrel and shall be kept in a straight and square alignment to the receiving bell during assembly.

- F. No weight will be allowed for nor payment made for the gasket or lubricant used, but the cost thereof shall be included in the unit price bid for compression joint cast iron and/or ductile iron pipe and fittings.
- G. All "job" cut pipe ends shall be ground, filed or otherwise properly worked on so as to be both square to the pipe barrel and beveled similar to "factory" finished pipe ends. There shall be no "burrs" on any part of the cut pipe end.

## 2.2 COMPRESSION JOINTS FOR PRESTRESSED CONCRETE CYLINDER PIPE

- A. Compression joints for prestressed concrete cylinder pipe shall be made in accordance with AWWA C301 and with the requirements of the particular item specification(s) for prestressed concrete cylinder pipe.

## 2.3 COMPRESSION JOINTS FOR ASBESTOS CEMENT PIPE

- A. Compression joints for asbestos cement pipe shall be made in accordance with the requirements of AWWA C400 for asbestos cement pipe. All pipe ends, pushing home methods, pipe cutting, etc. shall be similar to that specified in the foregoing specifications.

## 2.4 FLANGED JOINTS FOR CAST IRON/DUCTILE IRON PIPE AND FITTINGS

- A. All flanged joints shall be thoroughly bolted with through stud or tap bolts of required size. Full face type rubber gaskets of an approved quality equal in all respects to "Rainbow" gaskets one-eighth (1/8) inch thick as manufactured by the U.S. Rubber Company shall be used in all flanged joints. All bolt heads and nuts shall conform in dimensions to the American Standard heavy series and nuts shall be hexagonal cold pressed with well fitting threads. Bolts and nuts shall be cadmium plated by an approved process with a plate thickness of 0.0003 to 0.0005 inches. In lieu of cadmium plating, galvanizing will be acceptable. All studs shall be made from silicon bronze ASTM B 124 with bronze nuts where used in contact with any liquid or buried underground or as called for on the contract drawings.
- B. All nuts and bolts that come into contact with water shall be painted with two (2) heavy coats of Inertol No. 49 thick or approved equal, made for bolts, studs, nuts or gaskets used for flanged joints, and the cost thereof shall be included in the unit price bid for flanged cast/ductile iron pipe and flanged cast/ductile iron fittings.

## 2.5 FLANGED JOINTS FOR STEEL CYLINDER PIPE

- A. Flanged joints for pre-stressed concrete cylinder pipe and for steel pipe shall be installed as shown on the drawings. Flanges shall be either cast steel, forged or rolled steel, or properly welded and machined fabricated steel plates welded to pipe cylinder with two (2) continuous welds. They shall have plain faces and shall be faced true and smooth at right angles to the axis of the pipe and shall be spot faced on the back. Drilling shall conform to ANSI one hundred twenty-five (125) pound standards. All bolts for flanges and for other types of bolting shall conform to ASTM A 307, Grade A, except where one or both flanges are cast iron, in which case bolts shall be Grade B.

- B. All bolts used in the finished work for flanges and tied joints for concrete pipe shall be of medium open hearth or electric furnace steel. The ends of all bolts must be finished to a standard radius in an acceptable manner. All screw threads shall be American Standard Coarse Thread (N.C.). Stud bolts shall be used to make the flanged joints on pipe.

All nuts shall be hexagonal, cold pressed, semi-finished and made of medium open hearth, electric furnace or Bessemer process steel. All dimensions shall be according to American Standard Heavy. Bolts and nuts shall be galvanized before shipment and not primed. Gaskets for flanged pipe shall be full faced rubber one-eighth (1/8) inch thick equal to Rainbow Style 9 as manufactured by the U.S. Rubber Company.

- C. All forged or rolled steel pipe flanges shall conform to ASTM A 181, Class 60.
- D. All structural steel shall conform to ASTM A 36.
- E. Iron castings must be smooth and free from blowholes and other defects and the material shall conform to ASTM A 48, Class 30 B.

## 2.6 MECHANICAL JOINTS

- A. All mechanical joints shall be thoroughly bolted in accordance with the manufacturer's recommendations with cadmium plated tee head bolts and nuts of high strength, heat treated cast iron or other approved materials having a minimum yield strength of forty-five thousand (45,000) pounds per square inch and an ultimate tensile strength of seventy thousand (70,000) pounds per square inch. Gaskets for sludge, gas, waste lines, etc., shall be plain rubber gaskets coated with Thickol or ASTM D 2000, Type SA-710, or equal. Gaskets for water service shall be plain rubber gaskets made of first grade plantation rubber in accordance with ANSI A21.11. Glands shall be of high strength cast/ductile iron.
- B. Where connections are made between wrought iron pipe and mechanical joints, an approved type of transition gasket and fitting shall be used in the mechanical joint in accordance with the manufacturer's standards and recommendations.
- C. All "job" cut pipe ends shall be ground, filed or otherwise properly worked on so as to be both square to the pipe barrel and beveled similar to "factory" finished pipe ends. There shall be no "burrs" on any part of the cut pipe end.
- D. Joint bolts shall be tightened by the use of approved wrenches and to a tension recommended by the pipe manufacturer. Overstressing of bolts to compensate for poor installation practice shall not be permitted.
- E. If sections of pipeline are "preassembled", at a location other than the intended final resting location of the piping, so as to include a fitting or line valve, the Contractor shall handle such "preassembled" sections so as to avoid deflections greater than allowed in published data normally provided by the respective pipe manufacturer. Such sections shall be limited in length to include no more than a standard length of pipe plus one (1) fitting and shall contain no more than two (2) preassembled joints. Any excessively deflected "preassembled pipe" shall be disassembled, the gaskets shall be discarded, and the preassembly (if it be repeated) all at the Contractor's risk and expense.

- F. Where joints are underground, bolts and nuts shall be stainless steel Type 316.
- G. Where shown on the drawings, or ordered, mechanical joints shall be provided with approved harnesses to effect tied joints.
- H. No special payment will be made for lock type joints, glands, bolts, nuts or gaskets used for mechanical joints, but the cost thereof shall be included in the unit price bid for mechanical joint cast/ductile iron pipe and mechanical joint cast/ductile iron fittings. Payment on a tonnage basis will be based on the body weight of the pipe or fittings only and will not show additional weight of accessories.
- I. Approved harnesses to effect tied joints will be paid for as a part of their respective pipeline construction.

## 2.7 BALL AND SOCKET JOINTS

- A. Ball and socket joints shall be made where shown on the drawings and shall conform to AWWA C111 and shall be subject to the approval of the Engineer.
- B. Ball and socket joints shall be as manufactured by Clow Corporation, American Cast Iron Pipe Company or equal.

## 2.8 GROOVED-END JOINT COUPLINGS

- A. Grooved-end joint couplings for ductile iron piping shall be used where indicated on the drawings. Grooved and joint couplings shall be watertight, and designed for the working pressures specified for the piping system with which they are to be used. Couplings shall be self-centering and shall engage and lock in place the grooved pipe and pipe fitting ends, in a positive couple. Where grooved-end joint couplings are shown on the drawings, pipe grooves shall be located such as to provide a flexible-type joint which provides for linear and angular movement. Coupling housing clamps shall be fabricated in two or more sections of malleable iron castings, conforming to the requirements of ASTM A 47, Grade 32510. Coupling gaskets shall be molded synthetic rubber, conforming to ASTM D 2000, Grade 3BA615A14-B13. Bolts shall be oval neck, track head type, with hexagonal heavy nuts conforming to ASTM A 183. Grooved, hinged flange adapters, with gaskets, shall be furnished for making valve or flanged connections, and shall be constructed of the same materials as used for the couplings.
- B. Pipe grooving shall be done by the manufacturer and in accordance with the pipe coupling manufacturer's specifications.
- C. Field grooving of pipe shall not be permitted, except for occasional field make-up pieces when permitted by the Engineer.
- D. Grooved-end joint couplings shall be Victaulic, Dresser or equal.

## 2.9 BOLTLESS RESTRAINED JOINT

- A. Boltless restrained joints shall be used where called for on the drawings or as directed by the Engineer to provide restraint against external forces or against separation due to internal pressure.
- B. Types of boltless restrained joints acceptable are "Super-Lock" by Clow Corporation, "Flex-Ring" by American Cast Iron Pipe Company, "TR-Flex" by United States Pipe and Foundry Company or equal.

PART 3 - INSTALLATION (NOT APPLICABLE)

END OF SECTION 331113.10

## SECTION 331113.13 - DUCTILE IRON PIPE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish all the materials for and shall properly place at the locations shown on the drawings or as directed, all ductile iron pipe of the sizes specified, shown or required for the proper completion of the work included under this contract.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. All ductile iron pipe shall conform to AWWA C151 with the ends being designed for one of the type joints as specified herein.
- B. To assure that the iron is suitable for satisfactory drilling and cutting, the chemical constituents shall meet the physical property recommendations of ASTM A 536.
- C. The minimum wall thickness of the pipe barrel shall be that indicated in ANSI A21.50 (AWWA C150) for laying condition "2", 150 psi internal working pressure and a surge pressure of 100 psi and 5 ft. depth of cover unless otherwise indicated on the drawings. ANSI A21.50 (AWWA C150) CLASS 52 shall be the minimum thickness class for ductile iron pipe furnished under this specification unless otherwise shown on the drawings.

## 2.2 COATING AND LINING

- A. The outside surface of all ductile iron pipe shall be shop coated with either a coal tar or asphalt base bituminous material. If this coating material is found to be damaged prior to the pipe trench being backfilled, the Contractor shall provide and apply additional material of that required to repair the damages. The Contractor shall have sufficient coating material available at the job site prior to laying the pipe.
- B. The interior of the pipe shall be lined with cement mortar and seal coated in complete conformance with ANSI A21.4 (AWWA C104).

## 2.3 JOINTS

- A. Mechanical Joints and Push-on Joints including their respective appurtenances shall conform to ANSI A21.11 (AWWA C111).
- B. Flanged Joints shall conform to AWWA C110 or ANSI A21.10. Flanged joints shall not be installed underground except within structures as indicated on plans or directed by the Engineer.
- C. Appurtenances used to make flanged joints shall include: one-eighth (1/8) inch thick rubber gaskets, bolts having American Standard Heavy Unfinished Hexagonal Head and Nut dimensions in conformance with ANSI B18.1, and material for bolts and nuts shall conform to ASTM A 575 or A 576.
- D. Ball and socket joints (river crossing) shall be restrained, boltless and capable of deflecting up to 15 degrees and shall be installed in accordance with the manufacturer's recommendations.

## 2.4 POLYETHYLENE ENCASEMENT

- A. The ductile iron pipe, fittings and appurtenances buried underground, shall be encased with 8 mil polyethylene film conforming to AWWA C105, unless noted otherwise.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. All trenches, when pipe laying is in progress, shall be kept dry and all pipes and specials shall be laid accurately to the required lines and grades and shall be uniformly supported along their entire lengths. The bottom of the excavation shall be properly trimmed, with holes at each joint to receive the bell and to permit the properly cementing the joints.
- B. Pipe shall be fully entered and shall abut against adjacent pipe and in such a manner that there will be no unevenness along the inverts.



- C. When pipes enter or pass through concrete walls, manholes, sewers or other structures, holes shall be provided and the pipes properly cemented in place so as to form a watertight joint.

END OF SECTION 331113.13

## SECTION 331113.16 - CAST GREY IRON/DUCTILE CAST IRON FITTINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish all the materials for and shall properly place at the locations shown on the drawings or as directed, all cast grey iron/ductile iron fittings of the sizes specified, shown or required for the proper completion of the work included under this contract.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. All standard and special cast grey iron/ductile iron castings shall conform to the latest applicable AWWA and/or ANSI specifications for pressure fittings with end conditions as specified herein. AWWA C110 (ANSI A21.10) shall be applicable for all cast grey iron/ductile iron fittings.

#### 2.2 PRESSURE RATINGS

- A. Fittings for pipe sizes of 12 inch diameter and smaller shall be rated for 250 psi working pressure and fittings for pipe sizes of 14 inch diameter and larger shall be rated for 150 psi working pressure in accordance with AWWA C110. Fittings for higher working pressures will be noted on the plans.

## 2.3 END CONDITIONS

- A. The end conditions of each fitting shall be as required to accommodate the jointing requirements for the particular pipe material being connected to the fitting in accordance with the piping layout shown on the plans. The particular pipe material to be connected to the fitting is specified elsewhere in these specifications.

## 2.4 COATING AND LINING

- A. The outside surface of all cast grey iron/ductile iron fittings shall be shop coated with either a coal tar or asphalt base bituminous material. If this coating material is found to be damaged prior to the pipe trench being backfilled, the Contractor shall provide and apply additional material of that required to repair the damages. The Contractor shall have sufficient coating material available at the job site prior to laying the pipe.
- B. The interior of each fitting shall be lined with cement mortar and seal coated in complete conformance with ANSI A21.4 (AWWA C104).

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. All fittings shall be installed at the locations and grades shown on the plans or as directed by the Engineer. Mis-located fittings shall be relocated to the required location by the Contractor at his own expense.
- B. All joints shall be made in accordance with these specifications.
- C. Thrust restraint shall be provided in accordance with the plans and specifications.

END OF SECTION 331113.16

## SECTION 331413 - WATERLINE CONSTRUCTION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This work shall consist of the construction of a potable water pipeline in accordance with these specifications and in reasonably close conformity to the lines and grades indicated on the plans or as established by the Engineer. This work shall include excavating for pipe, fittings, valves, thrust blocks and other appurtenances, clearing and grubbing and the removal of all materials necessary for placing the pipe, except removals listed separately; furnishing and placing granular or concrete bedding and granular backfill as required, constructing and subsequently removing all necessary cofferdams, cribs, and sheeting, pumping and dewatering, making all pipe joints as required, installing all necessary pipe, joining to existing and proposed appurtenances as required, performing leakage tests as specified, disinfecting and restoration of disturbed facilities and surfaces. Arrangements for and the performance of the adequate and satisfactory disposal of all test and disinfection waters shall be the Contractor's responsibility. The Contractor shall chlorinate the water main as often as necessary to achieve an approved potable water test.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Pipe, fittings, specials, valves, joint materials, hydrants, thrust blocks, backfill and other appurtenances shall be the size and kind specified in the proposal and shown on the plans.

## PART 3 - EXECUTION

### 3.1 LAYING PIPE

- A. The Contractor shall furnish all of the proper tools and equipment required for the safe, proper handling and laying of all pipe, fittings, and specials that are to be installed in this work. All storage, handling, laying, and backfill methods shall be performed so as to avoid damaging either the interior or the exterior surfaces of all pipe fittings, specials, joint materials, or other appurtenances, and any such damage shall be remedied at the Contractor's expense.
- B. Before any pipe is lowered into the trench, it shall be inspected for damage, and any unsatisfactory lengths shall be rejected. Cast metal pipe and fittings shall be inspected for cracks by ringing with a light hammer while suspended. The interior and exterior of each pipe length used shall be cleaned as necessary to remove all dirt or other foreign material before it is inspected. The interior of the pipe shall be kept clean until the work is accepted.
- C. No pipe shall be laid in water, mud or when trench conditions or weather is unsuitable for such work.
- D. If mud, surface water, leaves and/or other debris have been permitted to enter the strung-out pipe, the inside shall be cleaned with a strong hypochlorite solution after all such foreign materials are completely cleaned from the pipe and before the pipe is lowered into the trench.
- E. Pipe shall not be pushed off the bank nor shall it be permitted to fall into the trench. Each type of pipe, fitting, special or other appurtenances shall be handled in strict accordance with recommendations of its respective manufacturer.
- F. No rocks, stones, metal, concrete, bricks, pavement pieces, wood, soil lumps or other hard materials too big to pass through a six (6") inch screen shall be permitted within six (6") inches of the pipe after it is laid in the trench. Any pipe endangered by such debris shall be subject to removal and disposal at the Contractor's expense.
- G. When pipe laying is not in progress, the open ends of installed pipe shall be closed by appropriate means to prevent the entrance of dirt and water. In the event ground water, sewage water or other potential contaminants enter any portion of the pipeline, after it is laid, cleaning and preliminary disinfection with a strong hypochlorite solution shall be done.
- H. Pipe lengths shall not be deflected at the joint to any greater degree than recommended by the manufacturer of the particular joint being used. Where deflections in excess of such recommendations are necessary, the appropriate specifications for the particular type of pipe being installed shall govern the mode of accomplishing such excessive deflections.

### 3.2 JOINTING PROCEDURES

- A. The particular method of making up pipe joints shall be governed by the type of pipe material and type of joint in accordance with the drawings and/or specifications.

### 3.3 ANCHORAGE

- A. All hydrants, plugs, caps, tees and bends shall be provided with a reaction backing or shall be restrained by attaching suitable metal rods, clamps, anchored fittings or harnessed joints, as shown on the plans or as specified so as to prevent movement.
- B. Reaction backing shall be of concrete, with steel reinforcement as required, unless otherwise shown on the drawings. Backing shall be placed between solid ground and the fitting or other part of the pipeline to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that as indicated on the plans. The backing shall be so placed unless otherwise directed, that the pipe and fitting joints will be accessible for repair.
- C. Steel tie rods or clamps of adequate strength to prevent movement may be used instead of concrete backing. Steel tie rods or clamps shall be used to connect the hydrant watch valves to the main and to connect the hydrant to the water valves when shown on the drawings. Steel rods or clamps shall be painted with three coats of an approved bituminous paint or coat tar enamel.

### 3.4 BACKFILLING

- A. Backfilling shall be accomplished in a two-step procedure as follows: 1) partial backfill before leakage tests, and 2) completion of backfill after tests. Departure from this procedure due to traffic or other conditions shall be approved by the Engineer.

### 3.5 MAINTENANCE OF EXISTING DITCHES

- A. The Contractor shall use the utmost care in maintaining ditches and other waterways, and, if either bottoms or banks of such ditches are disturbed, they shall be promptly restored and maintained for the life of the guaranty period. Similar care shall be used in preventing damage to existing pavement by caving of trench walls and undermining such pavement. If pavement is damaged, the Contractor shall repair same at his own expense.

### 3.6 CLEARING SITE AND RESTORING DAMAGED SURFACES

- A. Upon completion of the backfill work, the Contractor shall immediately remove and dispose of all surplus materials including dirt and rubbish.
- B. Unless otherwise called for on the plans, the Contractor shall replace all pavement, sidewalks, sod, or other surfaces disturbed to a condition equal to that existing before the work was started, furnishing all materials, labor, equipment, etc., at no additional cost to the Owner.

- C. All restoration of lawns shall be performed in accordance with these specifications as a part of performing the work as specified herein.
- D. All restoration of driveways, sidewalks, roadways and shoulders (berms) shall be in accordance with these specifications as a part of performing the work as specified herein.
- E. Upon completion of the foregoing work, all tools and other property belonging to the Contractor shall be removed, and the site shall be left in good condition.

### 3.7 LEAKAGE TESTS

- A. All pipeline construction shall be subjected to hydrostatic leakage testing of each valved section, as it is completed, unless otherwise directed by the Engineer. All pipes, valves, fittings, etc. shall be laid in such a manner as to leave all joints watertight.
- B. Each section of pipe being tested shall be filled slowly with water, and, before applying the specified test pressure, all air shall be expelled from the pipe. The method of obtaining and placing test water(s) into the pipeline shall be approved by the Engineer.
- C. The test shall be observed by the Engineer or his designate. The Owner will furnish a pressure gauge for measuring the pressure on the water main. The Contractor shall furnish a suitable pump, pipes, bulkheads and all appliances, labor, fuel, and other appurtenances necessary to make these tests.
- D. The test pressure shall be maintained for sufficient length of time to allow for a thorough examination of joints and elimination of leakage where necessary. The pipeline shall be made absolutely tight under the test pressure.
- E. The Contractor shall drain each section of the waterline piping after it has been tested. If the drains are connected to valve or drain vaults, then, within a reasonable period of time after the test has been completed, the Contractor shall pump all water out of the vaults.
- F. In cold weather, immediately after testing a section of the waterline piping, the Contractor shall open all valves, air cocks, by-passes, and drains; shall drain that section of the pipeline, including the bonnets of all valves contained therein, and shall take all other precautions necessary to prevent injury due to freezing to the water main, piping and appurtenances.
- G. Every precaution must be taken to remove, valve-off, or otherwise protect delicate control equipment in or attached to pipelines to prevent damage or injury thereto.
- H. Leakage is defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, as required to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled as herein required.
- I. In calculating leakage, the Engineer will not make allowance for any leakage at the valves, the removable bulkheads, etc.

- J. The evaluation of actual leakage to standard pressure leakage is calculated by the application of the ratio determined from the square root of respective pressures, other factors being equal.
- K. The test pressure shall be 150 psi unless otherwise specified elsewhere in these specifications. Testing procedure shall be as specified herein for the particular pipe material contained in the section tested and shall be subject to modification as required by a particular pipeline material specification or part thereof, as contained elsewhere in these specifications.
- L. For cast iron pipe (CIP) or ductile iron pipe (DIP), AWWA C 600 shall govern the test, except that the allowable leakage rate shall be 12 gpd per mile of pipe per inch of diameter.
- M. All defective materials and construction found in the pipeline as a result of leakage tests shall be corrected by removal of the defective materials and reconstruction with sound materials and construction. The entire section shall then be retested in accordance with the foregoing.
- N. Any testing performed without the knowledge of the Engineer shall not be considered a test for the purpose of this specification.
- O. The lack of hydrants, branch shutoff valves, or any other attachments to the line being tested shall not preclude the testing of each valved section as it is completed. In the event that hydrants, branch shutoff valves or any other attached appurtenances are not available for installation prior to testing of each valved section, then plugs or other approved means of containing line pressure must be utilized so as to test each valved section of main line as it is completed. A retest of each valved section will then be necessary after all appurtenances are installed. There will be no additional payment for any such retests.
- P. The Contractor shall provide all pressure test equipment. The Owner shall provide all test water required and shall provide test gauges.

### 3.8 DISINFECTION

- A. Prior to disinfection, all pipeline construction shall be flushed to remove any foreign material. Flushing shall be performed after completion and approval of the leakage tests.
- B. Flushing shall be continued for at least five (5) minutes. In the event the foregoing requirements cannot be met due to the Owner's facilities being inadequate, alternate rate(s) and duration(s) of flushing shall be used.
- C. Disinfecting water mains shall be in accordance with AWWA C 651 and as specified herein.
- D. The following disinfectants may be used: Chlorine or chlorine water; calcium hypochlorite; sodium hypochlorite solution, or chlorinated lime-water mixture. Chlorine shall be applied at one extremity of a pipe section via a corporation stop (installed in the top of the pipe by the Contractor) and bled at the opposite extremity of a properly segregated section.



Precautions shall be taken to prevent dosed water from flowing into the potable water supply. All high points on the section treated shall be properly vented for air escape.

- E. The rate of applying the disinfectant shall provide at least 25 ppm (mg per liter) chlorine dose at the outlet end of the line section being treated. The disinfecting period shall be twenty-four (24) hours, and, at the end of this period, a chlorine residual of at least 10 mg per liter shall exist at the outlet end of the line.

In the event of unfavorable or unsanitary conditions of installation, poor packing, or high pH, the period of disinfection may be extended. For shorter periods of disinfection, higher dosages shall be required.

- F. Sterilizing water shall be disposed of in a satisfactory manner by the Contractor. If the foregoing disinfection procedure fails to provide thorough disinfection of the line, it shall be repeated as necessary in the pipeline for a period of 20 - 30 days after it is placed into operation.
- G. Tests for efficacy of sterilization shall be made by the Owner, and repeated sterilization shall be carried out by the Contractor when required.
- H. Contractor shall provide all disinfectants and disinfection equipment. Owner shall provide all test waters needed.

END OF SECTION 331413

## SECTION 331443 – PACKAGED PUMPING SYSTEMS FOR WATER

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The Contractor shall furnish and install one (1) complete factory-built and tested duplex pump station, consisting of a basin (wet well) package, NEMA 4X stainless steel control panel enclosure with alarms, pump, pump removal system, discharge assembly, level control system, and all necessary internal wiring and controls to form a complete packaged system.
- B. For ease of serviceability, all pumps and motor shall be of like type and horsepower thought the system.
- C. The Contractor shall provide all labor, materials, tools and equipment required to furnish and install the pump station complete as shown on the Contract Drawings and as specified herein.
- D. The contract drawings and specifications were prepared based on the named manufacturer in this item and the Contractor shall include in his base bid proposal, equipment by the specified manufacturer.

#### 1.3 QUALITY ASSURANCE

- A. All pump manufacturers must have been in the business of manufacturing complete pump stations for a minimum of five (5) years successful field operation of actual proposed equipment and minimum of 10 installations at equivalent application.
- B. The pump manufacturer shall be the entity which designs, machines, assembles, hydraulically tests and warranties the final product. Any entity that does not meet this definition will not be considered an acceptable supplier. For quality control reasons and future pump and parts availability, all major castings of the pump shall be sourced and machined in North America.
- C. Supplier shall provide a list of names and dates of similar installations for verification by the engineer or Owner's Representative.

- D. Manufacturer must demonstrate to the satisfaction of engineer that the proposed pump equipment will meet system flows and heads required. In addition, pre-submittal must also demonstrate to the satisfaction of the engineer that the equipment being proposed meets or exceeds all performance and safety requirements, materials of construction, and user benefits of the specified equipment. Only pre-approved pump station manufacturers will be considered. All bids utilizing manufacturers not pre-approved will be considered non-responsive.
- E. Certified Pump Test
  - 1. Each pump shall be shop tested for capacity, head, speed, power and efficiency in accordance with Standards of the Hydraulic Institute.
  - 2. Certified copies of each test curve shall be furnished to the Engineer for approval.
  - 3. Test shall consist of checking each pump at its rated speed, head, capacity, efficiency, and brake horsepower.
  - 4. The pumps shall not leave the manufacturer's plant until receipt of the Engineer's approval.
- F. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- G. If Contractor chooses to submit a bid that does not meet all the requirements of this specification, the bid shall include a written description of the deviation with data that shows the magnitude of and justification for the deviation from this specification. The decision to accept material deviating from this specification shall be the responsibility of the SPECIFYING ENGINEER.

#### 1.4 SUBMITTALS

- A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 specifications and any additional information listed herein.
- B. Product Data: Submit the manufacturer's technical data and installation instructions including certified pump curves with efficiency, capacity, head, speed, brake horsepower required and operating point required for each pump. Submit all wiring diagrams.
- C. Manufacturer's Data:
  - 1. The Contractor shall submit, as a minimum, the following information:
    - a. Motor data, including starting kVA, starting torque, full load current and torque efficiency curves, and power factor curves (typical motor test data from equivalent motors are acceptable).
    - b. Materials of construction for all components.
    - c. Details of the new pump installation.

2. Manufacturer's Certificates, including certified test curves with the design points clearly marked (computer model printouts are not acceptable). Performance curves shall be submitted for each pump to be supplied to both the Engineer and Owner.
  3. The pump manufacturer must be certified to ISO 9001 by an accredited agency, with scope of registration including design control and service after sales activities.
- D. Warranty: The Equipment Manufacturer shall submit a warranty certificate for review for all pump equipment. The date of the warranty begins after commissioning and operational demonstration.
- E. After receipt of notice to proceed, the contractor shall furnish the engineer the shop drawings detailing the equipment to be furnished for the pump station, including dimensional data and materials of construction.
- F. Prior to completion of equipment delivery, the contractor shall supply one (1) electronic digital copy in PDF format and three (3) paper copies of Operation and Maintenance instructions.

## 1.5 WARRANTY

- A. The manufacturer shall provide a warranty on any defective part(s) and labor to replace defective parts for a period of twenty-four (24) months after notice of owner's acceptance, but no greater than twenty-seven (27) months after receipt of shipment. The owner will return any equipment found to be defective to the manufacturer for inspection and validation of the defect. Defective equipment will be repaired or replaced and shipped back to customer at no charge.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable pump station manufacturer(s) are:
1. Excel Fluid Group, LLC,
  2. Or Engineer pre-approved equal.

### 2.2 PUMP STATION

- A. Wet Well Basin
1. Fiberglass Basin, Chop-Hoop Filament Wound Construction,
  2. Manufactured to ASTM D3753 Specifications,
  3. Sizes: 72" (6') Diameter and 300" (25') Deep.

4. Wet Well Includes Fiberglass or Steel Anti-Floatation Flange; One Monolithic Structure; capable to withstand 150% of Anticipated Maximum Pressure Exerted by Saturated Soil (120 lbs./cf).
  5. Two (2) 3" outlet stubs in basin wall.
  6. One (1) 3" inlet stub in basin wall 180° from outlet.
- B. Access Hatch Cover:
1. Aluminum Cover with (1) Lockable Hinged Access Door,
  2. Stainless Steel Hinge and Hardware, Rated for 300# PSF.
- C. Guide Rail Assembly:
1. Two (2) Cast Iron Base Elbow Stationary Fittings, Bolted to Wet Well Floor with Stainless Steel Studs with 3" Diameter Flanged Base Elbow Fittings.
  2. Two (2) Cast Iron Upper Guide Rail Brackets, Mounted on Wet Well Access Cover Frame.
  3. 1" or 2" 304 Stainless Steel Guide Rails as required.
  4. Two (2) Cast Iron Moveable Fittings, Mounted on Pump Discharges, Allowing Pumps to be removed without Entering Wet Well.
  5. Two (2) 316 Stainless Steel Lifting Chain, Attached to Pump Lifting Handles.
  6. Includes Intermediate Guide Rail Brackets if Wet Well Depth is Greater Than 20' (Ft.) Deep.
- D. Submersible Pumps:
1. Submersible Non-Clog Pumps with 3" Discharge, 3.0 HP, 460 V, 3 Phase.
  2. 50' Pre-Wired Power Cords.
  3. Heat and Seal Fail Alarm Sensors.
- E. Discharge Piping:
1. Socket or Flanged Pipe and Fittings, Ranging from 3.00" Diameter, SCH 80 PVC.
- F. Valve Options: No Valves Required.
- G. Electrical Controls:
1. Duplex Control Panel, NEMA 4X Stainless Steel Enclosure with Inner Door,
  2. HOA Switches, Run Lights, Alarm Lights, Seal Moisture Sensor and Motor Thermal Circuits, High Water Alarm Light and Audible Horn with Silence, Battery Operated Alarm Light, ETMs.

3. Power 460 V, 3 Phase with Transformer for Control System.
  4. Laminated Schematic mounted inside Panel Door.
- H. Level Controls:
1. Four (4) Float Switch Level Controls, Normally Open.
- I. Control Panel Stand:
1. 304 Stainless Steel Construction, Hinged Access Door,
  2. Lockable Hasps, Includes Stainless Steel Cable Hangers,
  3. Serves as Wet Well Vent and Junction Box.
- J. Safety Grate:
1. •Aluminum "I" Bar Construction, Safety Orange Powder-Coated Finish,
  2. 316SS Hardware, Tamper Proof SS Hinge Bolts,
  3. 300# PSF Load Rated, With Lockable Capability.
- K. SCADA Compatibility:
1. Ethernet Module for Control and Status to External System.
- L. Electrical Plugs/Receptacles:
1. Electrical Pin and Sleeve Quick Disconnect Power Connections, Type 4X, Water and Gas Tight Design.
- M. Performance and Pump Schedule
1. In order to insure proper operation in all conditions, pump(s) must operate without overheating in continuous operation, maximum head condition required by the system. Pump(s) must also be capable of operating at zero or negative heads without damage to the pump(s).
  2. Pump Schedule:
 

|                |                            |
|----------------|----------------------------|
|                | <u>Duplex Pump Station</u> |
| Pump Capacity: | 25 gpm @ 175 ft            |
| Motor Speed:   | 1800 RPM                   |
| Motor Size:    | 3 HP                       |
| Discharge:     | 3"                         |

## PART 3 - EXECUTION

### 3.1 TESTING AND STARTUP

- A. The pumps provided shall be factory tested at three points to verify the pump performs at the design points.
  - 1. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve.
  - 2. The standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.
  - 3. All completed stations shall be factory leak tested to assure the integrity of all joints, seams and penetrations. All necessary penetrations such as inlets, discharge fittings and cable connectors shall be included in this test along with their respective sealing means (grommets, gaskets etc.).
- B. The Contractor shall test all power and control devices in Control Panel for proper operation.
- C. A factory trained service technician shall be provided for a minimum of one-half (1/2) day to test and make adjustments to the control panel and level system to place it into operation and provide training in operation and maintenance.
- D. After all testing has been completed to the satisfaction of the Owner and/or Engineer, the entire Lift Station and Control Panel System shall operate satisfactorily for a minimum test period of 30 days.
  - 1. Cumulative down time of all components furnished shall not exceed 1/2 hour as recorded by the Engineer during the test period.
  - 2. System documentation shall be delivered on the last day of test period. Test period shall not end until system documentation has been delivered.
- E. If the cumulative downtime limit is exceeded, the Engineer shall have the following options:
  - 1. Extend the test period as required until the cumulative downtime during the preceding 30 days does not exceed 1/2 hour as recorded by the Engineer.
  - 2. Sub-systems which have no components contributing to the cumulative downtime will be approved as a partial acceptance.
  - 3. Subsystems which have components that contributed to the cumulative downtime shall have their test period begin after all repairs and adjustments have been made.

### 3.2 FIELD TESTING

- A. Each pump shall be submerged, operated and tested for performance compliance to its respective curve.

END OF SECTION 331443



## SECTION 400523 - PROCESS VALVES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Extent of each type of size of valve required is indicated on drawings and/or schedule.
- B. All valves used for a particular service are to be of the same manufacturer, make and style for each valve type.
- C. Each valve unit shall be of the proper size and type to suit the intended service with appropriate; body style, operator, joint accessories, coatings, guides, supports, pertinent accessories to be complete, in place, tested and ready for service in conformance with project conditions.

#### 1.3 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Provide manufacturer's illustrated catalog data depicting general construction, materials list, coatings and necessary appurtenances in sufficient detail to verify product compliance.
- C. Shop Drawings: Provide manufacturer's drawings showing; principal dimensions, operator detail and arrangements, project schedule tag reference or location of intended usage as required to suit project conditions.

#### 1.4 QUALITY ASSURANCE

- A. Each valve shall be subjected to operation and hydrostatic tests at the manufacturer's plant as specified within applicable AWWA Standards.
- B. All coated surfaces shall receive manufacturer's production and holiday testing as specified in applicable AWWA Standards.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Preparation for Transport: Prepare valves for shipping as follows:
  - 1. Ensure valves are dry and internally protected against rust and corrosion.

2. Protect valve ends against damage and entry of dirt, etc. by use of appropriate end protectors.
  3. Set valves in best position for handling. Set gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.
- B. Storage: Use the following precautions during storage:
1. Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
  2. Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.
- C. Handling: Use a sling to handle valve whose size requires handling by crane or lift. Rig valves to avoid damage to exposed or internal valve parts. Do not use handwheels and stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Valves bodies shall be of either gray or ductile cast iron and shall have the name, monogram, or initials of the manufacturer cast thereon.
- B. Valves shall have nonrising stems except where noted, open by turning left or counter-clockwise and be provided with either a 2-inch square nut for buried valves or handwheel for exposed valves unless otherwise noted. The direction of opening shall be indicated by an arrow cast on the body and/or the actuator.
- C. All body bolts and nuts shall be bronze or stainless steel for buried, submerged or nonprotected applications and cadmium plated for exposed or interior applications that will receive protective finish coatings.

### 2.2 GATE OR TAPPING VALVES

- A. The valves, described in this section shall be resilient seated gate valves manufactured to meet or exceed AWWA C509. Valves shall be of compression type seal design, providing bubble tight shut-off with bi-directional seating ability for pressures up to 200 psi.
- B. The valve shall have a smooth, unobstructed waterway free from any sedimentation pockets. Valve shall provide a 100% port of nominal pipe size when fully open. Tapping valve port shall be sized to permit a full pipe port tap.
- C. Body style shall be mechanical joint type for buried service, flange joint type for exposed service and when required, to include special end connections for tapping requirements or otherwise if indicated on the contract drawings.

- D. Stuffing boxes shall be O-ring seal type with two (2) rings located in steam above thrust collar.
- E. Thrust bearings shall be of the low friction torque reduction type, located both above and below the steam collar.
- F. Valves shall be as manufactured by; American-Darling, Clow, M & H, Mueller, U.S. Pipe or an approved equivalent.

## 2.3 BUTTERFLY VALVES - WATER

- A. Butterfly valves shall comply with the latest revision of AWWA Specification C504, Class 150B. Valve discs shall be ductile iron, one (1) piece cast design for constant drip tight closure with flow in either direction for pressure up to 150 psi.
- B. Body style shall be full bodied, mechanical joint for buried service and flange joint type for exposed service unless otherwise indicated on the contract drawings.
- C. Wafer or lug body styles, when called for, shall have body applied seats that totally encapsulate the inside surface of the valve and also serve as the flange gaskets.
- D. All valve seat mating surfaces shall be against a 304 stainless steel or nickel-chromium disc edge surface for body applied seats or a 304 stainless steel surface with an O-ring seal against the body for disc applied seats as applied by means of manufacturers specified herein.
- E. Full body style valve seats shall be of Buna-N (Nitrile) rubber applied to either the body or the disc:
  - 1. Body applied seats shall be retained by a bonding process meeting ASTM-D-429, Test Method "B" or may be mechanically retained.
  - 2. Disc applied seats to be mechanically secured by a 304 stainless steel retention ring and fasteners to allow for field adjustability or replacement.
- F. Shafts shall be 316 or 304 stainless steel construction. Shaft bearings shall be self-lubricated sleeve type. Shaft seals may be of V-type packing or standard O-ring seals allowing replacement without removing the valve shaft.
- G. Valves shall be as manufactured by; American-Darling, Mueller, Pratt, DeZurik, Keystone or an approved equivalent.

## 2.4 BUTTERFLY VALVES - AIR

- A. Valves utilized shall be specifically designed for air service and 25 psi air pressure.
- B. Butterfly valves shall meet the intent of the latest AWWA Specification C504, Class 25. These valves shall be a fully lugged wafer type or a flanged type design as indicated on the contract drawings; with cast iron body, ASTM A126, Class B.

- C. Disc to be ductile iron, ASTM A536, Grade 65-45-12 with electroless nickel plating or solid welded on nickel disc edge.
- D. Elastomer seats shall be in the body. Seat on disc edge is not acceptable in air systems. Seats shall be of EPDM, and be field replaceable without special tools. Elastomer thickness, not inclusive of backing rings or stiffeners, shall be a minimum of 3/8-inch for valves 6 inches and smaller; and 1/2-inch for valves 8 inches and larger.
- E. Shafts shall be of 304 or 316 stainless steel construction. Shaft seals shall be adjustable chevron packing or O-ring.
- F. Discharge butterfly valves shall have locking lever operators.
- G. The valves shall be the product of Keystone, DeZurik or an approved equivalent.

## 2.5 CHECK VALVES - WATER

- A. Swing Check with Lever: Valves shall be quiet closing and constructed for a minimum of 150 pounds working pressure. They shall be iron body, bronze seats, with outside lever and adjustable weights and have hinge pins of stainless steel or bronze. Valves shall be a product of APCO, Clow, Empire-GA, Mueller, U.S. Pipe, or an approved equivalent.
- B. Air Cushioned Swing Check: Valves shall be GA Industries Model 250-D cushioned swing check valves with outside lever and weight; APCO; or an approved equivalent. Cushioned check valves shall be installed in the locations noted.
- C. Swing Check with Flapper: Valves shall be quiet closing and constructed for a minimum of 150 pounds working pressure. They shall be iron body and an acrylonitrile-butadiene (NBR) flapper with a steel disc for strength and a steel bar molded inside. Valves shall be a product of APCO, Clow, Empire GA, Mueller, U.S. Pipe, or an approved equivalent.
- D. Swing check valves shall be in full compliance with the latest revision of AWWA C508.
- E. Angle Check: Shall be installed on the discharge of a booster pump. It will open when upstream pressure exceeds downstream pressure, and close tightly to prevent backflow when downstream pressure exceeds upstream pressure. The opening and closing speeds of the valve shall be independently adjustable. The valve shall include a visual indicator assembly. Valves shall be a product of OCV Model 94-3 or a comparable type valve from Cla-Val, GA Industries, or an approved equivalent.

## 2.6 CHECK VALVES - AIR

- A. The body of wafer type construction shall be designed for 25 psi air pressure.
- B. Valves shall have an EPDM sealing member suitable for continuous duty operation.
- C. Bodies shall be cast iron, ASTM A126, Class B with aluminum bronze plates. The valve shall be drilled to match standard ANSI 125 flanges.

- D. Valves shall be Mission "Duo-Check II"; Techno Check Valve; an approved equivalent.

## 2.7 KNIFE GATE VALVES

- A. Knife gate valves shall be wafer style with tapped bolt holes, one (1) piece body design, and suitable for 0 to 150 psig drip-tight shut-off service. Valves over 20 inches in diameter shall be suitable for 50 psig rating.
- B. Valve, bodies, blade, stem, and all other wetted parts shall be 304 stainless steel. The gate shall have a rounded bottom with beveled knife edge and all sides of gate should be finish ground.
- C. Valves shall have handwheel with rising stem and rated for service pressures. Valves over 20 inches in diameter shall be bevel gear operated.
- D. Flanges shall be drilled to ANSI B 16.1, CL 125, 150 psi standard.
- E. Valve packing shall be suitable material, multiple V-ring, compression type with a definite packing gland coated with plastic or epoxy to prevent corrosion.
- F. The yoke sleeve shall be acid resisting bronze.
- G. Provide neoprene elastomer seat ring.
- H. Valves shall be the product of DeZurik Series L825, Ecolaine Series 7L, Red Valve Series G or an approved equivalent.

## 2.8 PLUG VALVES

- A. Valves shall be the nonlubricated, eccentric type with resilient, soft faced Buna-N rubber plugs providing bi-directional dead-tight shut-off to the full valve rating. Valve pressure ratings shall be 175 psi through 12 inches and 150 psi for valves over 12 inches.
- B. Bodies of valves shall be furnished with a welded overlay seat of not less than 90% pure nickel. Seat area shall be completely covered with raised surface weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.
- C. Plugs shall be of ASTM A126 Class B cast iron. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat shall be externally adjustable in the field with valve in line under pressure.
- D. Valve bearings shall be sleeve type, oil impregnated, permanently lubricated, stainless steel. Nonmetallic bearings shall not be acceptable.
- E. Shaft seals may be of the multiple V-ring or O-ring type conforming with ASTM C504 and shall be externally adjustable and replaceable without removing the valve while under pressure.

- F. Valves shall be as manufactured by; DeZurik, Keystone, Milliken or an approved equivalent.

## 2.9 PRESSURE RELIEF VALVES - AIR

- A. The pressure relief valves shall be compatible with the operating conditions of the blowers as defined elsewhere in these specifications. Each of the blowers shall be furnished with a weighted pressure relief valve on the discharge as shown on the drawings.
- B. The weight loaded pressure relief valve shall be cast iron body with cast iron weights. The cast iron weights shall be easily added or subtracted so that an adjustment can be made to accommodate the blower's pressure capabilities.
- C. The weighted pressure relief valves shall be as manufactured by Fuller Company; Roots Type PW; or an approved equivalent.

## 2.10 HYDROSTATIC PRESSURE RELIEF VALVES - WATER; TANK TYPE

- A. Valves to be of floor and wall type as required to suit project conditions. All such valves are to be of same manufacturer throughout project and installed per published recommendations of such.
- B. Valves shall be of flanged body style and be complete with body, or wall, pipe in length of concrete thickness being placed, removable strainer and soft composition rubber seats on both the body and cover.
- C. Floor types have integral locking lugs to retain cover, but allow for removable if necessary.
- D. Wall types shall be hinged with bronze pin and may permit use of an independent wall casting if strainer is mounted within the valve unit.
- E. Valves shall be as manufactured by; American-Darling, Clow, Trumbull Industries or an approved equivalent.

## 2.11 MUD VALVES

- A. Valves shall be of the rising stem type unless otherwise noted.
- B. The valve body shall be flanged and drilled to ANSI B 16.1, CL 125, 150 psi standard.
- C. The stem, stem nut, disc ring, and seat ring shall be bronze.
- D. Extension stems, operator, stem supports, floor box, etc. shall be provided as required by specifications, Valve Schedule and/or shown on the drawings.
- E. Valve shall be as manufactured by; Clow, M & H, Troy Valve, Trumbull Industries or an approved equivalent.

## 2.12 TELESCOPING VALVES

- A. Valves shall be capable of giving an infinitely variable discharge rate to suit travel range as indicated on the drawings.
- B. Valves shall be of the rising stem type, unless otherwise noted.
- C. General Contractor shall provide normal bolted, cast iron flange at elevation shown on the drawing and shall be responsible to provide sufficient straight pipe below the valve to allow for full travel of the tube inside.
- D. Each valve shall consist of an offset cast iron floor stand with suitable stem guide, cut tooth pinion bar rack assembly, spur gear with ductile iron locking panel, clear plastic stem cover with cap and travel scale indicator. Pinion shaft is operated by a 12-inch diameter offset handwheel with a rotating crank handle, or an 18-inch diameter top mounted handwheel with anti-rotation plate as required by valve schedule and/or plan illustration.
- E. The decant tube is to be of PVC pipe, smooth, stiff, concentric, connected on upper end with stainless steel bail and threaded adjustable rod connected to the bar rack assembly.
- F. Special flange having a neoprene O-ring insert and a flange transition seal gasket shall be provided by the equipment manufacturer to bolt to pipe flange by Contractor. Foundation bolts for operating stand will be stainless steel furnished with the equipment.
- G. Valves shall be as manufactured by; FMC Corporation, Waterman Industries or an approved equivalent.

#### 2.13 SURGE RELIEF VALVE

- A. Valves shall open rapidly when system pressure exceeds the intensity for which the pilot is set and close upon pressure subsidence below pilot setting. Provision shall be incorporated to regulate the closing speed of the valve. Initial relief pressure to be factory set.
- B. The main valve shall operate on the differential piston principle such that the area on the underside of the piston is no less than the pipe area, and the area on the upper surface of the piston is of a greater area than the underside of the piston.
- C. The valve piston shall be guided on its outside diameter by long stroke stationary Vee ports which shall be downstream of the seating surface to minimize the consequences of throttling.
- D. The valve shall be capable of operating in any position and shall incorporate only one flanged cover at the valve top from which all internal parts shall be accessible. The valve may be furnished either in a globe or angle design to suit project conditions.
- E. The valve interior trim shall be bronze conforming to ASTM B62.
- F. All controls and piping shall be noncorrosive construction materials.
- G. A visual valve position indicator shall be provided for observing the valve piston position at any time.

- H. Valves shall be as manufactured by GA Industries Figure 6600-DL or an approved equivalent.

## 2.14 COMBINATION AIR RELEASE VALVES

- A. Single Body Combination Air Valve sizes 1" (25 mm) through 8" (200 mm), (single body, double orifice) allow a large volume of air to escape out the large orifice when filling a pipeline and closes when liquid enters the valve. When the valve is closed and pressurized, the small air release orifice will open to allow small pockets of air to escape automatically and independently of the large orifice.
- B. The large orifice shall also allow large volumes of air to enter during pipeline drainage to break the vacuum. The body inlet must be baffled to protect the float from direct forces of rushing air and water to prevent premature valve shut-off.
- C. The Buna-N seat must be fastened to the valve cover without distortion for drop tight shut-off. The floats shall be heavy stainless steel. The plug or float shall be center guided through hex bushings for positive shut-off.
- D. Valve exterior to be painted with universal metal primer paint.
- E. All materials of construction shall be certified in writing to conform to ASTM specifications as follows:
  - 1. Body & Cover 1" - 4" (25 - 100 mm) Ductile Iron ASTM A536 GR 65-45-12
  - 2. Body & Cover 6" - 8" (150 - 200 mm) Cast Iron ASTM A126 GR.B
  - 3. Float Stainless Steel ASTM A240
  - 4. Needle & seat Buna-N
  - 5. Plug Stainless Steel ASTM A276
  - 6. Leverage frame Delrin/Cast Iron ASTM D4181/ASTM A126 GR.B
  - 7. Bronze components meet current lead-free requirements.
- F. Valves shall be as manufactured by APCO Model 143C, GA Industries Figure 945, or an approved equivalent.

## 2.15 FLAP GATES/TIDE GATES

- A. Unless otherwise indicated, flap gates/tide gates shall be as follows:
  - 1. Flap valves shall have a flanged cast iron frame and flap with bronze seats having heavy duty cast iron double hinge arms with stainless steel hinge pins.
  - 2. All gates shall be fully automatic, operating solely by differences in pressure on both sides of the valve. Each valve shall be adjustable so as to provide the optimum opening and yet close providing a virtually watertight seal when no seating head is present.
  - 3. The flap gate shall be secured to a flanged wall casting or thimble connection unless otherwise indicated. Wall thimbles, when needed, shall be a one-piece design supplied by the flap gate manufacturer.



4. Valves shall be as manufactured by Hydro-Gate, Rodney Hunt, Troy Valve or an approved equivalent.

## 2.16 DIGESTER GAS VALVES

- A. The gas service valves for the digesters shall be nonlubricated eccentric plug valves with resilient plug seal which shall be Type RS Buna-N and shall be UL listed for gas service.
- B. The plug valves shall provide complete shut-off of the flow stream and the O-ring seal shall be completely gas-tight, permitting no leakage whatsoever of the sewage gas to the atmosphere.
- C. Corrosion-resistant bushings of the permanently lubricated type shall be provided in the upper and lower plug journals to support the rotating element true unions. Bearings shall be stainless steel or bronze suitable for sewage gas service. Tape sprayed, or roll-on bushing or sleeves are not acceptable.
- D. Valves shall be as manufactured by DeZurik Series 425 or an approved equivalent.

## 2.17 OPERATORS

- A. All valves 6 inches and larger, and all buried, submerged, or chain operated valves shall be gear operated. Gears for valve operation shall be sized for the working pressure and installed in such a manner that the stuffing box will be accessible for packing.
- B. Manual Operation
  1. Valves shall be equipped with nut, handwheel, crank, chain, gears, floor stand, and other appurtenances as required for manual operation as specified or scheduled.
  2. Operation shall be designed so that the effort required to operate the handwheel, lever, or chain shall not exceed 25 lbs. applied at the extremity of the wheel or lever.
  3. Handwheels on valves 4 in. and larger shall not be less than 12 in. in diameter.
  4. Chainwheels shall be provided when the installed centerline of valve is over 5 ft.-6 in. above the floor. Chains shall be cadmium plated and loop 3 ft.-6 in. from the floor. Orient chainwheel and provide intermediate pulley mounting, if necessary, to permit unobstructed chain operation.
  5. Wrench nuts shall be cast iron or bronze, 1-15/16 in. at top, 2 in. square at base and 1-3/4 in. high with a flanged base.
    - a. Provide one (1) tee wrench for each valve type used and of each significant length differential required. All wrenches supplied shall be a length so that the bar handle extends approximately 3 feet above finished grade in addition to the required bury depth length(s).

### C. Hydraulic Operation

1. Valves for hydraulic operation shall be equipped with cylinders in accordance with AWWA C540, mounted on the valve bonnet. The size of the cylinder shall be determined by the valve manufacturer to be adequate for specified pressure and operating conditions in each instance where a hydraulically operated valve is specified in the definitive specifications of this section. Unless otherwise specified, cylinders above 12 inches in size, or where the cylinder pressure exceeds 100 lbs., shall be cast iron bronze-lined type.

### D. Electric valve operations

1. The operator shall be the helical and worm gear type driven by an electric motor. All power gearing shall be grease lubricated. The actuator shall be in conformance with AWWA C540. The valve manufacturer shall furnish the value of the maximum operating torque required to operate the valve as defined in the Appendix to AWWA C540. The operator manufacturer shall furnish evidence that the operator is designed to equal or exceed the torque requirements.
2. Unless otherwise noted, the operator shall be geared to operate the valve from the fully open position to the fully closed position or vice-versa in approximately 60 seconds. It shall be possible to change this cycle time by substituting suitable gear trains. The operator shall be equipped with a declutchable handwheel for manual operation. The operator shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering.
3. Suitable reduction gearing shall be provided off the main shaft of the gearing, turning approximately 270 degrees while the valve performs full travel. The reduction gearing shall be equipped with the following position indicating devices for each operator:
  - a. A mechanical position indicator dial;
  - b. The output signal shall be 4-20 mA; a standard potentiometer, 1000 ohms with linearity of +/- 3% for indication in the remote controller;
4. Each operator shall be equipped with adjustable torque switches for overload protection in both opening and closing directions with torque switch bypass for unseating.
5. Each operator shall be equipped with four adjustable train gear limit switches. Each limit switch shall include a switch and counter gear. The setting accuracy shall be less than 1/10 turn of the operator output shaft. Two (2) gear limit switches are for remote indication of end positions.
6. Each motor shall be 480 volts, 60 Hz, three phase, induction type as recommended by the operator manufacturer.
7. Three (3) thermostats in series placed in the winding shall provide the motor with thermal protection. They shall interrupt the control circuit as soon as the temperature goes beyond the permissible winding temperature.

8. Each operator shall be equipped with a reversing magnetic starter. The starter shall be capable of receiving contact closures from remote sources to actuate the operator in either direction. Control voltage shall be 120 volts supplied by a transformer included in the control enclosure. Each operator shall include a local OPEN-STOP-CLOSE control, push button station, and a pad lockable LOCAL-OFF-REMOTE selector switch.
9. All electrical components shall be integral with the operator, housed in a watertight NEMA 4X enclosure and completely wired.
10. A circuit-breaker disconnect shall be provided with the operator.
11. Easily identifiable terminal blocks shall be provided for all external power, control, and signal connections.
12. Operators, located outdoors, shall include thermostats and space heaters in the motor and control compartments.
13. The operator shall be as manufactured by AUMA, Rotork, Limitorque, EIM, or equal.

## 2.18 PROTECTIVE COATINGS

- A. All iron parts of valve assemblies shall be painted before leaving the shop.
- B. All exterior and internal waterway ferrous surfaces of each valve, except finished or bearing surfaces shall be shop painted with a liquid or powder epoxy coating of approximately 10 mils dry film thickness conforming to AWWA C-550.

## 2.19 EXTENSION STEMS AND STEM GUIDES

- A. When required by drawings, schedule or project details, provide an extension stem made of cold-rolled steel material and the same size as the stem of the valve it operates. If the extension is more than 8 ft. long, intermediate stem guides shall be installed and supported from the wall by suitable brackets at a maximum spacing of 8 ft.
- B. Brackets and stem guides shall be made of cast iron and fully adjustable. The guide block shall be bronze bushed where it contacts the extension stem. Stem guides shall be as manufactured by the Eddy Valve Co., Rodney Hunt, or equal. Secure stem guides to walls with stainless steel bolts. In the event of off-set or misalignment, provide off-set extension rod with universal end fittings at valve actuator and stem drop connection.
- C. Extension stem shall have connecting socket for 2-inch square nut and pinsocket to lock on valve operating nut.

## 2.20 VALVE BOXES

- A. Valve boxes shall be cast iron, 5-1/4" shaft, three-piece screw type, adjustable boxes. The top section to have a drop lid of which to be marked for service which it is used cast thereon. Cover and boxes shall be round pattern.

- B. Provide proper base size and shape to straddle the valve bonnet without touching or being supported by the valve mechanism. Use No. 6 base size for 6-inch and 8-inch gate valves or typical butterfly valve operators, No. 160 oval base size for 12-inch and larger gate valves or other size necessary to suit a particular valve manufacturer's requirements.
- C. Extension sections shall be provided where the depth of trench is such that they are needed to bring the top of the box to finished grade. The valve box shall be installed so that it is perfectly vertical and centered on the valve operating nut.

## 2.21 FLOOR BOXES AND STANDS

- A. Each valve operator projecting through a floor shall be equipped with a floor box or floor stand and extension stem.
- B. Floor boxes for access to operating nuts of valves, sluice or slide gates shall be cast iron cover and body with bronze or brass bushings. Casting length to equal the thickness of the concrete slab in as much as possible. Floor boxes shall be as manufactured by Clow, Trumbull Industries or an approved equivalent.
- C. Floor stands shall be made of cast iron and shall extend to a level where handwheel or other operator is easily operated. Stands shall be fitted with bronze bushings to maintain proper stem alignment, brass or stainless steel nameplates shall be provided to identify related valve manufacturer, valve type and size or in the case of stand being of valve manufacturer, cast in name would suffice. Provide plastic stem covers with open-close scale for all rising stem applications. Stands shall be anchored to the concrete slab with stainless steel bolts.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Valves shall be carefully handled and placed so as not to permit any damage to the interior coatings, disc or seat. Internal type lifting devices shall not be permitted. Do not use handwheels or stems as lifting of rigging points.
- B. All valves shall be carefully installed in their respective positions free from distortion and stress. Connecting joints shall conform to applicable requirements of the specifications.
- C. Stem guides shall be accurately aligned.
- D. If the valve box is tipped or otherwise not centered on the valve operating nut or not installed at the proper elevation, the Contractor shall, at his own expense, make whatever correction is required to remedy the defect promptly, upon notice to do so by the Engineer.

### 3.2 TESTING

- A. All valves shall be tested in place by the Contractor as far as practicable under conditions for the pipelines in which they are placed, and defects revealed in valves or connections under test shall be corrected at the expense of the Contractor to the satisfaction of the Engineer.

### 3.3 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintaining instructions, and a complete parts and recommended spare parts list. The O & M Manuals shall be in compliance with the General Requirements of these specifications.

END OF SECTION 400523

## SECTION 402336 - PIPES AND PIPE FITTINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK:

- A. Extent of pipe, tube, and fittings required by this section is indicated on drawings and/or specified in other sections.
- B. Types of pipe, tube, and fittings specified in this section include the following:
  - 1. Steel Pipes.
  - 2. Copper Tube.
  - 3. Brass Pipes
  - 4. Cast-Iron Pressure Pipes.
  - 5. Cast-Iron Soil Pipes.
  - 6. Clay Pipes.
  - 7. Concrete Pipes.
  - 8. Asbestos-Cement Pipes.
  - 9. Corrugated Metal Pipes.
  - 10. Plastic Pipes.
  - 11. Plastic Tubing.
  - 12. Acid-Resistant Pipes.
  - 13. Drainage Tile and Pipes.
  - 14. Grooved Piping Products.
  - 15. Miscellaneous Piping Materials/Products.
- C. Pipes and pipe fittings furnished as part of factory- fabricated equipment, are specified as part of equipment assembly in other sections.

#### 1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Welding: Quality welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
  - a. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, the National Certified Pipe Welding Bureau (NCPWB).
2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.
3. NSF Labels: Where plastic piping is indicated to transport potable water, provide pipe and fittings bearing approval label by National Sanitation Foundation (NSF).

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing Manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.
- B. Welding Certifications: Submit reports as required for piping work.
- C. Brazing Certifications: Submit reports as required for piping work.
- D. Maintenance Data: Submit maintenance data and parts lists for each type of mechanical fitting. Include this data, product data, and certifications in maintenance manual; in accordance with requirements of Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Except for concrete, corrugated metal, hub-and-spigot, clay, and similar units of pipe, provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.
- B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.
- C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packing with durable, waterproof wrapping.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
- B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

### 2.2 STEEL PIPES AND PIPE FITTINGS

- A. Black Steel Pipe: ASTM A 53, A 106 or A 120; except comply with ASTM A 53 or A 106 where close coiling or bending is required.
- B. Galvanized Steel Pipe: ASTM A 53 or A 120; except comply with ASTM A 53 where close coiling or bending is required.
- C. Seamless Steel Pipe: ASTM A 53, A 106, or A 120; except comply with ASTM A 53 or A 106 where close coiling or bending is required.
- D. Galvanized Seamless Steel Pipe: ASTM A 53 or A 120; except comply with ASTM A 53 where close coiling or bending is required.
- E. Electric-Resistance-Welded Steel Pipe: ASTM A 135.
- F. Electric-Fusion-Welded Steel Pipe: ASTM A 671, A 672, or A 691.
- G. Stainless Steel Pipe: ASTM A 312; Grade TP 304.
- H. Stainless Steel Sanitary Tubing: ASTM A 270; Finish No. 80.
- I. Yaloy Steel Pipe: ASTM A 714; Class 4; Grade IV.
- J. Steel Water Pipe: AWWA C200 for pipe 6" and larger.
- K. Coal Tar Protective Coatings and Linings for Steel Water Pipe: AWWA C203 for enamel and tape, hot applied.
- L. Chlorinated Rubber-Alkyd Paint System for Steel Water Pipe: AWWA C204.
- M. Cement-Mortar Protective Lining and Coating for Steel Pipe: AWWA C205.
- N. Cast-Iron Flanged Fittings: ANSI B16.1, including bolting.



- O. Cast-Iron Threaded Fittings: ANSI B16.4.
- P. Malleable-Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated.
- Q. Malleable-Iron Threaded Unions: ANSI B16.39; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.
- R. Threaded Pipe Plugs: ANSI B16.14.
- S. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
  - 1. Material Group: Group 1.1.
  - 2. End Connections: Buttwelding.
  - 3. Facings: Raised-face.
- T. Steel Pipe Flanges for Waterworks Service: AWWA C207.
- U. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing.
- V. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe.
- W. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.
- X. Yelow-Steel Buttwelding Fittings: ASTM A 714.
- Y. Stainless-Steel Buttwelding Fittings: MSS SP-43.
- Z. Cast-Iron Threaded Drainage Fittings: ANSI B16.12.
- AA. Forged Branch-Connection Fittings: Except as otherwise indicated, provided type as determined by Installer to comply with installation requirements.
- BB. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2", and where pipe size is less than 1-1/2", and do not thread nipples full length (no close-nipples).

## 2.3 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88; Type (wall thickness) as indicated for each service; hard-drawn temper, except as otherwise indicated.
- B. DWV Copper Tube: ASTM B 306.
- C. ACR Copper Tube: ASTM B 280.
- D. Cast-Copper Solder-Joint Fittings: ANSI B16.18.

- E. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.
- F. Cast-Copper Solder-Joint Drainage Fittings: ANSI B16.23.
- G. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.
- H. Cast-Copper Solder-Joint Drainage Fittings: For "sovent" drainage systems, ANSI B16.32.
- I. Cast-Copper Flared Tube Fittings: ANSI B16.26.
- J. Bronze Pipe Flanges/Fittings: ANSI B16.24.
- K. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

## 2.4 BRASS PIPE AND FITTINGS

- A. Red Brass Pipe: ASTM B 43.
- B. Cast-Bronze Threaded Fittings: ANSI B16.15.
- C. Cast-Bronze Threadless Fittings: ASTM B 61 or B 62.

## 2.5 CAST IRON PRESSURE PIPES AND PIPE FITTINGS

- A. Ductile-Iron Pipe: ANSI A21.51; AWWA C151.
- B. Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water: ANSI A21.4; AWWA C104.
- C. Polyethylene Encasement for Gray and Ductile Cast-Iron Piping: ANSI A21.5; AWWA C105.
- D. Cast-Iron Fittings: AWWA C110.
- E. Gray-Iron Fittings: AWWA C110.
- F. Ductile-Iron Fittings: AWWA C110.
- G. Rubber-Gasket Joints: AWWA C111.

## 2.6 CAST-IRON SOIL PIPES AND PIPE FITTINGS

- A. Hubless Cast-Iron Soil Pipe: FS WW-P-401.
- B. Cast-Iron Hub-and-Spigot Soil Pipe: ASTM A 74.
- C. Hubless Cast-Iron Soil Pipe Fittings: Neoprene gasket complying with ASTM C 564 and stainless steel clamp holding band.

- D. Cast-Iron Hub-and-Spigot Soil Pipe Fittings: Match soil pipe units; complying with same standards (ASTM A 74).
- E. Compression Gaskets: ASTM C 564.
- F. Lead/Oakum Joint Materials: Provide products complying with governing regulations for use in service indicated.

## 2.7 CLAY PIPES AND PIPE FITTINGS

- A. Vitrified Clay Pipe: ASTM C 700, Standard Strength (SS) except where Extra Strength (XS) indicated, with resilient gasket joints complying with ASTM C 425.
- B. Fittings for Clay Pipe: Match clay pipe; provide units produced by same manufacturer, complying with same standards.

## 2.8 CONCRETE PIPES AND PIPE FITTINGS

- A. Reinforced Concrete Pipe: ASTM C 76, Class as indicated, with modified tongue-and-groove compression gasket joints complying with ASTM C 443.
- B. Concrete Pipe: ASTM C 14, Class 2, unless otherwise indicated.
- C. Fittings for Concrete Pipe: Match concrete pipe; provide units produced by same manufacturer, complying with same standards.

## 2.9 CORRUGATED METAL PIPES AND PIPE FITTINGS

- A. Corrugated Metal Pipe: AASHTO M36, helically or circumferentially corrugated, mill-galvanized steel, size and gage as indicated.
  - 1. Furnish bituminous coated conduit complying with AASHTO M190, as follows:
    - a. Type A, full bituminous coating.
    - b. Type B, half bituminous coating.
    - c. Type C, full bituminous coating and paved.
- B. Fittings for Corrugated Metal Pipe: Match corrugated metal pipe; provide units produced by same manufacturer, complying with same standards.

## 2.10 PLASTIC PIPES AND PIPE FITTINGS

- A. Acrylonitrile-Butadiene-Styrene Pipe (ABS): ASTM D 1527.
- B. Acrylonitrile-Butadiene-Styrene Sewer Pipe (ABS): ASTM D 2751.
- C. Cellulose Acetate Butyrate Pipe (CAB): ASTM D 1503.
- D. Fiberglass Reinforced Epoxy Pipe (FRE): ASTM D 2310 and D 2996.

- E. Polybutylene Pipe (PB): ASTM D 2662.
- F. Polybutylene Hot- and Cold-Water Pipe (PB): ASTM D 3309.
- G. Polyethylene Pipe (PE): ASTM D 2104.
- H. Polyvinyl Chloride Pipe (PVC): ASTM D 1785.
- I. Polyvinyl Chloride Water Pipe (PVC): AWWA C900.
- J. Polyvinyl Chloride Sewer Pipe (PVC): ASTM D 2729.
- K. Polyvinyl Chloride Drain, Waste, and Vent Pipe (PVC): ASTM D 2665.
- L. Chlorinated Polyvinyl Chloride Pipe (CPVC): ASTM F 441.
- M. ABS Pipe Fittings:
  - 1. Schedule 40 Socket: ASTM D 2468.
  - 2. Schedule 80 Socket: ASTM D 2469.
  - 3. Schedule 80 Threaded: ASTM D 2465.
  - 4. Solvent Cement: ASTM D 2235.
  - 5. Solvent Cement (To Join ABS To PVC): ASTM D 3138.
- N. CAB Pipe Fittings: Provide fittings of same material by same pipe manufacturer for same pressure rating.
  - 1. Solvent Cement: ASTM D 2560.
- O. FRE Pipe Fittings: Mechanically fastened union-type non-threaded couplings with "O" ring seals.
- P. PB Fittings:
  - 1. SDR 11 Socket: ASTM D 3309.
- Q. PE Fittings:
  - 1. Butt Heat Fusion: ASTM D 3261.
  - 2. Insert Fusion: ASTM D 3197.
  - 3. Socket Type: ASTM D 2683.
  - 4. Insert: ASTM D 2609.
- R. PVC Fittings:
  - 1. Schedule 40 Socket: ASTM D 2466.
  - 2. Schedule 80 Socket: ASTM D 2467.
  - 3. Schedule 80 Threaded: ASTM D 2464.
  - 4. DWV Socket: ASTM D 2665.
  - 5. Sewer Socket: ASTM D 2729.

6. Solvent Cement: ASTM D 2564.
7. Solvent Cement (To Join PVC To ABS): ASTM D 3138.

S. CPVC Fittings:

1. Schedule 40 Socket: ASTM F 438.
2. Solvent Cement: ASTM D 2564.

T. PLASTIC TUBING AND TUBE FITTINGS:

U. Polybutylene Tubing (PB): ASTM D 2666.

V. Polybutylene Hot- and Cold-Water Tubing (PB): ASTM D 3309.

W. Polyethylene Tubing (PE): ASTM D 2737.

X. Polyvinyl Chloride Tubing (PVC): ASTM D 2740.

Y. PB Fittings:

1. Socket Fusion: ASTM D 3309.
2. Compression: As recommended by manufacturer.
3. Crimp-Type: As recommended by manufacturer.

Z. PE Fittings:

1. Insert: ASTM D 2609.

AA. PVC Fittings:

1. Insert: ASTM D 2609.

2.11 ACID-RESISTANT PIPES AND PIPE FITTINGS

- A. Cast-Iron Pipe; Acid-Resistant: High-silicon cast-iron pipe of type indicated, complying with ASTM A 518.
- B. Lead Pipe: Acid-resistant chemically-pure hard lead, with 7% antimony.
- C. Glass Pipe: ASTM C 599.
- D. Fittings for Acid-Resistant Pipe: Provide fittings matching pipe, and with equal-or-better acid resistance; comply with same standards where applicable. Unless otherwise indicated, provide fittings produced by manufacturer of pipe, and recommended for service indicated.

2.12 DRAINAGE TILE AND PIPE, FITTINGS, AND ACCESSORIES

- A. Clay Drain Tile: ASTM C 4; Standard Class, unless otherwise indicated; lengths as indicated.

- B. Concrete Drain Tile: ASTM C 412; Standard Quality, unless otherwise indicated; lengths as indicated.
- C. Porous Concrete Pipe: ASTM C 654; Standard Strength, unless otherwise indicated.
- D. Perforated Asbestos-Cement Pipe: ASTM C 508; Type III, unless otherwise indicated.
- E. Perforated Polyvinyl Chloride Pipe (PVC): ASTM D 2729; perforated except where standard sections of pipe are indicated.
- F. Perforated Clay Pipe: ASTM C 700; Standard Strength, unless otherwise indicated.
- G. Perforated Concrete Pipe: ASTM C 444, Type 1; and also ASTM C 14, Class 2.
- H. Perforated Bituminized Fiber Pipe: ASTM D 2311.
- I. Fittings and Accessories for Drainage Tile and Pipe: Unless otherwise indicated, provide fittings matching and of same material as pipe units; comply with same standards, where applicable, except fittings need not be perforated where pipe is required to be perforated.
- J. Tile Joint Accessories: Where open-joint drainage tile is indicated, provide joint accessory units as follows:
  - 1. Heavy-mesh burlap joint covers, with copper wire ties.
  - 2. Coal-tar saturated felt covers, with copper wire ties.
  - 3. Copper screen covers, 18-14 mesh, with copper wire ties.
  - 4. Corrosion-resistant metal spacer-band covers.

## 2.13 GROOVED PIPING PRODUCTS

- A. General: As Installer's option, mechanical grooved pipe couplings and fittings may be used for piping systems having operating conditions not exceeding 230 deg F (110 deg C), excluding steam piping and any other service not recommended by manufacturer, in lieu of welded, flanged, or threaded methods, and may also be used as unions, seismic joints, flexible connections, expansion joints, expansion compensators, or vibration reducers.
- B. Coupling Housings: Malleable iron conforming to ASTM A 47.
- C. Coupling Housings: Ductile iron conforming to ASTM A 536.
- D. Coupling Housings Description: Grooved mechanical type, which engages grooved or shouldered pipe ends, encasing an elastomeric gasket which bridges pipe ends to create seal. Cast in two or more parts, secure together during assembly with nuts and bolts. Permit degree of contraction and expansion as specified in manufacturer's latest published literature.
- E. Gaskets: Mechanical grooved coupling design, pressure responsive so that internal pressure serves to increase seal's tightness, constructed of elastomers having properties as designated by ASTM D 2000.

1. Water Services: EDPM Grade E, with green color code identification.
  2. Other Services: As recommended by Manufacturer.
- F. Bolts and Nuts: Heat-treated carbon steel, ASTM A 183, minimum tensile 110,000 psi.
1. Exposed Locations: Tamper resistant nuts.
- G. Branch Stub-Ins: Upper housing with full locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts.
- H. Fittings: Grooved or shouldered end design to accept grooved mechanical couplings.
1. Malleable Iron: ASTM A 47.
  2. Ductile Iron: ASTM A 536.
  3. Fabricated Steel: ASTM A 53, Type F for 3/4" to 1-1/2"; Type E or S, Grade B for 2" to 20".
  4. Steel: ASTM A 234.
- I. Flanges: Conform to Class 125 cast iron and Class 150 steel bolt hole alignment.
1. Malleable Iron: ASTM A 47.
  2. Ductile Iron: ASTM A 536.
- J. Grooves: Conform to the following:
1. Standard Steel: Square cut.
  2. Lightweight Steel: Roll grooved.
  3. Cast Iron: Radius cut grooved, AWWA C606.
- K. Manufacturer: Subject to compliance with requirements, provide grooved piping products of one of the following:
1. ITT Grinnell Corp.
  2. Stockham Valves & Fittings, Inc.
  3. Victaulic Co. of America.

#### 2.14 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.
1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.

1. Tin-Lead Solder: ASTM B 32, Grade 50A.
  2. Tin-Antimony Solder: ASTM B 32, Grade 95TA.
  3. Silver-Lead Solder: ASTM B 32, Grade 96TS.
- C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.
1. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.
- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.
- E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.
1. Manufacturer: Subject to compliance with requirements, provide piping connectors of the following:
    - a. Fernco, Inc.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance.
1. Comply with ANSI B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of building; limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.



- C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.

### 3.2 PIPING SYSTEM JOINTS

- A. General: Provide joints of type indicated in each piping system.
- B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- C. Braze copper tube-and-fitting joints where indicated, in accordance with ANSI B31.
- D. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- E. Mechanically Formed Tee Connections: In lieu of providing tee fittings in copper tubing, Installer may, as option, provide mechanically formed tee connections, providing they are in accordance with the following:
  - 1. Size and wall thickness of both run tube and branch tube are listed by Manufacturer of forming equipment as "Acceptable Application".
  - 2. Height of drawn collar is not less than 3 times wall thickness of run tubing.
  - 3. End of branch tube is notched to conform to inner curve of run tube, and dimpled to set exact penetration depth into collar.
  - 4. Resulting joint is minimum of 3 times as long as thickness of thinner joint member, and brazed using B-CuP series filler metal.
- F. Mechanically Formed Couplings: In lieu of providing couplings in copper tubing, Installer may, as option, provide mechanically formed couplings, provided they are in accordance with the following:
  - 1. Form couplings by first annealing area at end of tube where expansion will occur. Insert tube expander to die size required and expand tube end to accept tubing of same size.
  - 2. Resulting joint is minimum of 3 times as long as thickness of tube, and brazed using B-CuP series filler metal.
- G. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.
- H. Weld pipe joints in accordance with recognized industry practice and as follows:
  - 1. Weld pipe joints only when ambient temperature is above 0 deg F (-18 deg C) where possible.

2. Bevel pipe ends at a 37.5 deg angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
  3. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
  4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
  5. Do not weld-out piping system imperfections by tack- welding procedures; refabricate to comply with requirements.
  6. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.
  7. At Installer's option, install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.
- I. Weld pipe joints of steel water pipe in accordance with AWWA C206.
  - J. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
  - K. Lead Joint Installation: Tightly pack joint with joint packing material. Do not permit packing to enter bore of finished joint. Clean joint after packing. Fill remaining joint space with one pouring of lead to indicate minimum depth measured from face of bell. After lead has cooled, calk joint tightly by use of hammer and calking iron.
  - L. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.
  - M. Clay Pipe Joints: Comply with ASTM C 12.
  - N. Concrete Pipe Joints: Except as otherwise indicated, comply with applicable provisions of "Concrete Pipe Field Manual" by the American Concrete Pipe Assn.
  - O. Corrugated Metal Pipe Joints: Comply with manufacturer's instructions and recommendations.
  - P. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards:
    1. Heat Joining of Thermoplastic Pipe: ASTM D 2657.
    2. Making Solvent-Cemented Joints: ASTM D 2235, and ASTM F 402.
  - Q. Glass Pipe Joints: Comply with manufacturer's instructions and recommendations.
  - R. Open Drain-Tile Joints: Except as otherwise indicated, provide 1/4" open joint, with top 2/3 of annular space covered by joint accessory material.
  - S. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.

### 3.3 PIPING INSTALLATION

- A. Install drainage piping (perforated, porous or tile) from lowest end of slope to highest, solidly bedded in filtering or drainage fill. Shape bed for bells of piping (if any). Place bells/hubbs and grooved ends of units up-stream. Lay perforated pipe with perforations down.
- B. Install gray and ductile cast-iron water mains and appurtenances in accordance with AWWA C600.
- C. Install asbestos-cement pressure pipe in accordance with AWWA C603.

### 3.4 CLEANING, FLUSHING, INSPECTING

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
  - 1. Inspect pressure piping in accordance with procedures of ASME B31.
- B. Disinfect water mains and water service piping in accordance with AWWA C601.

### 3.5 PIPING TESTS

- A. Test pressure piping in accordance with ASME B31.
- B. General: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
  - 1. Required test periods is 2 hours.
  - 2. Test long runs of Schedule 40 pipe at 150 psi, except where fittings are a lower Class or pressure rating.
  - 3. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
  - 4. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- C. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- D. Drain test water from piping systems after testing and repair work has been completed.

## SECTION 406196 – PROCESS CONTROL DESCRIPTIONS

### VILLAGE OF CADIZ, OHIO

### WATER TREATMENT PLANT HAB IMPROVEMENTS

### REVISED DESCRIPTION OF THE FILTER BACKWASH OPERATION

OCTOBER 2019

#### 1. INTRODUCTION

1.1. The original filter backwash system (1993) consisted of four main steps without a Filter-To-Waste step. The revised system now includes a Filter-To-Waste step which now precedes the Return to Service step. The Filter-To-Waste step allows the filter to function normally except the filtered water flows to the Backwash Water Recovery Basin. This additional step allows the filter to “mature” or “ripen” before it is placed back into normal service.

1.2. The five main backwash operation steps for the revised system are as follows:

1.2.1. Terminal Headloss

1.2.2. Backwash System

1.2.3. Air Purge

1.2.4. Filter-To-Waste

1.2.5. Return to Service

1.3. The twelve shaded/highlighted valve identification labels/tags shown below are for valves that were installed in 1993 with the original General Filter Company’s “CentROL” filter system. The shaded/highlighted (existing) valves are electric solenoid controlled air operated and the new valves are electric motor operated.

2. GENERAL VALVE DESCRIPTIONS: The sequence of the filter backwash operation is identical for each of the four filter cells. The backwash operation consists of five steps, the first of which is initiated when the water level rises in a cell to a pre-determined level (Terminal Headloss) or when an Operator initiates it manually. The backwash operation is controlled by the opening and closing of the sets of solenoid/motor actuated butterfly valves described below.

2.1. There are four sets of six valves for each of the four filter cells. They are as follows:

2.1.1. Influent Valves INF-BV-01, INF-BV-02, INF-BV-03, and INF-BV-04 control the flow from the Recarbonation (CO<sub>2</sub>) Tank to the filters.

2.1.2. Effluent Valves FFR-BV-01, FFR-BV-02, FFR-BV-03, and FFR-BV-04 control the filtered water flow to the Disinfectant (Cl<sub>2</sub>) Contact Tank.

- 2.1.3. Filter-To-Waste Valves FFR-BV-05, FFR-BV-06, FFR-BV-07, and FFR-BV-08 control filtered water flow to the Backwash Water Recovery Basin.
- 2.1.4. Backwash Waste Valves BWW-BV-01, BWW-VB-02, BWW-BV-03, and BWW-BV-04 control the filter backwash waste water flow to the Backwash Water Recovery Basin.
- 2.1.5. Backwash Water Flow Valves FPR-BV-02, FPR-BV-03, FPR-BV-04, and FPR-BV-05 control backwash water flow from the high service pumps to the filters in order to clean the granular media.
- 2.1.6. Air Purge Valves ARP-BV-01, ARP-BV-02, ARP-BV-03, and ARP-BV-04 control the flow of compressed air from the air wash blower to the filters in order to agitate the granular media during backwashing.

2.2. One valve is common for all four filters as described below:

- 2.2.1. Backwash Flow Control Valve FPR-BV-01 controls the rate of backwash water flow from the high service pumps to the filter being backwashed. The rate of flow is measured by a magnetic flow meter installed just upstream of the valve. The Operator has the capability to set a predetermined rate of flow.

2.3. The following table summarizes the valve identification labels/tags for each filter:

| VALVE NAME                | FILTER No. 1 | FILTER No. 2 | FILTER No. 3 | FILTER No. 4 | COMMON    |
|---------------------------|--------------|--------------|--------------|--------------|-----------|
| Influent Valve            | INF-BV-01    | INF-BV-02    | INF-BV-03    | INF-BV-04    | -         |
| Effluent Valve            | FFR-BV-01    | FFR-BV-02    | FFR-BV-03    | FFR-BV-04    | -         |
| Filter-To-Waste Valve     | FFR-BV-05    | FFR-BV-06    | FFR-BV-07    | FFR-BV-08    | -         |
| Backwash Waste Valve      | BWW-BV-01    | BWW-BV-02    | BWW-BV-03    | BWW-BV-04    | -         |
| Backwash Water Flow Valve | FPR-BV-02    | FPR-BV-03    | FPR-BV-04    | FPR-BV-05    | -         |
| Air Purge Valve           | ARP-BV-01    | ARP-BV-02    | ARP-BV-03    | ARP-BV-04    | -         |
| Backwash Flow             | -            | -            | -            | -            | FPR-BV-01 |

| VALVE<br>NAME    | FILTER<br>No. 1 | FILTER<br>No. 2 | FILTER<br>No. 3 | FILTER<br>No. 4 | COMMON |
|------------------|-----------------|-----------------|-----------------|-----------------|--------|
| Control<br>Valve |                 |                 |                 |                 |        |

### 3. BACKWASH OPERATION SYSTEM DESCRIPTION

3.1. **TERMINAL HEADLOSS:** The backwash sequence starts at terminal headloss or Operator initiation. The influent and effluent flows are stopped and the backwash waste valve is opened.

3.1.1. Influent Valve INF-BV-01, INF-BV-02, INF-BV-03, or INF-BV-04 closes.

3.1.2. Effluent Valve FFR-BV-01, FFR-BV-02, FFR-BV-03, or FFR-BV-04 closes.

3.2. **BACKWASH SYSTEM:** Backwash water flow and air flow are started simultaneously when the cell water level reaches the wastetroughs. Simultaneous air and water flow is continuously applied to the granular media while the backwash wastewater is overflowing the trough.

3.2.1. Backwash Waste Valve BWW-BV-01, BWW-BV-02, BWW-BV-03, or BWW-BV-04 opens.

3.2.2. Backwash Water Flow Valve FPR-BV-02, FPR-BV-03, FPR-BV-04, or FPR-BV-05 opens.

3.2.3. Air Purge Valve ARP-BV-01, ARP-BV-02, ARP-BV-03, or ARP-BV-04 opens.

3.3. **AIR PURGE:** Once the backwash cycle is complete, the air is discontinued. The water continues to flow, purging the underdrain and media bed to remove entrapped air.

3.3.1. Air Purge Valve ARP-BV-01, ARP-BV-02, ARP-BV-03, or ARP-BV-04 closes.

3.4. **FILTER TO WASTE:** Filter returns to service except that its filtered water is allowed to flow to backwash waste for a pre-determined period of time.

3.4.1. Backwash Waste Valve BWW-BV-01, BWW-BV-02, BWW-BV-03, or BWW-BV-04 closes.

3.4.2. Backwash Water Flow Valve FPR-BV-02, FPR-BV-03, FPR-BV-04, or FPR-BV-05 closes.

3.4.3. Influent Valve INF-BV-01, INF-BV-02, INF-BV-03, or INF-BV-04 opens.

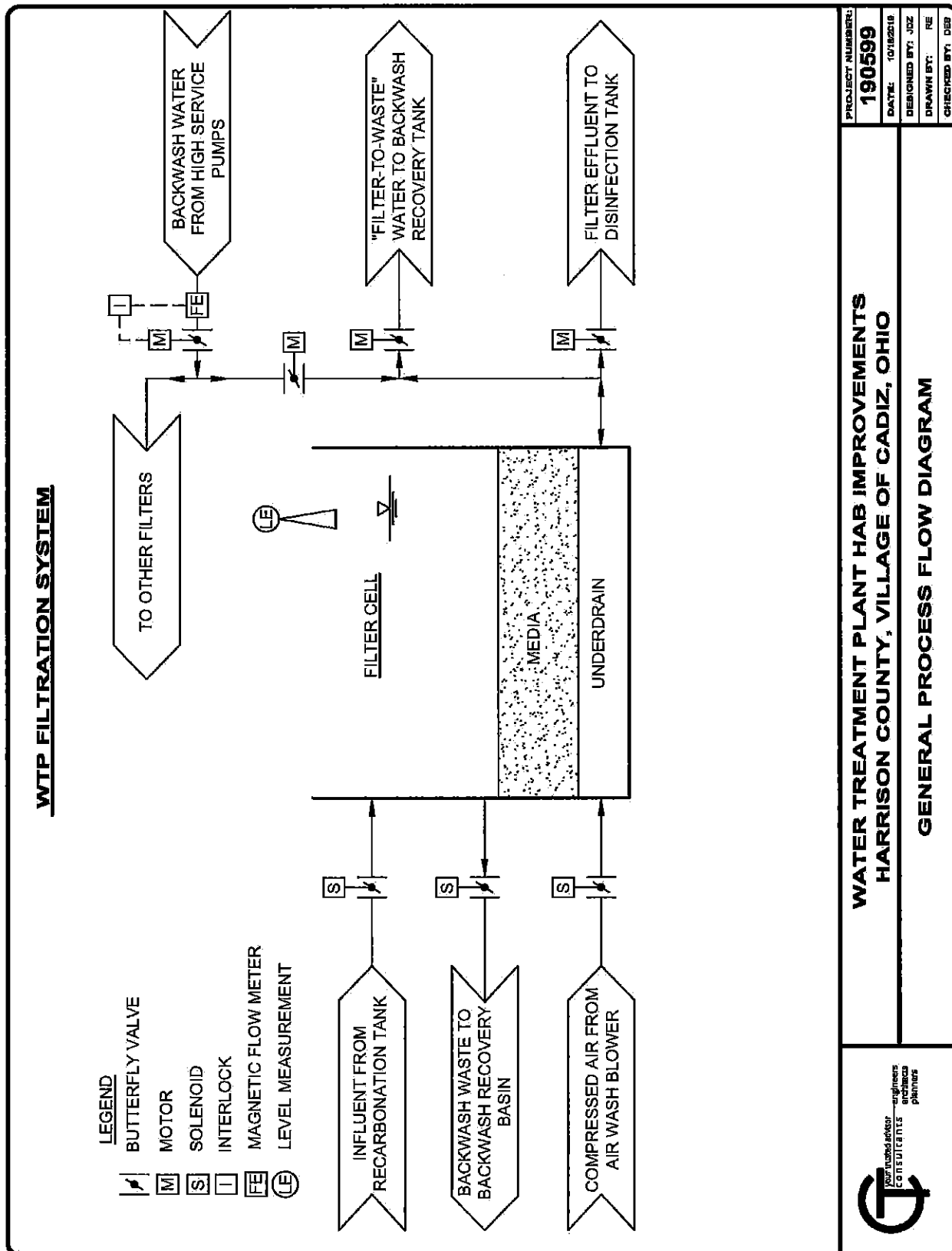
3.4.4. Filter-To-Waste Valves FFR-BV-05, FFR-BV-06, FFR-BV-07, and FFR-BV-08 opens.

3.5. **RETURN TO SERVICE:** The filter is then returned to service as follows.

3.5.1. Filter-To-Waste Valves FFR-BV-05, FFR-BV-06, FFR-BV-07, and FFR-BV-08 closes.

3.5.2. Effluent Valve FFR-BV-01, FFR-BV-02, FFR-BV-03, or FFR-BV-04 opens.

4. GENERAL PROCESS FLOW DIAGRAM is presented on the following page.



END OF SECTION 406196



## SECTION 407113 – MAGNETIC FLOW METERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1 through 48 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section includes furnishing and installing all required magnetic flow meters as shown on the Drawings, as specified or directed. The meters shall include a primary metering element, sensors, transmitter, and other appurtenances required for a complete installation.
- B. It is the intent of this contract that the final installation shall be complete in all respects and the Contractor shall be responsible for minor details and any necessary special construction not specifically included in the Drawings or Specifications.
- C. Refer to Special Provisions for the type and number of flow meters required.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 RESPONSIBILITY AND COORDINATION

- A. Under this Contract, the Contractor shall be responsible for the purchase, storage, and installation of the flow meter, transmitter, and any accessories required. The device shall be completely wired, tested, and be suitable for operation. The control equipment wiring between the device and the power supply, and piping between meter and transmitter shall be the responsibility of the Contractor. The Drawings and Specifications are intended to illustrate and define the equipment installation; however, the Contractor shall be properly install, adjust, and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Specifications.

#### 1.5 SUBMITTALS

- A. The Contractor shall submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.
- B. Product Data: Submit manufacturer's technical data and application instructions.

## PART 2 - PRODUCTS

### 2.1 MAGNETIC METERS

- A. Each meter shall include a magnetic metering tube, removable electrode, a signal converter with local indicator, flow totalizer and listed specials.
- B. Each metering system shall be accurate to less than plus or minus 1% of the actual flow rate.

#### C. METERING TUBE

1. The magnetic flow meter shall operate on DC voltage in which the voltage induced is directly proportional to the volumetric flow through the meter.
2. The metering tube shall be constructed of 304 stainless steel with 150 lb. ANSI flanges for connections. The meter liner shall be Teflon.
3. By nature of its design, the meter shall feature zero stabilization with no drift, low power consumption and require no field calibration unless one of the control PC boards is replaced.
4. The meter and housing shall be capable of submergence and shall meet NEMA 6P standards, as a minimum. Refer to Special Provisions.
5. When required by the Special Provisions, especially on intermittent flows, the meter shall be provided with positive zero return.
6. Grounding of the meter shall be accomplished by the Manufacturer's standard method for use on lined or non-conductive pipe. Grounding rings shall be of Type 316 stainless steel.
7. The meter shall run on a 115 volt, 60 Hz, single phase power supply, which shall be provided by the Electrical Contractor.
8. The meter shall be accurate to plus or minus 0.5% of full scale under the specified operating conditions. Voltage or frequency fluctuations in the power supply of plus or minus 10% shall not produce an error of more than plus or minus 0.5% of full scale.
9. The meters shall be as manufactured by Brooks, Krohne, Siemens, Sparling, or equal.

#### D. ELECTRODES

1. The electrodes or electrode cartridge shall be Type 316 stainless steel and shall be capable of being removed in the field for cleaning with the meter on-line, under pressure and without recalibration. This shall be accomplished by inserting the electrode through a corporation cock or valved assembly.
2. The electrode housing shall also be made of 316 stainless steel.
3. The electrode shall be screwed into the end of the valve fitting to provide a positive seal rated at the same pressure as the meter.
4. The electrode will be fastened to the valve or meter by a chain of a sufficient length that will allow cleaning, but prevent damage due to accidental dropping.

## E. SIGNAL CONVERTER - TRANSMITTER

1. The signal converter-transmitter shall be microprocessor based and shall be a product of the metering tube manufacturer. Each signal converter transmitter shall work with any of the flow meters provided. The unit shall be field scalable and shall require no zero-point adjustment. The unit shall be provided with self-diagnostics PC card, automatic data checking and data retention for a minimum of 10 years.
2. The signal converter-transmitter shall be wall mounted within 50 ft. of the flow meter. The signal converter-transmitter enclosure shall have a NEMA 4 minimum rating.
3. The signal converter-transmitter shall amplify and convert the DC input signal from the flow meter into a 4-20 mA DC signal proportional to the volumetric flow through the meter.
4. The DC signal shall drive an integral flow indicator.
5. The local flow indicator shall indicate flow in gallons per minute (GPM) and totalize.
6. The signal converter-transmitter shall run on a 115 volt, 60 Hz, single phase power supply, which shall be provided by the Electrical Contractor.
7. The signal converter-transmitter shall be accurate to plus or minus 0.5% of full scale under the specified operating conditions. Voltage of frequency fluctuations in the power supply of plus or minus 10% shall not produce an error of more than plus or minus 0.5% of full scale.

## 2.2 FULL PROFILE INSERTION ELECTROMAGNETIC FLOW METER

### A. GENERAL

1. The electromagnetic flow meter shall consist of a flow sensor based on Faraday's Law of Electromagnetic Induction and microprocessor-based signal converter

### B. SENSOR

1. Operating principle: Utilizing Faraday's Law of Electromagnetic Induction, the flow of a conductive liquid around the sensor induces an electrical voltage that is proportional to the velocity of the flow.
2. Construction: The sensor material shall be constructed of 316 Stainless Steel and coated with NSF 61 certified approved epoxy coating.
3. Hastelloy Electrodes (Optional) shall be used when corrosive fluid is present.
4. Sensor operating Temp: +14° to +170° F @ 250 PSI
5. Electronics operating temperature (Converter): -4° to +140° F
6. Size: 4" to 138" diameter (see instrument schedule)
7. Installation hardware shall include a Stainless Steel 2" full ported valve with a stainless steel nipple.
8. Submergence:
  - a. The sensor shall be NEMA 6P or IP68 rated to be permanently submerged up to 6 feet.
  - b. The sensor shall be NEMA 6P or IP68 rated to be permanently submerged up to 30 feet (option with IP68 rated strain relief connection only).

9. Converter enclosure: NEMA 4X or IP67 enclosure
10. Display: background illumination with a six button menu driven alphanumeric 5-line, 40-character display to indicate flow rate, totalized values, settings, and faults (ProComm)
11. Power supply: 90/265 VAC or 11-35VDC
12. Outputs: 4-20mA (0-21mA) into 1000 ohms max
13. Standard Outputs:
  - a. Four separate digital programmable outputs: open collector transistor useable for pulse, frequency, or alarm settings, for standard converters and Modbus configuration.
  - b. Two separate digital programmable outputs: open collector transistor usable for pulse, frequency, or alarm settings, for Profibus and HART configurations.
14. Communications: Option: RS-485 Modbus, Profibus Protocols and HART (Must specify at the time of order.)
15. Sensor and signal converter performance:
  - a. Flow Range: 0.3 fps to 32\* fps for accuracies stated below. \*Maximum velocities may be restricted to less than 32 fps in larger diameter applications.
  - b. Accuracy: +/- 0.5% of actual flow for flow range of 1 f/s to 32 f/s, and +/-1% from .3 f/s to 1 f/s
  - c. Separation: Maximum distance of 500 feet between signal converter and sensor without the use of any additional equipment. Longer cable lengths shall be available upon request. Please contact the factory.
  - d. bi-directional flow capabilities (Optional)
16. Totalizer: Three eight-digit counters for forward flow, reverse flow and net
17. The electromagnetic insertion flow meter shall be McCrometer 395L for forward flow, or 394L bi-directional Full Profile Insertion Mag Meter or equal.

#### C. SPARE PARTS

1. Spare parts for the equipment shall include the following, unless otherwise noted.
2. One set of manufacturers recommended spare parts.
3. Extra operation manuals as required.

#### D. OPERATOR FUNCTIONS

1. Calibration
  - a. Each flow sensor shall be N.I.S.T. wet calibrated and all of the calibration information and factory settings matching the sensor shall be stored integrally within the converter's non – volatile memory. At initial commissioning, the flow meter commences measurement without any initial programming. Should the signal converter need to be replaced, the new signal converter will upload all previous settings and resume measurement without any need for reprogramming or rewiring.
  - b. An N.I.S.T traceable certificate of calibration shall accompany each flow sensor.

## E. MANUFACTURER

1. The Full Profile Insertion Flow Meter shall be an FPI Mag as manufactured by McCrometer, Inc.

## 2.3 TERMINAL POINTS

- A. Flow meter units shall be provided with terminal points to facilitate the exchange of the central control functions between the units and the process control system(s) as indicated on the Electrical Drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. The equipment shall be installed in accordance with the manufacturer's recommendations.

### 3.2 INSPECTION, STARTUP, AND TESTING

- A. The manufacturer of the flow meters shall provide a representative to check the installation, make final adjustments, supervise initial startup of each system, and prepare a written report thereof for the Owner.
- B. The representative shall also instruct the Owner's personnel in the operation and maintenance of the equipment.

### 3.3 OPERATION AND MAINTENANCE MANUALS

- A. Prior to or with the delivery of equipment, the manufacturer shall provide copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list. The O & M Manuals shall be in compliance with General Requirements.

### 3.4 SPECIAL PROVISIONS - SCHEDULE

- A. MAGNETIC METERS:

|                    |                          |
|--------------------|--------------------------|
| Meter              | Magnetic Flow Meter      |
| Pipe Size/Material | 10 inches, DIP           |
| Liquid             | Filtered Municipal Water |
| Solids             | <0.0%                    |
| Flow Rate          | 0 to 1,000 GPM           |
| Tube Mounting      | F-F                      |
| Display Housing    | NEMA 4X, Wall Mounting   |
| Number Required    | One (1)                  |

B. INSERTION METERS:

|                        |  |
|------------------------|--|
| Meter                  | Full Profile Insertion Flow Meter  |
| Pipe Size/Material     | 16 inches, DIP   |
| Liquid                 | Potable Municipal Water  |
| Solids                 | <0.1%  |
| Flow Rate              | 0 to 1000 GPM  |
| Mounting               | 2 inch threaded service saddle in existing pipe  |
| Display Housing        | NEMA 4X, Wall Mounting   |
| Number Required        | Four (4)   |
| Installation Condition | Probe submerged 20' of water, Converter non-submerged, flow direction from granular media filter underdrains to disinfection tank. |

END OF SECTION 407113

## SECTION 432100 - PUMPING EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The Contractor shall provide all labor, materials, tools and equipment required to furnish and install all pumps under this section, complete as shown on the Contract Drawings and as specified herein.
- B. The pumps shall include all drives, drive shafts, couplings, belts, belt guards, drive bases, pump bases, anchor bolts, and other appurtenances as specified or required for a complete installation.
- C. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 SUBMITTALS

- A. Submittals shall be in accordance with the General Requirements.
- B. Submittals with the bid
  - 1. At the time of bidding, the Contractor shall submit, as a minimum, the following information:
    - a. Manufacturer's Certificates, including certified test curves with the design points clearly marked (computer model printouts are not acceptable). Performance curves shall be submitted for each pump to be supplied.
    - b. Motor data, including starting Kva, starting torque, full load current, full load torque efficiency curves, and power factor curves (computer model printouts not acceptable).
    - c. Where required, verification that the variable speed drive is capable of delivering the required torque and power over the entire speed range of the pump.
    - d. Materials of construction for all components.

2. The bid submittal package shall be enclosed in a separate envelope with the section number marked clearly on the outside and shall be submitted with the Contractor's bid.

## PART 2 - PRODUCTS

### 2.1 HORIZONTAL SPLIT CASE CENTRIFUGAL PUMPS

- A. Horizontal split case centrifugal pumps shall be in accordance with the requirements described in the following paragraphs and in the Equipment Schedule of this section.
- B. All pumps used for one application shall be produced by the same manufacturer.
- C. Pumps shall be of the manufacturer and model noted in Equipment Schedule or equal.
- D. Each pump shall be shop tested for capacity, head, speed, power, and efficiency in accordance with Standards of the Hydraulic Institute. Six certified copies of each test curve shall be furnished to the Engineer for approval. The pumps shall not leave the manufacturer's plant until receipt of the Engineer's approval.
- E. Each pump shall also be hydrostatically tested in accordance with the Hydraulic Institute Standard Test Code.
- F. The pump casing shall be of extra heavy cast iron, with minimum tensile strength of 30,000 lbs. and shall be split parallel to the shaft. Bearing housing supports, suction and discharge flanges shall be cast, bored and machined integrally with the lower half casing. Upper and lower half casings shall be dowelled and bolted together. Removable upper and lower half casing and bearing caps must permit inspection or removal of the entire rotating assembly without disturbing the piping. Flanges shall be 125 lb. ANSI standard.
- G. The impeller shall be of one-piece cast bronze of the enclosed, double suction type, accurately machined and balanced to minimize thrust; shall be keyed and axially adjusted on the shaft by means of threaded shaft sleeves. Shaft shall be protected by renewable bronze shaft sleeves that are threaded and tighten with shaft rotation and are free to expand at the stuffing box end.
- H. Renewable cast iron casing wearing rings shall be accurately machined and securely mounted in the pump casing. Renewable impeller wearing rings shall be of bronze and mounted on the impeller at the suction inlets and held in place with set screws. When bronze casing and impeller wearing rings are furnished, they shall be of dissimilar alloy.
- I. Rotating assembly shall be supported by heavy-duty, grease lubricated, cartridge mounted ball bearings. The out-board bearing shall be a double row bearing, locked in position by bearing lock nuts. The inboard bearings shall be single row bearing, free to move axially in the bearing housing. Dual lip seals shall seal the bearing housings against dirt and moisture.



Removable bearing caps and bearing covers shall permit inspection or service of the bearings without disturbing the pump casing or piping. Bearing housings shall be designed for grease lubrication. Grease relief shall prevent over-lubrication. When oil lubricated bearings are furnished, constant level oilers shall be mounted on the bearing covers. Stuffing boxes, to seal the pump shaft, shall be located on the shaft center line and include a minimum of five packing rings and a lantern ring in each packing box. Internally drilled liquid passages in upper half casing shall provide lubrication to the packing area through the lantern ring. Heavy cast split glands shall be furnished on each stuffing box designed for easy removal for packing inspection and maintenance. Heavy fabricated steel base (with drip lip) to mount the pump and driver shall be furnished. Flexible shaft coupling shall be furnished to connect the driver to the pump. Coupling shall be enclosed in OSHA compliant coupling guard.

J. Motors

1. Unless otherwise specified in the Equipment Schedule, each pump shall be provided with a horizontal squirrel cage induction type motor of sufficient power such that no point on the pump curve requires more than the nameplate horsepower of the motor furnished.
2. The motors shall be NEMA Design B, with Class F insulation for a 60 degree C maximum temperature rise above 40 degree C ambient, and a 1.15 service factor. The motor enclosure shall be of the TFEC type.
3. The motors shall be in conformance with the latest recommendations of IEEE and NEMA, including noise requirements.

K. Electrical Controls:

1. The Contractor shall furnish all labor, equipment and materials to install a single pump control center as shown on the Drawings in a NEMA 4X stainless steel enclosure, for operation on a 480 volts, 3 phase, 60 Hertz, 3 wire supply. For each pump motor, there shall be included: running & fault pilot lights, local/remote selector switches, start & stop pushbuttons, solid-state soft starter with adjustable overload protection with manual reset.
2. The motors will be powered by solid-state soft starters (SS's) installed in a common NEMA 4X stainless steel enclosure.
3. If a motor is disabled (e.g. overload, overtemp, or in off position) it shall shut down and lock out. Overload and disconnect functions shall be provided by a single temperature-insensitive component.
4. The pump manufacturer shall provide the pump control center.

2.2 SHOP PAINTING

- A. All surfaces shall be thoroughly cleaned of dirt, grease, oil, rust, scale, or other injurious substances. All metal surfaces shall be sandblasted in accordance with SSPC-SP10, Near-White Blast Cleaning.

- B. All metal surfaces which shall be partially or wholly submerged shall receive a shop coat of polyester resin primer. All non-galvanized metal surfaces which will be above water surfaces shall receive a shop coat of a universally compatible primer.

## 2.3 ACCESSORIES

- A. Each pump shall be provided with easily identifiable terminal points to facilitate the exchange of the central control functions between the pumps and the process control system as indicated on the Contract Drawings.
- B. Pressure Gauges and Connections:
  - 1. Pump suction and discharge flanges shall be tapped for gauge connections as indicated in the Specifications.
  - 2. Gauge connections shall be 1/2 in. in diameter.

## 2.4 SPARE PARTS

- A. Each pump shall be provided with one spare set of packings, valve seats, seals, drive belts and gaskets and any other necessary spare parts as recommended by the pump manufacturer. Any special tools required for maintenance shall be supplied with each pump.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. The equipment shall be installed in accordance with the manufacturer's recommendations.

## 3.2 INITIAL LUBRICATION

- A. Initial lubrication required for startup and field test operation shall be furnished and applied in accordance with the manufacturer's recommendations.

## 3.3 INSPECTION, STARTUP, AND TESTING

- A. The manufacturer of the pumps with drive motors of 25 hp or larger shall provide a representative to check the installation, make final adjustments, supervise initial startup of each pump, and prepare a written test report thereof for the Owner.
- B. The representative shall instruct the Owner's personnel in the operation and maintenance of the equipment.
- C. For smaller pumps with drive motors of less than 25 Hp, the manufacturer shall make final adjustments, provide initial startup, and instruct the Owner's personnel in the operation and maintenance of the equipment.

### 3.4 PUMP TEST

- A. Unless otherwise noted, certified performance data based upon tests of each actual pump proposed to be furnished shall be submitted to the Engineer for acceptance. Tests shall be performed in accordance with the Test Code of the Hydraulic Institute Standards and shall demonstrate compliance with the operating conditions specified. The Engineer shall be notified and afforded the opportunity to witness the test.

### 3.5 MOTOR TEST

- A. Tests shall be performed in accordance with the American Standard Test Code.
- B. Short commercial test: For motors of less than 25 Hp, a certified report of the short commercial test of each actual motor proposed to be furnished shall be submitted to the Engineer for acceptance.
- C. Complete test: For motors of 25 Hp and greater, certified motor efficiency curve at 100, 75, and 50 percent of full load based upon a complete test of a motor of identical design specifications to the motor proposed to be furnished shall be submitted.

### 3.6 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance (O&M) manuals shall be provided prior to or with the delivery of the equipment. The O & M manuals shall include instructions on storage, installation, start-up, and operation and maintenance, together with a complete parts list and a recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

### 3.7 EQUIPMENT SCHEDULE

#### A. NON-POTABLE WATER PUMPS: NORMAL SERVICE

|                            |                                      |
|----------------------------|--------------------------------------|
| Type of Pump               | Centrifugal Horizontal               |
| Number Required            | 2                                    |
| Pumped Liquid              | Surface Water                        |
| Liquid Temperature         | 32-85 degrees F                      |
| Design Capacity, each      | 700 gpm                              |
| TDH                        | 249 ft.                              |
| Minimum Pump Efficiency    | 75%                                  |
| Minimum Motor Horsepower   | 75                                   |
| Motor Speed                | 3600 rpm                             |
| Power Requirements         | 460 volt, 3 phase, 60 Hz             |
| Solid Size, Maximum        | 0.625 in.                            |
| Model                      | Crane Deming Model 5062, Size 6X4X9A |
| Discharge Size             | 4 in.                                |
| Suction Size               | 6 in.                                |
| Materials of Construction: |                                      |
| Casing                     | Ductile Iron                         |
| Impeller                   | Cast Iron                            |

END OF SECTION 432100

## SECTION 432411 - VERTICAL TURBINE PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1 through 46 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This specification includes the supply of five (5) vertical turbine pumps. Pump shall include motor, bowl assembly, suction strainer, column and lineshaft, discharge head, sealing assembly, pump bases, anchor bolts, and other appurtenances as specified or required for a complete installation.
- B. Furnish all labor, material, equipment, products, incidentals and testing required and necessary to provide a complete and operational system, where shown and specified.
- C. All work performed under this section shall be in accordance with all approved trade practices and manufacturer's recommendations.
- D. Coordinate all work with this equipment and any other associated equipment, installed and specified under other sections of these specifications.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. The vertical turbine pumps specified in this section shall be furnished by and be the product of one manufacturer who shall be responsible for the design, coordination, and the satisfactory operation of the system.
- C. Manufacturer Experience
  - 1. The pumping equipment shall be furnished by a manufacturer engaged in the production of the specified type of engineered pumping equipment for a minimum of 10 years.
  - 2. The manufacturer shall have furnished similar equipment for at least 15 other installations performing similar duty, including process, capacity, submergence and environment. Each previous installation shall have performed satisfactorily for at least 10 years in North America at municipal water treatment plants.
- D. All materials shall be new.

- E. Each pump shall also be hydrostatically tested in accordance with the Hydraulic Institute Standard Test Code.
- F. Pumps are to be engineered and manufactured under a written Quality Assurance program. The Quality Assurance program is to be in effect for at least ten years, to include a written record of periodic internal and external audits to confirm compliance with such program.
- G. Pump are to be engineered and manufactured under the certification of ISO-9001:2000.

#### 1.4 SUBMITTALS

- A. Submittals shall be in accordance with the General Requirements.
- B. Product Data: Provide unit capacities, physical dimensions, motor, motor starter, and control equipment delivered, utility requirements and locations, point loads.
  - 1. Manufacturer's Certificates, including certified test curves with the design points clearly marked (computer model printouts are not acceptable). Performance curves shall be submitted for each pump to be supplied.
  - 2. Motor data, including starting Kva, starting torque, full load current, full load torque efficiency curves, and power factor curves (computer model printouts not acceptable).
  - 3. Verification that the variable speed drive is capable of delivering the required torque and power over the entire speed range of the pump.
  - 4. Materials of construction for all components.
- C. Shop Drawings: Provide a complete set of detailed shop drawings, operation and maintenance manual, and parts list of supplied equipment. The shop drawings shall indicate the complete details of the unit as delivered and installed.
- D. Testing
  - 1. Pump Test:
    - a. A certified factory hydrostatic and performance test shall be performed on each bowl assembly in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition.
    - b. Results of the performance tests shall be certified by a Registered Professional Engineer and submitted for approval before final shipment.
  - 2. Motor Test
    - a. A certified motor efficiency curve at 100, 75, and 50 percent of full load based upon a complete test of a motor of identical design specifications to the motor proposed to be furnished shall be submitted.

- E. Provide operation and maintenance (O&M) manuals prior to or with the delivery of the equipment. The O & M manuals shall include instructions on storage, installation, start-up, and operation and maintenance, together with a complete parts list and a recommended spare parts list. The O & M manuals shall be in compliance with the General Requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. The vertical turbine pumps shall be manufactured by:
1. Deming Vertical Turbine Pumps by Process Systems, Inc.;
  2. Flowserve;
  3. Fairbanks Nijhuis;
  4. Or approved equal.

### 2.2 PERFORMANCE

- A. The pump shall be designed for continuous or intermittent operation.
- B. Design Parameters:

| Item No. | Label ID | Type             | Design Pump Flow (gpm) | Design Pump TDH (ft) | Estimated Motor Horse Power | Discharge Diameter (in) | Location                   | Notes/Comments                               |
|----------|----------|------------------|------------------------|----------------------|-----------------------------|-------------------------|----------------------------|--|
| 1        | HP-1     | Vertical Turbine | 700                    | 246                  | 60                          | 6                       | WTP High Service Pump Room | Type "SD" head mount. Replaces 50 HP pump.   |
| 2        | HP-2     | Vertical Turbine | 700                    | 246                  | 60                          | 6                       | WTP High Service Pump Room | Type "SD" head mount. Replaces 60 HP pump.   |
| 3        | HP-3     | Vertical Turbine | 1050                   | 267                  | 100                         | 8                       | WTP High Service Pump Room | Type "SD" head mount. Replaces 100 HP pump.  |
| 4        | RAW-1    | Vertical Turbine | 700                    | 609                  | 200                         | 8                       | Tappan Lake Raw Water PS   | Type "FSD" head mount. Replaces 100 HP pump. |
| 5        | RAW-2    | Vertical Turbine | 700                    | 609                  | 200                         | 8                       | Tappan Lake Raw Water PS   | Type "FSD" head mount. Replaces 100 HP pump. |

1. Raw water pumps pump filtered lake/reservoir water.
2. High service pumps pump potable municipal water.
3. All power is 480 volts, 3 phase.

## 2.3 CONSTRUCTION

### A. Impeller

1. Aluminum bronze construction.
2. One-piece construction, single suction, enclosed multi-vane, and radial flow design.
3. The waterways through the impeller shall have extremely smooth contours, devoid of sharp corners, so as to promote maximum efficiency.
4. Balanced and secured to the shaft using stainless steel collets.
5. Adjustable by means of a top shaft-adjusting nut.

### B. Bowls

1. Close-grained cast iron construction.
2. Castings shall be free from blowholes, sand holes and be accurately machined and fitted to close dimensions.
3. Flanged connected.
4. Design with smooth passages to ensure efficient operation.
5. Epoxy coat interior.

### C. Impeller Shaft

1. Type 416 stainless steel construction.
2. Supported by bronze or neoprene bearings located on both sides of each impeller.
3. Impeller shaft coupling constructed of Type 416 stainless steel.

### D. Column Pipe and Joints

1. Max 5-foot sections
2. Flanged
3. ASTM A53, Grade A steel pipe construction

### E. Lineshafts and Bearings

1. Ample size to transmit the torque and operate the pump without distortion or vibration.
2. Type 416 stainless steel construction
3. Interchangeable sections not over five feet in length.
4. Bearings shall be of neoprene or nitrile material construction retained in bronze guides that are fitted into the column coupling and secured in place.

### F. Discharge Head Assembly

1. The discharge head is to be of Heavy Duty Cast Iron (or Fabricated Steel).
2. It shall form a suitable base for mounting the motor and include an above ground 125# ANSI discharge flange.
3. It shall have a separate motor shaft with means for adjusting impellers.
4. The stuffing box shall be of 416 stainless steel construction and shall be invertible to provide a new wearing surface sized large enough for the specified seals.
5. The discharge head shall also include a rotation arrow and a stainless steel nameplate.
6. Machined openings to permit use of pre-lubrication and water level indicator assemblies.
7. Provide Coupling guards.

G. Shaft Sealing

1. Cartridge Split-Face Mechanical Seals.
  - a. A temperature rating of 250 degrees Fahrenheit (° F.) or higher.
  - b. Hydraulically balanced.
  - c. Materials of Construction.
    - 1) Seal Faces. Clean Water. Carbon/silicon carbide.
    - 2) Hardware, Glands, and Sleeves. 316 stainless steel.
    - 3) Elastomers. EPR, Viton.
    - 4) Springs. Hastelloy C or Elgiloy.
  - d. Subject to compliance with the specifications, provide the seals from one of the following approved manufacturers.
    - 1) Chesterton Type 442C.
    - 2) John Crane Type 3710.
    - 3) Flowserve Type PSIII.

H. Seal Environmental Controls.

1. In accordance with API 682 except as noted.
2. Standard Flushing Plan 13.
  - a. Furnish brass needle valve to control flow.
  - b. Furnish pipe nipple and valve on second gland flush port to vent air from seal chamber before start-up.

I. Vibration Limitations (Field)

1. The limits of vibration as set forth in the standards of the Hydraulic Institute shall govern.

J. Motors:

1. Type: TEFC, Vertical Hollow Shaft (VHS), NRR, Premium Efficient, approximately 1800 RPM.
2. The motor shall be designed for continuous or intermittent duty of 3 phase, 60 cycle, (460) volt alternating current, equipped with Variable Frequency Drive (VFD).
3. The motor shall be NEMA, with Class F insulation for a 60 degree C maximum temperature rise above 40 degree C ambient, and a 1.15 service factor.

2.4 CONTROLS AND POWER

- A. The motors will be powered by new variable frequency drives (VFD's) and controlled by new panels by others.

2.5 ACCESSORIES

- A. Provide each pump with easily identifiable terminal points to facilitate the exchange of the central control functions between the pumps and the process control system as shown.



- B. Pressure Gauges and Connections:
  - 1. Pump suction and discharge flanges shall be tapped for gauge connections.
  - 2. Gauge connections shall be 1/2 in. in diameter.
- C. Strainer
  - 1. Supply a 316 stainless steel basket strainer for the suction bell mouth with an open area a minimum of 7 times the suction bowl inlet.

## 2.6 SPARE PARTS

- A. Provide each pump with one spare set of seals, valve seats, seals, drive belts and gaskets and any other necessary spare parts as recommended by the pump manufacturer. Any special tools required for maintenance shall be supplied with each pump.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Shut down and disconnect existing equipment prior to proceed with associated work.
- B. Remove existing pump and accessory equipment not required in the installation of the new pump.
- C. Furnish all labor, materials and equipment necessary to perform demolition required.
- D. Dispose of Existing Equipment: Deliver such items of salvage to a storage location as designated by the Owner. Should the Owner not wish to retain any such material, it, along with all unsalvageable materials, shall be disposed off the project site.

### 3.2 INSTALLATION

- A. Verify existing conditions, elevations before starting work.
- B. Installation of equipment shall be in accordance with pump manufacturer's instructions.
- C. Installation and assembly of the pumping equipment into the wet well shall be supervised by experienced and qualified personnel of the pump supplier. A qualified person shall make all adjustments to the pumping equipment and supervise start-up of the pump.

### 3.3 INSPECTION, STARTUP, AND TESTING

- A. The manufacturer shall provide a representative to check the installation, make final adjustments, supervise initial startup of each pump, and prepare a written test report thereof for the Owner.

- B. The Contractor shall conduct in the presence of the Engineer, a field capacity test for 30 minutes at the specified pump capacity, and a one (1) hour step-test at four (4) different flow rates of fifteen (15) minutes each and at the shut off head of the pump.
- C. The representative shall instruct the Owner's personnel in the operation and maintenance of the equipment.

#### 3.4 INSTRUCTION OF OPERATING PERSONNEL

- A. Provide the service of a qualified factory-trained manufacturer's representative to conduct training as specified by the Division 1 requirements.

END OF SECTION 432411

## SECTION 463143 CARBON DIOXIDE GAS FEED EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing and installation of the carbon dioxide gas feed equipment and all pertinent accessories, complete and in place, ready for service as shown and specified.
- B. The carbon dioxide gas feed system described herein shall consist of a control panel, pH probe, and gas diffusers. The panel will have valves that will both automatically and manually feed carbon dioxide gas to the pretreated water through submerged diffusers. The automatic function will be driven by input from a pH probe placed in the pretreated water to maintain a desired pH set point within a range of 7.0 to 9.0.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data and application instructions.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURER

- A. Approved manufacturer for Carbon Dioxide Gas Feed Panel, pH Sensor and Gas Diffuser Assembly provided as complete system shall be TOMCO, Loganville, Georgia,
- B. Or engineered pre-approved equal.

#### 2.2 DESIGN PARAMETERS

- A. Flow range: 0 to 15 pounds per hour.
  - 1. Minimum: 10 pounds per hour.
  - 2. Average: 12 pounds per hour.
  - 3. Maximum 15 pounds per hour.

## 2.3 EQUIPMENT

### A. Carbon Dioxide Gas Feed Panel

1. Carbon Dioxide Feed Control Panel Assembly: Each assembly shall be pre-piped and pre-wired in a panel enclosure, and including the following components:
  - a. Panel enclosure shall be suitable for wall mounting and sized to house gas feed components and electrical, instrumentation, and control components. Provide enclosure with hinged, lockable access door. Panel enclosure shall be stainless steel NEMA 4X.
  - b. Gas Feed Components:
    - 1) Second stage pressure regulator to reduce carbon dioxide vapor to 40-70 psig prior to flowmeter, and a 0-150 psi pressure gage with isolation valve downstream of the regulator.
    - 2) Tube-type flowmeter with 5 inch glass tube with direct reading scale, and stainless steel float and end fittings. Panel enclosure shall include a door-mounted window for external viewing of flowmeter.
    - 3) Pneumatic-actuated flow control valve designed to receive a 4-20 mAdc control signal from the pH controller, utilizing carbon dioxide gas as the pneumatic source.
    - 4) Manual flow control valve with two block valves, for use in bypassing pneumatic-actuated valve.
    - 5) Pipe, Valves and Fittings: Type 304 stainless steel. Provide gas and vent inlet and outlet connections on panel enclosure walls. For pipe and fittings, follow Section 13510.
  - c. Electrical, Instrumentation and Control Components:
    - 1) Provide panel with 120V, 20A, 1-pole molded case circuit breaker for incoming power.
    - 2) A pH controller, complete with proportional band and reset control functions, set point, manual/automatic selection and manual output adjustment, LCD pH display, high and low pH alarms consisting of both light and audio warning, and 4-20 mA dc output signal to control valve. Controller shall be door mounted on panel enclosure. Provide remote Start-Stop input for WTP SCADA control.
    - 3) Provide door-mounted, two position selector switch for Power On-Off control.
    - 4) Provide door-mounted, if required, two position selector switch for selection of Re-carbonation (if multiple basins)
    - 5) Provide door-mounted, push-to-test indicator lamps for Power On, High pH, and Low pH.
    - 6) Provide panel enclosure with provisions for connection of power and instrumentation wiring and conduits.
    - 7) Provide terminals and dry contacts for WTP SCADA system for the following signals:
      - 8) Power On.
      - 9) Provide analog output for monitoring of pH level by WTP SCADA system.
    - 10) Identify each door-mounted indicator lamp, switch and device with engraved plastic name plates fastened with stainless steel screws.

- 11) Ground lug properly sized for termination of the ground wire
- 12) Connect incoming and outgoing wire and cable to a master numbered terminal strip. Provide permanent sleeve type wire markers for every wire leaving or entering a terminal.
- 13) Provide a permanently affixed tape on equipment and components within panel or an adjacent surface which identifies the device.
- 14) A placard shall be affixed to the inside surface of the access door of the panel displaying the connection legend and the circuit schematic. The schematic shall identify each wire, junction and termination with respect to corresponding terminals and connections in the panel. Devices and connections associated with, but exterior to, the panel shall be shown in phantom and appropriately identified. The schematic may be a miniature, plasticized copy of the connection schematic furnished, if suitable for display.

B. pH SENSOR ASSEMBLY

1. Submersion-type with a pH gas electrode, reference electrode, thermo- compensator, and pre-amplifier, all enclosed in a corrosion-resistant PEEK body with mounting bracket and support pipe. pH sensors assemblies shall be installed 60-90 seconds downstream of gas diffuser, or as otherwise instructed by manufacturer.

C. GAS DIFFUSER ASSEMBLY

1. Manufacturer-designed, fine bubble diffusers, sized and configured for installation within Re-carbonation Basin as shown on Drawings and for efficient dispersion of carbon dioxide gas into process flow stream. Provide with stainless steel piping and mounting hardware, and ball valves for isolation.
2. Provide two (2) 8" diameter, round 50 micron pore size gas diffusers.

- D. Provide and install all interconnecting stainless steel piping from Manufacturer's Gas Feed Panel to the Gas Diffuser Assembly and all wiring in PVC coated conduit from the Gas Feed Panel to the pH Sensor Assembly.

## PART 3 - EXECUTION

### 3.1 DELIVERY

- A. All equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

### 3.2 INSTALLATION

- A. It is the intent of this Contract that the final installation shall be complete in all respects and the Contractor shall be responsible for minor details and any necessary special construction not specifically included in the drawings or specifications.

- B. Equipment shall be installed in strict conformance with the manufacturer's installation instructions, as submitted with Shop Drawings, Operation and Maintenance Manuals and/or any pre-installation checklists. Installation shall be secure in position and neat in appearance. Installation shall include any site preparation tasks as required by the Engineer or Manufacturer; such as unloading, touch-up painting, etc. and any other installation tasks and materials such as wiring, conduit, controls stands as determined by the Owner and/or specified by the Manufacturer.

### 3.3 MANUFACTURER'S SERVICES

- A. After completion of the installation, the equipment shall be tested by the Contractor in the presence of the Engineer under actual operating conditions. The test shall be conducted under the supervision of the manufacturer's technical representative. He shall provide a written report attesting that the units have been properly installed and placed into satisfactory operation.
- B. Provide a representative to check the installation, make final adjustments, supervise the initial startup of each mechanism, and prepare a written report thereof for the Owner.
- C. Provide a minimum of two (2) - 8 hour days of on-site service for start-up of the liquid carbon dioxide equipment.
- D. Provide a minimum of 8 hours service for on-site operator training related to maintenance and operation of all components of the liquid carbon dioxide equipment.

END OF SECTION 463143

## SECTION 464311 - RECTANGULAR BASIN SLUDGE COLLECTORS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1 Specification sections, apply to work of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section includes the furnishing, installation, and testing of all mechanically driven sludge collection equipment as shown and specified herein.
- B. In general, the equipment shall include: two (2) collector mechanisms including common drive motor with cover(s), mounting assemblies and chains, drive and driven sprockets, shafting, bearings, collector sprockets, collector chain, flights, wear shoes, and wear strips.
- C. The tanks share a common motor and drive unit where one tank's collector mechanism can be taken out of service while the other remains in service.
- D. It is the intent of this Contract that the final installation shall be complete in all respects and the Contractor will be responsible for all minor details, whether or not shown on the Drawings or specifically included in these Specifications.
- E. The equipment to be furnished hereunder shall be a complete package as shown.

#### 1.3 QUALITY ASSURANCE

- A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.
- B. The Equipment Manufacturer shall certify to not less than ten (10) years of experience in the application, design, and manufacture of sludge collector mechanisms in water and wastewater treatment plants and shall submit a list of not less than twenty-five (25) operating installations as evidence of meeting the experience requirement.
- C. In addition, the chain manufacturer shall certify to having not less than ten (10) years of chain and sprocket technology, and shall have tested non-metallic chain as specified herein in settling tanks of an operating water and wastewater treatment plant for a period of not less than five (5) years. Test result data shall be submitted to the engineer for review upon request.

#### 1.4 SUBMITTALS

- A. Submit manufacturer's technical data and application instruction in accordance with the General and Supplementary Conditions and Division 1 Specifications and any additional information listed herein.
- B. Submit complete design calculations from the manufacturer covering the selection and sizing of the collector chains, sprockets, shafts, drive chains and all drive components.
- C. Provide the expected life expectancy under normal operating and maintenance conditions.
- D. Provide the unit weights of all components over 300 pounds.
- E. Product Data: The Equipment Manufacturer shall select the collector components based upon design calculations incorporating the following criteria:
  - 1. Operation under dry tank conditions
  - 2. Friction factor - (Polyurethane on dry steel) 0.25
  - 3. Bearing friction - 0.05 per shaft assembly
  - 4. Shaft deflection - not to exceed 3/64" per foot of shaft length
  - 5. Normal flight loading: 8 lb/l.f.
  - 6. Peak flight loading: 16 lb/l.f.
  - 7. In no event shall the collector components be less than specified herein.
- F. Shop Drawings: Submit complete working detail and dimension drawings showing the proposed installation of all equipment. No work shall be done upon the fabrication and manufacture of any equipment until this submittal has been approved.
- G. Operation and Maintenance (O & M) Manual: Complete package operating and maintenance instructions. The maintenance manuals shall contain copies of the approved shop drawings, operating instructions, maintenance requirements, spare parts list, warranty and etc.

#### 1.5 WARRANTY

- A. The Manufacturer shall warrant the equipment to be free of material or workmanship defects for one (1) year from the date of installation, or eighteen (18) months from shipment, whichever date occurs first.

#### 1.6 DESIGN CRITERIA

- A. General Parameters:
  - 1. No. of Tanks: Two (2).
  - 2. Tank Size, each: 44'-6" long X 16'-0" wide X 17.32' total depth.
  - 3. Drive Assembly: One (1) drive assembly for two (2) tanks.
  - 4. Flow Type: Freshwater from a surface source.



- B. Side Water Depth (SWD) and Flow (MGD):
  - 1. SWD at Rated Maximum Daily Flow of 0.5 MGD, each tank: 14'-8 3/4"
- C. Design Flow Data:
  - 1. Surface Overflow Rate, each tank, at 0.5 MGD: 702 gpd/sq ft
  - 2. Volume of each tanks: 77,000 gallons at SWD
  - 3. Detention Time, at 0.5 MGD: 3.7 hours

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Collector mechanism acceptable manufacturers are:
  - 1. E & I Corporation, Westerville, Ohio;
  - 2. Viking Chains Enviro Division, a Division of Connexus Industries Inc.;
  - 3. Polychem by Brentwood Industries; or
  - 4. Walker Process Equipment.

### 2.2 GENERAL DESCRIPTION

- A. This equipment is intended for installation in a rectangular sludge settling tank. Tank influent will be freshwater from a surface water source mixed with coagulants to aid with the settlement of solids. The basin will be filled and dewatered and the sludge collection equipment shall be capable of operation under all possible foreseeable conditions and water levels from dewatered and dry to complete submergence.

### 2.3 NON-METALLIC COLLECTOR CHAIN AND PINS

- A. Collector Chain
  - 1. NCS720S, or approved equal of non-metallic type having 6" pitch links with an average weight of 1.5 pounds per foot.
  - 2. Catalog working load of a minimum 3,100 pounds based upon strength, fatigue and wear considerations.
  - 3. Manufactured of glass reinforced polyester
  - 4. Molded with the barrel and side bars as an integral assembly.
- B. Collector Chain Pins
  - 1. The chain shall be assembled with pins not less than 7/8" diameter, manufactured of reinforced nylon resin, and shall provide full dead load bearing capacity throughout the full length of the link side bar hubs.
  - 2. Have a T- head to engage retainer lugs molded integrally with one link side bar hub as a positive means to prevent pin rotation.
  - 3. Locked in position by a retainer ring molded integrally with the opposite side bar hub and shall provide a positive locking contact around the full periphery of the pin.

- C. The attachment links shall be of similar construction with the flight pusher plate, extending the full depth of the flight, molded integrally with the link side bars and designed to minimize loading on the flight attachment bolts. The attachment mounting hold spacing shall conform to ANSI Standard B29.21M81 and shall accommodate four (4) 3/8" diameter #316 stainless steel hexagon head attachment bolts, hexagon nuts, and cut washers.
- D. The manufacturer, along with the approval-drawing submittal, shall include certified documentation that the proposed chain is proof load tested to 5000 pounds as quality assurance procedure during manufacture.

## 2.4 FIBERGLASS FLIGHTS

- A. 3" x 8" x 15'-10" nominal size especially designed for sludge collector service.
- B. Manufactured using 55% (minimum) continuous fiberglass (by weight) through its entire length and be in compliance with ASTM D638, ASTM D695 and ASTM D790. Maximum water absorption shall be no greater than 0.6% after immersion for 24 hours at 73 degrees F in accordance with ASTM D570.
- C. Accurately drilled and notched by the equipment supplier to accept the chain flight attachments and wear shoes.
- D. Include a scraper lip on the leading edge to insure cleaning of the tank floor.
- E. Include filler blocks for bolting the member to the chain attachment links.
- F. Flight spacing shall be approximately 10'.
- G. Buoyant flight design will not be acceptable.
- H. Carefully group and band together the flights for safe shipment and storage.

## 2.5 WEARING SHOES

- A. Provide each scraper with 1/2" wearing shoes to run on the floor rails.
- B. UHMW-PE or Nylon 6-6 with a minimum hardness of 62 Shore "D".
- C. Reversible providing two (2) usable wearing surfaces.

## 2.6 DRIVEN SPROCKETS AND COLLECTOR CHAIN SPROCKETS

- A. Sprockets for drive and collector chains shall be machined from ultra-high molecular weight polyethylene (UHMW) material or Nylon-6 materials with teeth accurately formed to match the pitch of the chain.
- B. All collector chain sprockets shall be of the double life type and of split construction.

- C. Driving sprockets shall be firmly keyed to the headshaft and idler sprockets shall rotate freely on split static sleeves clamped to the static shafts or solid static sleeves integrated to the non-metallic stub shafts.
- D. The driven sprocket shall be split with not less than 40 teeth and shall not be less than 33.25 inch pitch diameter.
- E. The drive sprocket shall be a cast iron or stainless steel shear pin hub with a sprocket plate consisting of 11 teeth and having a pitch diameter of 9.26 inches.
- F. Headshaft sprockets shall be not less than 22.21" pitch diameter and shall have not less than 23 teeth.
- G. All other collector chain sprockets shall be not less than 16.59" pitch diameter and shall have not less 17 teeth.
- H. Traction wheels, idler wheels or other substitutions for sprockets will not be acceptable.

## 2.7 SHAFTING

- A. All shafting shall be solid, cold-finished steel, straight and true, and shall be held in alignment with set collars.
- B. The headshaft shall contain keyways with fitted keys and shall be sized to transmit the power required plus 1/4" corrosion allowance.
- C. Fixed shaft brackets shall be 3/8" steel for support and shall be mounted with 3/4" anchor bolts.
- D. Non-metallic shafting may be accepted by the Engineer upon request.

## 2.8 BEARINGS

- A. Cast iron construction with UHMW-PE inserts, water lubricated peak cap, self-aligning type, especially designed to prevent the accumulation of settled solids on their surfaces.
- B. Bolted directly to the concrete wall in a manner which will permit their easy alignment.
- C. Suitable for continuous operation under both submerged and dry conditions.

## 2.9 WEAR STRIPS

- A. UHMW-PE material 3/8" thick by 3" wide in 10'-0" minimum length sections.
- B. Anchor to the concrete floor with drill-in anchors.

## 2.10 NON-METALLIC DRIVE CHAIN

- A. NH78 or approved equal non-metallic, having 2.609" pitch links with an average weight of 1.4 pounds per foot.
- B. Minimum catalog working load of not less than 1,750 pounds, based upon strength, fatigue and wear considerations.
- C. The chain shall be manufactured of unfilled acetyl resin injected with Teflon and connected with 316 stainless steel pins. The pins shall be constructed to prevent rotation and shall be held in place without the use of cotters or drive pins.
- D. The drive chain arrangement shall include a chain tightener to take up excessive slack in the drive chain. The tightener assembly shall include a stainless steel or non-metallic slide base and mounting bracket with a self-lubricated molded polyurethane or UHMW idler sprocket.
- E. The chain drive above the operating platform shall be covered with a removable guard of No. 14 gauge type 316 stainless steel.

## 2.11 DRIVE UNIT

- A. The drive unit shall consist of an electric motor directly connected to a speed reducer through the use of a flexible coupling. V-belt drives will not be acceptable.
- B. Mount the motor and gear reducer as a common unit directly on the concrete.
- C. The number of tanks operated by each drive shall be as shown.
- D. A jaw clutch shall be provided that will allow for the independent operation of collectors that share a drive motor.
- E. Speed reducers shall be of the helical or worm gear type, fully housed, running in oil, with antifriction bearings throughout. The speed reducer shall have a minimum service factor of 2.0 based on the required torque of the collecting mechanism.
- F. Motors shall be totally enclosed type as specified and wired for 460 volts, 60 hertz, 3 phase current. Motors shall not exceed 1,800 revolutions per minute (rpm). The motors shall operate continuously without overloading at 75 percent to the motor nameplate horsepower.
- G. Provide over-torque protection utilizing a shear pin hub assembly to protect the collector drive unit. Over-torque protection is activated when the aluminum shear pin breaks due to high system loading, disengaging the drive sprocket from the hub and dispenses a trip pin that is detected by the limit switch.

## 2.12 CORROSION PROTECTION

- A. All equipment furnished under this item, with the exception of the drive and motor units will be subject to a damp corrosive atmosphere and submergence.

- B. All items shop assembled such motors and reducers shall be coated with the manufacturer's standard paint.
- C. All components furnished under this item which will be installed below the tank rim, shall be of material which is inherently corrosion resistant, or has been shop finished with a protective plating or coating meeting the intent of this specification.
- D. All fabricated brackets, angles, chain guards, gear box covers, etc., shall be of 1/4" minimum thickness 316 stainless steel.
- E. All miscellaneous hardware and fasteners shall be 316 stainless steel.

#### 2.13 GENERAL ITEMS

- A. All anchor bolts shall be 316 stainless steel furnished by the Equipment Manufacturer and shall be of ample size and strength for the purpose intended. Set all anchor bolts in accordance with the Manufacturer's instructions.

### PART 3 - EXECUTION

#### 3.1 SERVICE

- A. Furnish the services of the Equipment Manufacturer's field service technician for two (2) trips and for up to a total of four (4) days on site.
- B. This service shall be for the purposes of verification of existing field conditions, installation check-out, initial start-up, testing, certification, and instruction of plant personnel.
- C. Submit a written report covering the technicians findings and installation approval covering all inspections and outline in detail and deficiencies noted.
- D. Four (4) hard copies and one (1) digital PDF format file of operation and maintenance (O&M) manuals shall be provided prior to or with the delivery of the equipment. The O&M manuals shall include instructions on storage, installation, start-up and operation and maintenance, together with a complete parts list and a recommended spare parts list.

#### 3.2 ACCEPTANCE TEST

- A. Field test the sludge collection equipment and mechanisms after erection to verify the structural and mechanical compliance to the torque requirements specified at normal and peak loads. Each collector mechanism shall be loaded to the full torque ratings specified. Submit complete test procedures for approval prior to testing.
- B. Normal operating load shall be taken as dry tank friction load plus a simulated flight loading of eight (8) lb. per lineal foot.

- C. Peak load shall be dry tank friction load plus a theoretical flight loading of sixteen (16) lb. per lineal foot.

END OF SECTION 464311

## SECTION 466113 - FILTER MEDIA

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. General provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

#### 1.2 SUMMARY

- A. Furnish and place filter media according to the specifications and the most currently published AWWA B100 standards.

#### 1.3 QUALITY ASSURANCE

- A. Obtain materials from sources regularly engaged in producing and furnishing the specified materials.
- B. Filter media shall be produced for use in contact with potable water and comply with ANSI/NSF 61 - Drinking Water System Components - Health Effects.

#### 1.4 SUBMITTALS

- A. Provide the Engineer with a minimum 0.5 cubic foot samples of each specified media.
- B. Provide an affidavit with the samples stating that the materials furnished comply with the applicable requirements of AWWA B100 and NSF 61.

#### 1.5 DELIVERY, STORAGE, AND HANDLING. In accordance with the manufacturer's instructions and Section 016000.

- A. Deliver all equipment in an undamaged condition and make shipment in bags or semibulk containers.
  - 1. Bags. Suitable heavy duty cloth, paper, or plastic bags containing not more than one cubic foot of material. Mark each bag so the contents are identified. Include gradation, date of filling, and lot or stockpile identification in the markings.
  - 2. Semibulk Containers. Suitable heavy duty, woven semibulk containers, each containing one or more tons of material with attached straps or sleeves strong enough to support their entire weight when full to aid in handling. Mark so that its contents are identified, including gradation, date of filling, and lot or stockpile identification.

B. Storage

1. Make all arrangements and provisions necessary for the storage of the filter equipment in accordance with the manufacturer's instructions.
2. Keep filter materials clean.
3. Cover materials shipped in bags or semibulk containers with a durable opaque material to block sunlight and to provide protection from weather.
4. Store bags and semibulk containers on pallets or dunnage.
5. Store each size and type of filter material separately.
6. When materials are shipped in bags or semibulk containers, do not remove material from the bags or the semibulk containers prior to placement in the filter under any circumstances, except for sampling.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Filter media shall comply with the AWWA B-100 standard.

B. In accordance with this specification, the filter media can be supplied by one of the following manufacturers:

1. Leopold – Xylem,
2. Unifilt Corporation,
3. CEI, Inc.,
4. Parry Co.,
5. Or Engineer approved Equal

C. Installation of the filter media shall be under the direct supervision of an employee of the filter manufacturer experienced in this procedure.

D. Filter Sand

1. Provide filter sand to a total finished depth as shown below.
2. Filter sand shall consist of hard, durable grains of siliceous material less than 2.4 mm in greatest dimension, and shall be visually free from dirt, loam, clay, and micaceous and organic matter. The particle-size distribution shall be determined using standard sieves calibrated in accordance with ASTM Method E11; grain size shall be defined in terms of the smallest sieve opening through which it passes; and percent sizes of sand shall be determined from a plot of the sieve data on probability paper, showing the percent of the material passing the sieve versus the sieve size opening.
3. After all filter sand is placed, and before any anthracite is placed, the filter shall be washed and scraped and placed at the finished elevation.

E. Filter Anthracite

1. Provide filter anthracite to a finished depth as shown below, with at least one additional inch to be provided and scraped off after washing.
2. Filter anthracite shall consist of hard, durable coal particles of various sizes, and shall be visually free of clay, shale, and extraneous dirt.



3. The hardness shall not be less than 2.7 on the Moh scale.
4. The specific gravity shall not be less than 1.4.
5. Particle (grain) size and percent sizes shall be determined as specified for filter sand.

After placement of the anthracite, wash the filter at a minimum rate of 15 gpm/sf at least three successive times, with the surface to be scraped after each washing. After washing, place the surface at the finished elevation, with additional material added if necessary to bring the surface to the finished elevation.

F. Anthracite and filter sand media shall have the following characteristics:

| <b>MEDIA</b> | <b>EFFECTIVE<br/>SIZE (mm)</b> | <b>UNIFORMITY<br/>COEFFICIENT</b> | <b>BED<br/>THICKNESS<br/>(in)</b> |
|--------------|--------------------------------|-----------------------------------|-----------------------------------|
| ANTHRACITE   | 0.85 TO 1.2                    | <1.70                             | 15                                |
| SAND         | 0.45 TO 0.55                   | <1.65                             | 12                                |
| SAND         | 0.85 TO 1.2                    | <1.70                             | 3                                 |

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Completely remove and dispose of the existing filter media.
- B. Thoroughly cleanse the filter tanks of deleterious materials and foreign matter.
- C. Special care shall be taken in transporting and placing the filter media to prevent contamination of any sort. Any filter media which may become dirty either before or after placing in the filters shall be either removed and washing or replaced by other clean filter media in a satisfactory manner. The filter shall be clean before placing of filter media.
- D. The several layers of filter media shall be placed accurately to the required depths and each layer shall be struck off to a true level surface. The filter shall be backwashed after the filter media has been placed to ascertain the required filter media depth has been installed. After backwashing, the bed depth shall be adjusted as required and the procedure repeated as necessary to meet the specifications for bed depth.

END OF SECTION 466113