

**FULTON COUNTY, GEORGIA**

**NORTH FULTON PUMP STATION UPGRADES**

**FOR**

**GAME CREEK PUMP STATION  
MORGAN FALLS PUMP STATION  
LAKE CHARLES PUMP STATION  
OLD ALABAMA PUMP STATION**

**CONSTRUCTION SPECIFICATIONS**

**FULTON COUNTY  
DEPARTMENT OF PUBLIC WORKS**

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*Division 1*

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**General Requirements**

## TESTING LABORATORY SERVICES

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### PART 1 – GENERAL

#### 1.01 SCOPE

- A. This Section includes testing which the Owner may require, beyond that testing required of the manufacturer, to determine if materials provided for the Project meet the requirements of these Specifications.
- B. This work also includes all testing required by the Owner to verify work performed by the Contractor is in accordance with the requirements of these Specifications (i.e., concrete strength and slump testing, existing soils conditions, soil compaction, etc.).
- C. This work does not include materials testing required in various sections of these Specifications to be performed by the manufacturer (e.g., testing of pipe).
- D. The testing laboratory or laboratories will be selected by the Owner. The testing laboratory or laboratories will work for the Owner.

#### 1.02 PAYMENT FOR TESTING SERVICES

- A. The cost of testing services required by the Contract shall be the responsibility of the Contractor.
- B. The cost of additional testing services not specifically required in the Specifications, but requested by the Owner or Engineer, shall be paid for by the Owner.
- C. The cost of material testing described in various sections of these Specifications or as required in referenced standards to be provided by a material manufacturer, shall be included in the price bid for that item and shall not be paid for by the Owner.
- D. The cost of retesting any item that fails to meet the requirements of these Specifications and/or false starts due to the Contractor's failure to properly schedule testing technicians shall be paid for by the Contractor. Retesting shall be performed by the testing laboratory working for the Owner.

## TESTING LABORATORY SERVICES

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### 1.03 LABORATORY DUTIES

- A. Cooperate with the Owner, Engineer and Contractor.
- B. Provide qualified personnel promptly on notice.
- C. Perform specified inspections, sampling and testing of materials.
  - 1. Comply with specified standards, ASTM, other recognized authorities, and as specified.
  - 2. Ascertain compliance with requirements of the Contract Documents.
- D. Promptly notify the Engineer and Contractor of irregularity or deficiency of work which are observed during performance of services.
- E. Promptly submit three copies (two copies to the Engineer and one copy to the Contractor) of report of inspections and tests in addition to those additional copies required by the Contractor with the following information included:
  - 1. Date issued.
  - 2. Project title and number.
  - 3. Testing laboratory name and address.
  - 4. Name and signature of inspector.
  - 5. Date of inspection or sampling.
  - 6. Record of temperature and weather.
  - 7. Date of test.
  - 8. Identification of product and Specification section.
  - 9. Location of Project.

## TESTING LABORATORY SERVICES

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SECTION 01410 - PAGE 3

- 10. Type of inspection or test.
  - 11. Results of test.
  - 12. Observations regarding compliance with the Contract Documents.
- F. Perform additional services as required.
- G. The laboratory is not authorized to release, revoke, alter or enlarge on requirements of the Contract Documents, or approve or accept any portion of the Work.

### 1.04 CONTRACTOR RESPONSIBILITIES

- A. Cooperate with laboratory personnel, provide access to Work and/or manufacturer's requirements.
- B. Provide to the laboratory, representative samples, in required quantities, of materials to be tested.
- C. Furnish copies of mill test reports.
- D. Furnish required labor and facilities to:
  - 1. Provide access to Work to be tested.
  - 2. Obtain and handle samples at the site.
  - 3. Facilitate inspections and tests.
  - 4. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.
- E. Notify the laboratory sufficiently in advance of operation to allow for the assignment of personnel and schedules of tests.
- F. Laboratory Tests: Where such inspection and testing are to be conducted by an independent laboratory agency, the sample(s) shall be selected by

## TESTING LABORATORY SERVICES

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SECTION 01410 - PAGE 4

such laboratory or agency, or the Engineer, and shipped to the laboratory by the Contractor at Contractor's expense.

- G. Copies of all correspondence between the Contractor and testing agencies shall be provided to the Engineer.

### 1.05 QUALITY ASSURANCE

Testing shall be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

### 1.06 PRODUCT HANDLING

Promptly process and distribute all required copies of test reports and related instructions to insure all necessary retesting or replacement of materials with the least possible delay in the progress of the Work.

### 1.07 FURNISHING MATERIALS

The Contractor shall be responsible for furnishing all materials necessary for testing.

### 1.08 CODE COMPLIANCE TESTING

Inspections and tests required by codes or ordinances or by a plan approval authority, and made by a legally constituted authority, shall be the responsibility of, and shall be paid for by the Contractor, unless otherwise provided in the Contract Documents.

### 1.09 CONTRACTOR'S CONVENIENCE TESTING

Inspection or testing performed exclusively for the Contractor's convenience shall be the, sole responsibility of the Contractor.

### 1.10 SCHEDULES FOR TESTING

- A. Establishing Schedule

## TESTING LABORATORY SERVICES

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### SECTION 01410 - PAGE 5

1. The Contractor shall, by advance discussion with the testing laboratory selected by the Owner, determine the time required for the laboratory to perform its tests and to issue each of its findings, and make all arrangements for the testing laboratory to be on site to provide the required testing.
  2. Provide all required time within the construction schedule.
- B. When changes of construction schedule are necessary during construction, coordinate all such changes of schedule with the testing laboratory as required.
- C. When the testing laboratory is ready to test according to the determined schedule, but is prevented from testing or taking specimens due to incompleteness of the Work, all extra costs for testing attributable to the delay will be back-charged to the Contractor and shall not be borne by the Owner.

#### 1.010 TAKING SPECIMENS

Unless otherwise provided in the Contract Documents, all specimens and samples for tests will be taken by the testing laboratory or the Engineer.

#### 1.011 TRANSPORTING SAMPLES

The Contractor shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.

END OF SECTION

***Division 2***

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**Site Work**

## REMOVAL OF EXISTING EQUIPMENT

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### SECTION 02062 - PAGE 1

#### PART 1 - GENERAL

##### 1.01 SCOPE OF WORK

Furnish all labor, equipment, materials, and incidentals required and remove all existing equipment and all pipe, fittings, valves, and appurtenances not required for the proper operation of the expanded systems. Removal will be consistent with the final configuration of the new systems as indicated on the Drawings, as specified herein or as required by the Engineer. The equipment and piping shall be removed from their present locations and shall be stored at a location determined by the Owner.

##### 1.02 RELATED WORK

- A. Modifications to Existing Structures, Piping, and Equipment is included in Section 02064.

#### PART 2 - PRODUCTS

(Not Used)

#### PART 3 - EXECUTION

##### 3.01 GENERAL

- A. The Contractor shall not proceed with the removal of any equipment, piping, or appurtenances without specific approval of the Engineer. Any equipment, piping or appurtenances removed without proper authorization, which are necessary for the operation of the existing systems or of the extended systems, shall be replaced to the satisfaction of the Engineer at the Contractor's expense.
- B. All existing tubing, insulation, hangers, and supports shall become the property of the Contractor immediately upon removal from their present locations. The Contractor shall remove such material from the plant site at his own expense and it shall not be reused.
- C. All existing valves, strainers, and other special line elements, greater than 3-in. diameter, removed shall remain the property of the Owner. The Contractor shall furnish all labor and material to identify, clean, protect, crate, and box and store them at a place designated by the Owner.

## REMOVAL OF EXISTING EQUIPMENT

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### SECTION 02062 - PAGE 2

- D. Pieces of equipment weighing 150 lbs or more shall be provided with suitable skids before storing.
- E. Wherever piping is removed for disposition, adjacent pipe, and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.
- F. Equipment to be retained by the Owner shall be carefully removed from the present location, cleaned, and immediately stored, at a place designated by the Owner.
- G. The Contractor shall take all necessary precautions against damaging the material and equipment to be stored. The Contractor shall repair any damage resulting from his operation, as directed by and to the satisfaction of the Engineer. Itemized lists of materials removed and stored shall be given to the Engineer daily. A final typed itemized list shall be furnished to the Engineer in 6 copies at the completion of construction. The list shall include items, method of packaging, and place of storage.

### 3.02 STORAGE LOCATIONS

It is the general intent of this specification that all equipment to be retained by the Owner shall be stored on campus as directed by the Owner.

END OF SECTION

**MODIFICATIONS TO EXISTING  
STRUCTURES, PIPING, AND EQUIPMENT**

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**SECTION 02064 - PAGE 1**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to modify, alter and/or convert existing structures as shown or specified and as required for the installation of new mechanical equipment, piping, and appurtenances. Existing piping and equipment shall be removed and dismantled as necessary for the performance of structural alterations in accordance with the requirements herein specified.

1.02 RELATED WORK

- A. Section 02100: Site Preparation
- B. Section 02220: Excavation, Backfill, Fill and Grading for Structures
- C. Section 02221: Excavation, Backfill , Fill and Grading for Pipe
- D. Section 02276: Temporary Erosion and Sediment Control
- E. Section 02999: Miscellaneous Work and Clean-up

PART 2 - PRODUCTS  
(Not Used)

PART 3 - EXECUTION

3.01 GENERAL

- A. The contractor shall cut, repair, reuse, excavate, demolish, or otherwise remove parts of the existing structures or appurtenances, as indicated on the Contract Drawings, herein specified, or necessary to permit completion of the work under this Contract. He shall dispose of surplus materials resulting from the above work in an approved manner. The above work shall include the cutting of grooves and chases in existing masonry to permit the proper bonding of new masonry to old, repainting of existing masonry, the drilling of holes into existing masonry for the purpose of setting dowel rods, anchor bolts, or other appurtenances, and

**MODIFICATIONS TO EXISTING  
STRUCTURES, PIPING, AND EQUIPMENT**

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**SECTION 02064 - PAGE 2**

the cutting of holes in masonry for the installation of pipe, conduits, and other appurtenances. The work shall include all necessary cutting and bending of reinforcing steel, structural steel, or miscellaneous metal work found embedded in the existing structures.

- B. The Contractor shall dismantle and remove all existing equipment, piping, and other appurtenances required for the completion of the work. Where called for or required, the Contractor shall cut existing pipelines for the purpose of making connections thereto. Anchor bolts for equipment and structural steel removed shall be cut off one inch below the concrete surface. Surface shall be finished as specified in Division 3.
- C. At the time that a new connection is made to an existing pipeline, additional new piping, extending to and including the most convenient new valve, shall be installed.
- D. No existing structure, equipment, or appurtenance shall be shifted, cut, removed, or otherwise altered except as shown on the drawings.
- E. When removing materials or portions of existing structures and when making openings in walls and partitions, the Contractor shall take all precautions and use all necessary barriers and other protective devices so as not to damage the structures beyond the limits necessary for the new work, and to damage the structures or contents by falling or flying debris. Unless otherwise permitted, line drilling will be required in cutting existing concrete.
- F. Materials and equipment removed in the course of making alterations and additions shall remain the property of the Owner, except those items not salvageable, as determined by the Engineer and the Owner shall become the property of the Contractor to be disposed of by him off the work site at his own place of disposal. Operating equipment shall be thoroughly cleaned, lubricated, and greased for protection during prolonged storage.

**MODIFICATIONS TO EXISTING  
STRUCTURES, PIPING, AND EQUIPMENT**

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**SECTION 02064 - PAGE 3**

- G. All alterations to existing structures shall be done at such time and in such manner as will comply with the approved time schedule. So far as possible before any part of the work is started, all tools, equipment, and materials shall be assembled and made ready so that the work can be completed without delay.
- H. All workmanship and new materials involved in constructing the alterations shall conform to the General Specifications for the classes of work insofar as such specifications are applicable.
- I. All cutting of existing masonry or other material to provide suitable bonding to new work shall be done in a manner to meet the requirements of the respective section of these specifications covering the new work. When not covered, the work shall be carried on in the manner and to the extent directed by the Engineer.
- J. Where holes in existing masonry are required to be sealed, unless otherwise herein specified, they shall be sealed with cement mortar or concrete. The sides of the openings shall be provided with keyed joints and shall be suitably roughened to furnish a good bond and make a watertight joint. All loose or unsound material adjacent to the opening shall be removed and, if necessary, replaced with new material. The method of placing the mortar seal shall provide a suitable means of releasing entrapped air.
- K. Surfaces of seals visible in the completed work shall be made to match as nearly as possible the adjacent surfaces.
- L. Non-shrink grout shall be used for setting wall castings, sleeves, leveling pump bases, doweling anchors into existing concrete, and elsewhere as shown.
- M. Where necessary or required for the purpose of making connections, the Contractor shall cut existing pipelines in a manner to provide an approved joint. Where required, he shall weld beads, flanges, or provide Dresser Couplings, all as required.

**SITE PREPARATION**

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**SECTION 02100 - PAGE 1**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This Section covers clearing, grubbing, and stripping of the construction site, complete as specified.
- B. Clear and grub all of the area within the limits of Construction or as required. The area to be cleared shall be approved by the Owner's Representative prior to the beginning of any clearing.
- C. Attention is directed to any Soil Erosion and Sediment Control Ordinances in force.

1.02 RELATED WORK

- A. Section 02221: Excavation, Backfill, Fill and Grading for Pipe
- B. Section 02276: Temporary Erosion and Sediment Control

PART 2- PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 SILTATION CONTROL

Before any clearing and grubbing operations, install all sedimentation and erosion control items.

3.02 TREES TO REMAIN

Prior to starting work, protect trees outside the contract limits with temporary fences, boxing, or other protective barrier. Areas under spread of branches shall not be used for any purpose likely to damage trees including parking or driving of vehicles.

## SITE PREPARATION

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### SECTION 02100 - PAGE 2

#### 3.03 CLEARING

Clearing consists of the removal of all exposed objectionable matter such as trees, brush, stumps, logs, grass, weeds, roots, organic matter, poles, stubs, rubbish, refuse dumps, sawdust piles, loose boulders of one cubic yard and other debris resting on or protruding through the ground surface. Clearing may be done by any method the Contractor elects to use, provided no damage is done to property, trees, or shrubbery to be retained in, or outside, the Limits of Construction.

#### 3.04 GRUBBING

Grubbing shall consist of the complete removal of all objectionable matter defined under Clearing, which is embedded in the underlying soil. Objectionable roots are defined as matted tree and brush roots, regardless of the size of the roots, and individual roots more than 3/4" in diameter. All grubbed items shall be removed to a minimum depth of 24" below subgrade.

#### 3.05 STRIPPING

In areas so designated, topsoil shall be stockpiled. The topsoil shall be protected until it is placed as specified. Any topsoil remaining after all work is in place shall be used on-site in areas designated.

#### 3.06 DISPOSAL OF CLEARED AND GRUBBED MATERIAL

The cost of disposal (including hauling if necessary) of cleared and grubbed material and debris shall be considered a subsidiary obligation; the cost of which shall be included in the contract prices. The contractor shall be responsible for obtaining necessary permits allowing him to burn material and debris on site in a safe manner. The contractor shall insure that no damage to adjacent trees, property owners or building shall be incurred.

#### 3.07 PRESERVATION OF TREES

Those trees which are designated for preservation by the Owner shall be carefully protected from damage. Erect such barricades, guards and enclosures for the protection of the trees during all construction operations.

## **SITE PREPARATION**

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### **SECTION 02100 - PAGE 3**

#### **3.08 PRESERVATION OF DEVELOPED PRIVATE PROPERTY**

- A. Exercise extreme care to avoid causing any unnecessary disturbance to developed private property bordering construction.
- B. All soil preservation procedures and replanting operations shall be completed under the supervision of a nursery representative experienced in such operations.
- C. Improvements to the land such as fences, walls, outbuildings and other structures which, if necessary, must be removed, shall be replaced with equal quality materials and workmanship.

#### **3.09 ACTIVE UTILITIES**

Active utilities traversing the site shall be preserved in operating condition. Repair damage to all such utilities due to work under this Contract, to the satisfaction of the authority having jurisdiction over the utility.

#### **3.10 EXISTING SERVICE**

Disconnect or arrange for the disconnection of utility service in accordance with regulations governing the utility concerned and as shown on the drawings or which interfere with the work.

#### **3.11 BENCH MARKS**

Maintain carefully all benchmarks, monuments, and other reference points. If disturbed, replace as directed by the Engineer.

END OF SECTION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes provisions for site dewatering.
- B. Dewatering consists of lowering and controlling groundwater levels and hydrostatic pressures to permit excavation and construction to be performed in near-dry conditions.
- C. The Contractor shall determine the depth of soil below subgrade elevation that is to be dewatered.

1.03 SUBMITTALS

- A. The Contractor shall submit the following in accordance with Conditions of Contract and Division 1, General Requirements:
  - 1. A layout of the dewatering system to coordinate with other construction activities.
  - 2. Observation well reports recording elevation of groundwater and piezometric water levels.

1.04 QUALITY ASSURANCE

- A. The Contractor shall perform dewatering operations with supervisory personnel having at least 5 years experience in field of dewatering.
- B. The Contractor shall maintain adequate supervision and control to ensure that stability of excavated and constructed slopes are not adversely affected by water, that erosion is controlled and that flooding of excavation or damage to structures does not occur.

PART 2 – PRODUCTS

NOT APPLICABLE

PART 3 – EXECUTION

3.01 DEWATERING

- A. The Contractor shall provide an adequate system to lower and control groundwater in order to permit excavation, construction of structures and placement of fill materials under dry conditions. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of structure foundations, drains, sewers and other excavations.
- B. The Contractor shall reduce hydrostatic head in water-bearing strata below structure foundations, drains, sewers and other excavations to extent that water level and piezometric water levels in construction areas are below prevailing excavation surface.
- C. Prior to excavation below groundwater level, the Contractor shall place the system into operation to lower water levels as required and then operate it continuously 24 hours a day, 7 days a week until drains, sewers and structures have been constructed, including placement of fill materials and until dewatering is no longer required.
- D. The Contractor shall dispose of water removed from excavations in a manner to avoid endangering public health, property and portions of work under construction or completed. The Contractor shall dispose of water in a manner to avoid inconvenience to others. The Contractor shall provide sumps, sedimentation tanks and other flow control devices as required by governing authorities.
- E. The Contractor shall provide standby equipment on site, installed and available, for immediate operation if required to maintain dewatering on a continuous basis in event any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, the Contractor shall perform such work as may be required to restore damaged structures and foundation soils at no additional expense.

**MODIFICATIONS TO EXISTING  
STRUCTURES, PIPING, AND EQUIPMENT**

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**SECTION 02064 - PAGE 4**

- N. The Contractor shall provide flumes, hoses, piping, and other related items to divert or provide suitable plugs, bulkheads, or other means to hold back the flow of wastewater, water, or other liquids, all as required in the performance of the work under this Contract.

3.02 CLEANING EXISTING STRUCTURES

Blasting will not be permitted to complete any work under this Contract. Care shall be taken not to damage any part of existing buildings, foundations, or outside structures.

END OF SECTION

3.02 OBSERVATION WELLS

- A. The Contractor shall provide, take measurements and maintain at least a minimum number of observation wells (piezometers) as indicated and additional observation wells as may be required by governing authorities.
- B. The Contractor shall observe and record daily elevation of groundwater and piezometric water levels in observation wells.
- C. The Contractor shall repair or replace within 24 hours, observation wells that become inactive, damaged, or destroyed. If required, suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. The Contractor shall add or remove water from observation well risers to demonstrate that observation wells are functioning properly.
- D. The Contractor shall remove observation wells when dewatering completed.

END OF SECTION

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR STRUCTURES**

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**SECTION 02220 - PAGE 1**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals necessary to perform all excavation, backfill, fill, grading for structures, and finish grading in preparation for landscaping and grassing, required to complete the work shown and specified. The work shall include, but not necessarily be limited to: excavation for structures, footings, all backfilling and fill: embankment and grading for structures; disposal of waste and surplus materials; and all related work such as sheeting, bracing and pumping.
- B. Topsoil, if any, excavated under this Section may be salvaged for convenience for use as necessary for landscaping.

1.02 RELATED WORK

- A. Section 01410: Testing Laboratory Services
- B. Section 02100: Site Preparation
- C. Section 02221: Excavation Backfill, Fill and Grading for Pipe

1.03 QUALITY ASSURANCE

- A. Provide services of a registered engineer or land surveyor to lay out site.
- B. Establish and maintain bench marks on the site for reference. All vertical dimensions shall be checked from these bench marks.
- C. Finished grades, as used herein, mean the required final grade elevations indicated on the drawings. Should finished grades shown on spot elevations conflict with those shown by the contours the spot elevations shall govern.

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR STRUCTURES**

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**SECTION 02220 - PAGE 2**

- D. Soil moisture during fill placement should be maintained within four percent (4%) of the optimum value determined by ASTM D 698 for general area and structural fill and within two percent (2%) of optimum for wall and backfill.
- E. All fill areas and areas at grade shall be proof-rolled with a fully loaded tri-axle dump truck or a 20-ton roller to detect any soft areas. Any areas which pump or rut excessively and cannot be densified by continued rolling shall be undercut.

1.04 JOB CONDITIONS

- A. Consider the Limits of Work indicated to make determination of the amount of grading. Limit grading to the work as shown and do not disturb the existing terrain or trees outside this work.
- B. Subsurface soil data: Subsurface investigation has been performed and data is available for reference. However, neither Architect, nor Owner assumes responsibility for completeness or accuracy of data contained therein and no claims for extra compensation or extension of time will be considered based on assumptions. Data may be examined in Owner's office.
- C. Items of historic or archaeological value discovered during earthwork operations shall remain property of the Owner.

1.05 PROTECTION

- A. Lateral Support of Excavation for Structures: Furnish, put in place, and maintain sheeting and bracing required to support the sides of the excavations, to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction, and to protect streets and utilities from damage due to lateral movement or settlement of ground.

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR STRUCTURES**

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**SECTION 02220 - PAGE 3**

- B. Control of Groundwater Level:
1. Maintain the groundwater level below subgrade of the structure until the concrete structures are up high enough to prevent flooding the structure. Support shall be maintained at both bottom and top levels of wall to prevent flotation.
  2. After the structure has been completed in its entirety, backfill as described hereinafter.
  3. Flotation shall be prevented by maintaining a positive and continuous operation of the dewatering system. The responsibility and liability for all damages which may result from failure of this system shall be included in the work of this Section.
  4. Disposal of drainage water shall be in an area approved by the Owner. Precautions shall be taken to prevent the flow or seepage of drainage back into the drainage area. Particular care shall be taken to prevent the discharge of unsuitable drainage to a water supply or surface water body.
  5. Removal of dewatering system shall be accomplished after the dewatering system is no longer required; the material and equipment constitute the system.

1.06 TESTING

- A. Soil testing shall be performed by an independent testing agency selected and paid by the Contractor in accordance with Section 01410.
- B. Testing agency shall perform the following testing:
1. Compaction tests in accord with ASTM D698-78.
  2. Field density tests for each 2'-0" lift, in accord with ASTM D2937-76 one test for each 10,000 sq. ft. of fill. One test is to be conducted for at least every 500 cubic feet of fill in trenches or restricted area fills.
  3. Inspection and testing subgrades and proposed fill materials.
  4. Examination of foundation excavations to determine if required soil bearing has been achieved.
  5. Examination of excavations to determine that required rock has been removed prior to fill placing and compacting.

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR STRUCTURES**

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**SECTION 02220 - PAGE 4**

6. Verification of unsuitable soil materials to be removed, where classified excavation is indicated.
- C. Duties relative to testing include:
  1. Provide representative fill soil samples to testing agency for test purposes. Provide 50 lb. of samples of each fill soil.
  2. Advise testing agency sufficiently in advance of operations to allow for completion of quality tests and for assignment of personnel.
- D. The responsibility for paying costs of additional testing beyond scope of that required and for retesting if initial test reveals nonconformance with specified requirements shall be included as part of the work in this Section.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Structural Fill:
  1. Compacted granular fill which will provide support for building or structure foundations will be referred to as structural fill. Backfill which is placed against the exterior side of the building walls or as fill over pipe lines will be referred to as common fill.
  2. The soil subgrade immediately beneath pavements and floor slabs should be compacted to at least 98% in the upper 18" of fill areas and the upper 12" of cut areas if they become disturbed during construction.
  3. Materials for compacted granular fill shall be gravel, sandy gravel, or gravelly sand free of organic material, loam, wood, trash, and other objectionable material and shall be will graded within the following limits:

| Sieve Size | Percent Finer by Weight |
|------------|-------------------------|
| 6"         | 100                     |
| No. 4      | 20-95                   |
| No. 40     | 0-60                    |
| No. 200    | 0-8                     |

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR STRUCTURES**

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**SECTION 02220 - PAGE 5**

Fill soils should be non-expansive material with a plasticity index of less than 30, a liquid limit of less than 50 and a maximum dry density (standard proctor ASTM D 698) of at least 90 pcf. Soil classifications GM, GC, SW, SP, SM, SC, ML, and CL will be allowed provided they meet the above criteria.

- B. Common Fill: Mineral soil, substantially free of clay, organic material, loam, wood, trash, or other objectionable material which may be compressible or which cannot be properly compacted. Common fill shall not contain stones larger than 10" (6" max. for within 2'-0" of roadway surface) in any dimension. Common fill shall not contain broken concrete, masonry, rubble, asphalt pavement or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling.
- C. Except as noted in the following paragraph, material used below subgrade within the limits of support of structures shall consist of lean concrete or material meeting the requirements for structural fill as defined above. Crushed stone of #57 size or finer may be used.
- D. Where excavation occurs in rock, the working mat shall consist of a lean concrete placed directly on firm rock after all loose rock has been removed.

**PART 3 - EXECUTION**

**3.01 EXCAVATION BELOW GRADE**

- A. If the bottom of any excavation is taken out below the limits indicated or specified, it shall be refilled with concrete or 6" layers of compacted structural fill.
- B. If the subgrade surface is not cared for through failure to postpone final excavation immediately above the subgrade until shortly before placing of the new work thereon, or other failure, or neglect to conduct the excavation work properly so that the surface of the subgrade is in proper condition when ready for construction, remove the unsuitable material and replace it with concrete or compacted structural fill.

**EXCAVATION, BACKFILL, FILL  
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**SECTION 02220 - PAGE 6**

3.02 STRUCTURE EXCAVATION AND COMPACTION PROCEDURES

- A. Excavation shall be made to such widths as will give suitable room for construction of the structures, for bracing and supporting, pumping and draining; and the bottom of the excavations shall be rendered firm and dry in all respects.
- B. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. Subgrade soils which become soft, loose, quick, or otherwise unsatisfactory for support of structures as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by structural fill.
- C. Dewatering shall be such as to prevent boiling or detrimental saturation at the base of the excavation as specified herein. Install such means as required to preserve the stability of the base of the operation.
- D. Excavating equipment shall be satisfactory for carrying out the work in accordance with the Specification. In no case shall earth be plowed, scraped, or dug with machinery so near to the finished subgrade as to result in excavation of, or disturbance of material below grade.
- E. During final excavation to subgrade level, take whatever precautions are required to prevent disturbance and remolding of the subgrade. Material which has become softened and mixed with water shall be removed. Hand excavation of the final 3" to 6" will be required as necessary to obtain a satisfactory undisturbed bottom.
- F. When excavation for foundations has reached prescribed depths, the Owner's Representative shall be notified, and he will inspect conditions.
- G. The fill shall be placed in layers having a maximum thickness of 8" measured before compaction. Each layer of fill shall be compacted to at least 95% of maximum dry density determined by ASTM Compaction Test, Designation D 698.
- H. Large compaction equipment should operate no closer than 5' from backfilled wall.

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR STRUCTURES**

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**SECTION 02220 - PAGE 7**

3.05      **COMPACTION**

- A.      Compaction shall be performed as specified hereinafter for the particular materials and operations.
  - 1.      Self-propelled compactors shall make compaction passes at a speed of approximately 5 miles per hour.
  - 2.      Areas adjacent to structures, and other areas inaccessible to a roller, shall be compacted with hand operated mechanical compaction equipment. Compaction of the fill by such means shall be to the same degree of compaction as obtained by other approved equipment, and the Owner may make the necessary tests to determine the amount of compactive effort necessary to obtain equal compaction. Unless such tests indicated that modifications may be made, the fill compacted by mechanical compactors shall be placed in 6" layers and thoroughly tamped over the entire surface. Compaction equipment is subject to approval by the Owner.
  
- B.      Compacted structural fill for structural foundations shall be placed in layers not to exceed 8" thickness by loose measure and shall be compacted to at least 95% of maximum dry density as determined by ASTM Test Designation D 698. The upper one foot of material in fill or at grade areas or cut surfaces should be scarified and compacted to a 98% criteria.
  
- C.      The surface of filled areas shall be graded to smooth, true lines, strictly conforming to grades indicated, and no soft spots or uncompacted areas will be allowed in the work.
  
- D.      Temporary bracing shall be provided as required during filling and backfilling of all structures to protect partially completed structures against all construction equipment loads, hydraulic pressures and earth pressures.

3.06      **BACKFILLING - COMMON FILL**

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR STRUCTURES**

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**SECTION 02220 - PAGE 8**

- A. Common fill may be used as backfill against the exterior walls of the structures. Material conforming to the requirements of common fill shall be placed in layers having a maximum thickness of 8" measured before compaction.
- B. Common fill shall be compacted to at least 95% of maximum density as determined by ASTM compaction tests, Designation D 698.
- C. Materials placed in fill areas shall be deposited to the lines and grades shown making due allowance for settlement of the material and for the placing of topsoil thereon.
- D. The surfaces of filled areas shall be graded to smooth, true lines, strictly conforming to grades indicated on the paving and grading drawings, and no soft spots or uncompacted areas will be allowed in the work.
- E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

**3.07 EARTH EMBANKMENTS**

- A. All organic materials, including peat and loam, shall be removed from areas beneath new embankments. If the subgrade slopes are excessive, the subgrade shall be stepped to produce a stable surface for the placement of the embankments. The natural subgrade shall then be compacted by mechanical compaction equipment. The prepared subgrade shall be inspected and approved by the Owner's Representative prior to the placement of structural fill.
- B. Fill shall be placed in layers 8" thick measured before compaction. Each layer shall be compacted to at least 95% of the maximum dry density as determined by the ASTM compaction test, Designation D-698.
- C. Existing slopes shall be reconstructed as shown.

**3.08 DISPOSAL OF UNSUITABLE AND SURPLUS MATERIAL**

**EXCAVATION, BACKFILL, FILL  
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**SECTION 02220 - PAGE 9**

- A. Unsuitable excavated materials and pavement shall become the property of the Contractor and removed and disposed of by him off the project site.
- B. Suitable excavated material may be used for fill or backfill if it meets the specifications for common fill and is approved by the Owner's Representative. Excavated material so approved may be neatly stockpiled at the site. If space limitations do not permit stock piling on the site, the Contractor will be required to make arrangements for off-site stockpiling. Transport of such material from and to the immediate site, including any stockpiling agreements, shall be entirely at the Contractor's expense and shall not constitute grounds for additional payment.
- C. Surplus excavated material shall be used to fill depressions or for other purposes as the Owner may direct; otherwise, it shall become the property of the Contractor and shall be removed and disposed of by the Contractor off the project site.

3.09 GRADING

- A. Grading in preparation for placing of topsoil, planting areas, paved walks and drives and appurtenances shall be performed at all places indicated, to the lines, grades, and elevations shown, and shall be performed in such a manner that the requirements for formation of slopes, lines and grades can be followed. All material encountered, of whatever nature, within the limits indicated, shall be removed and disposed of as directed. During the process of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.
- B. If at the time of grading it is not possible to place any material in its proper section of the permanent structure, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.
- C. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, due to discrepancies or in order to obtain satisfactory construction.

**EXCAVATION, BACKFILL, FILL  
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**SECTION 02220 - PAGE 10**

- D. Stones or rock fragments larger than 4" in their greatest dimensions will not be permitted in the top 6" of the finished subgrade of all fills or embankments.
- E. In cuts, all loose or protruding rocks on the backslopes shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross section and alignment shown.

3.10 DEFINITION OF ROCK

- A. General Excavation - Any material which cannot be excavated with a single-tooth ripper drawn by a crawler tractor having a draw bar pull rated at not less than 56,000 pounds (Caterpillar D8K or equivalent) or excavated by a front-end loader with a minimum bucket breakout force of 25,600 pounds (Caterpillar 977 or equivalent).
- B. Trench Excavation - Any material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 33,000 pounds (Caterpillar 225B or equivalent).

END OF SECTION

**EXCAVATION, BACKFILL, FILL  
AND GRADING FOR PIPE**

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**SECTION 02221 - PAGE 1**

**PART 1 - GENERAL**

**1.01 SCOPE OF WORK**

- A. This section includes, except as elsewhere provided, all excavation for piping and associated appurtenances including; filling, backfilling, grading, disposal of surplus material and restoration of trench surfaces and easements.
- B. Furnish and place all sheeting, bracing, and supports and remove from the excavation all materials which the Engineer may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry and in all respects acceptable. Deposit pipe bedding, or refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related closely to the rate of pipe laying. All excavation shall be made in open trenches.

**1.02 RELATED WORK**

- A. Section 02100: Site Preparation.
- B. Section 02220: Excavation, Filling, Backfilling, Grading for Structures

**PART 2 - MATERIALS**

**2.01 MATERIALS**

- A. General:
  - 1. Materials for use as fill shall be as described below. For each material, notify the Owner's representative of the source of the material and furnish, for approval, a representative sample weighing approximately 50 pounds, at least ten calendar days prior to the date of anticipated use of such material.
  - 2. Materials shall be furnished as required from off site sources and hauled to the site.

**EXCAVATION, BACKFILL, FILL  
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**SECTION 02221 - PAGE 2**

3. Disposal of unsuitable materials is specified in this Section. See paragraph 3.01.
- B. Common Fill:
1. Common Fill shall consist of mineral soil, free of organic material, loam, wood, trash, snow, ice, frozen soil and other objectionable material which may be compressible or which cannot be compacted properly. Common fill shall not contain stones larger than 10" in any dimension, broken concrete, masonry, rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling.
  2. Material falling within the above specification, encountered during the excavation, may be stored in segregated stockpiles for reuse. All material which, in the opinion of the Owner's Representative, is not suitable for reuse shall be spoiled as specified herein for disposal of unsuitable materials.
- C. Crushed Stone:
1. Crushed stone shall be used for pipe bedding, manhole bases, as a drainage layer below structures with underdrains and at other locations indicated on the drawings.
  2. Crushed stone shall be size No. 57.

**PART 3 - EXECUTION**

**3.01 DISPOSAL OF MATERIALS**

- A. Excavated material shall be stacked without excessive surcharge on the trench bank. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.
- B. Surplus excavated material which is suitable for use in backfilling or for replacing rock and boulders shall be stockpiled. Unsatisfactory surplus material including paving, rock or boulders and other material, shall be disposed of.

**EXCAVATION, BACKFILL, FILL  
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**SECTION 02221 - PAGE 3**

- C. It is expressly understood that no excavated material shall be removed from the site of the work or disposed of by the Contractor except as directed by the Owner's representative.
- D. Should conditions make it impracticable or unsafe to stack material adjacent to the trench, the material shall be hauled and stored. When required, it shall be re-handled and used in backfilling the trench. No extra compensation will be made for re-handling material.

**3.02 SHEETING AND BRACING**

Furnish, put in place, and maintain sheeting and bracing required to support the sides of the excavation and prevent loss of ground which could damage or delay the work or endanger adjacent structures. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

**3.03 TEST PITS**

- A. Contact and coordinate with local utilities before excavating test pits for the purpose of locating underground utilities of structures as an aid in establishing the precise location of new work. Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as hereinafter specified.
- B. Excavation of test pits shall be considered work incidental to furnishing and laying sewer pipe.
- C. If, for any reason, a test pit is left open for any period of time, it shall be barricaded and lighted.

**3.04 DRAINAGE**

- A. Furnish all materials and equipment and perform all incidental work required to install and maintain the drainage system proposed for handling groundwater or surface water encountered. Construction shall not begin until the Owner's representative is assured that the proposed method will be satisfactory. The requirements for a stable subgrade are indicated

**EXCAVATION, BACKFILL, FILL  
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**SECTION 02221 - PAGE 4**

above, and the Contractor must alter his drainage methods if the trench bottom is unsatisfactory.

- B. Provide pumping equipment and devices to properly remove and dispose of all water entering trench and excavation for structures. The grade shall be maintained acceptably dry until structures to be built therein are completed. All drainage shall be performed without damage to the trench, pavements, pipes or other utilities.
- C. Pipe and masonry shall not be laid in water or submerged within 24 hours after being placed. Water shall not flow over new masonry within four days after placement.
- D. In no event shall water rise to cause unbalanced pressure on structures until the concrete or mortar has set at least 24 hours. Prevent flotation of the pipe by promptly placing backfill.
- E. If underdrains are used for handling water, furnish and install pipe and crushed stone graded from coarse to fine, and furnish and install all pumps and equipment necessary to maintain the water level continuously at the required elevation. Pipe underdrains shall be laid with open joints and bedded in crushed stone for the full width of trench, to a depth of 6" below the invert of underdrain.
- F. The invert of underdrain shall be 12" below the normal subgrade. Pipe underdrains shall have no permanent outlet and shall be sealed at the completion of the work. The length of continuous underdrain to be used shall be limited as conditions require. An impervious bulkhead of clay or concrete shall be constructed in the trench bottom between 100 ft. lengths of the underdrainage system to obstruct the free flow of groundwater after construction is completed. For all excavation below normal grade for the purpose of installing underdrains, the crushed stone and underdrain pipe shall be considered a part of the drainage work to be done under the pipe items. Continuously guard against the loss of earth through subbase or the underdrain. Should loss of either take place, alter the stone size to provide a satisfactory barrier or filter.
- G. Where other methods of handling water prove inadequate, furnish, install, operate, and remove proper well point facilities.

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**SECTION 02221 - PAGE 5**

3.05 TRENCH EXCAVATION

- A. Excavation shall be made for all trenches which are required for the installation of pipes and manholes.
- B. Make excavations to the depth indicated on the drawings and in such a manner and to such widths as will give suitable room for laying the pipe within the trenches, for bracing and supporting, and for pumping and drainage facilities. Unless given permission to do otherwise, trenches shall be excavated by open cut method. Render the bottom of the excavations firm and dry in all respects. Permission may be granted for tunnel work for crossing under crosswalks, driveways or existing utility lines, however, such tunnels are limited to ten feet in length. All OSHA guidelines and requirements must be strictly followed.
- C. The trench may be excavated by machinery to, or just below the designated subgrade provided that the material remaining in the bottom of the trench is no more than slightly disturbed.
- D. Rock shall be removed to a minimum of 8" clearance around the bottom and sides of the pipe being laid.
- E. Where the pipes or ducts are to be laid directly on the trench bottom, the lower part of the trenches shall not be excavated to grade by machinery. The last of the material being excavated manually shall be done in such a manner that it will give a flat bottom true to grade, so that pipe or duct can be evenly supported on undisturbed material. Bell holes shall be made to provide proper bedding.

3.06 PIPE BEDDING

- A. The Contractor shall furnish and install pipe on the type of bedding shown on the drawings and as specified herein. Regardless of the type of bedding used, holes in the trench shall be provided to receive the pipe bell. The hole excavated shall be sufficient to relieve pipe bells of all loads and yet provide support over the total length of the pipe barrel.
- B. Bedding classes are as defined below and shown on the drawings:

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**SECTION 02221 - PAGE 6**

1. Two (2) types of bedding are specified:
  - a. For Class D Bedding, the trench bottom shall be hand shaped to receive the portion of the circumference of the pipe barrel shown on the drawings. Class D bedding shall be used for all pipe bedding unless shown otherwise in the drawings.
  - b. For Class C bedding, sand shall be compacted in the trench bottom, and compacted around the pipe to a depth shown on the drawings.
    - (1) Where the trench bottom has been excavated below grade, C bedding shall be used.
    - (2) Where consolidated rock has been moved from the trench bottom, Class C bedding shall be used.

**3.07 BACKFILLING**

- A. As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Where indicated on the drawings, crushed stone shall be placed and compacted to a point indicated on the detailed drawing.
- B. After the required crushed stone bedding has been placed, or after the pipe has been properly bedded on a shaped trench bottom, Common Fill material shall be placed to a depth of 1'-0" over the top of the pipe. Backfill shall be thoroughly compacted by hand-tamping as placed.
- C. Any space remaining between the pipe and side of the trench shall be packed full by hand shovel with sand, free from stones having a diameter greater than 2", and thoroughly compacted with a tamper as fast as placed up to a level of one (1) foot above the top of the pipe.
- D. The filling shall be carried up evenly on both sides with at least one person tamping for each person shoveling material into the trench.
- E. The remainder of the trench above the compacted backfill, as just described shall be filled and thoroughly compacted by rolling, ramming, or puddling, to prevent subsequent settling.

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**SECTION 02221 - PAGE 7**

- F. Where the pipes are laid across country, the trench backfill material shall be mounded 6" above the existing grade or as directed. Wherever a loam or gravel surface exists prior to cross country excavations, it shall be removed, conserved, and replaced to the full original depth as part of the work under the pipe items. In some areas it may be necessary to remove excess material during the cleanup process, so that the ground may be restored to its original level and condition. If loam or topsoil is not stored it may be replaced with loam or topsoil of equal quality and quantity.
- G. Where the pipes are laid in streets, the last 1'-0" layer shall be of Aggregate Base material otherwise thoroughly compacted.
- H. Backfill around manholes shall be selected material, compacted by puddling. All backfill shall be compacted, especially under and over pipes connected to the structures. Selected backfill shall be free from stones larger than 3".
- I. Rock fragments shall not be placed until the pipe has at least 2'-0" of earth cover. Small stones and rocks shall be placed in thin layers alternating with earth to insure that all voids are completely filled. Filling shall not be dropped into the trench in a manner to endanger the pipe. Rock fragments used shall not exceed 10 pounds.
- J. Bituminous paving adjacent to or effected by the excavation shall be broomed and hosed-clean immediately after backfilling. Dust control measures shall be employed at all times.

**3.08 RESTORING TRENCH SURFACE**

- A. Where the trench occurs adjacent to paved street, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate the backfill and maintain the surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore the level of the ground.
- B. The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved highway shall be restored to a condition at least equal to that existing before work began.

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**SECTION 02221 - PAGE 8**

- C. In sections where the sewer passes through grassy areas, remove and replace the soil, or loam seed. The depth of loam replaced shall be at least equal to that removed during trenching operations, but in no event shall it be placed less than 4" in depth.

3.09 FILL PLACEMENT

A. General:

1. Material placed in fill areas under and around structures shall be deposited within the lines and to the grades shown on the drawings, making due allowance for settlement of the material. Fill shall be placed only on properly prepared surfaces which have been inspected and approved by the Owner's Representative. No fill shall be placed on a frozen surface, nor shall snow, ice, or frozen material of any sort be placed in fill. If sufficient common fill material is not available from excavation on site, provide borrow as may be required.
2. Gravel base course material and crushed stone shall be provided as borrow.
3. Fill shall be brought up to substantial level lifts throughout the site, starting in the deepest portion of the fill. The entire surface of the work shall be maintained free from ruts, and in such condition that construction equipment can readily travel over any section. Fill shall not be placed against concrete structures until they have attained sufficient strength.
4. Fill shall be dumped and spread in layers by a bulldozer or other approved method. During the process of dumping and spreading, all roots shall be removed from the fill areas.
5. If the compacted surface of any layer of material is determined to be too smooth to bond properly with the succeeding layer, it shall be loosened by harrowing or by another approved method before the succeeding layer is placed.
6. All fill materials shall be placed and compacted in a dry condition. Dewater excavated areas as required to perform the work and in such a manner as to preserve the undisturbed state of the natural inorganic soils.

3.10 COMPACTION

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**SECTION 02221 - PAGE 9**

- A. Common Fill backfill material in trenches shall be placed in layers not to exceed eight (8) inches in depth as measured before compaction. Each layer shall be compacted by a minimum of four (4) coverages with the equipment described below, to at least 98% of maximum dry density as determined by ASTM D698, unless under a structure in which case 100% compaction shall be obtained. Incidental compaction due to traffic by construction equipment will not be credited toward the required minimum four (4) coverages.
- B. Common fill not within trenches shall be placed and compacted in a manner similar to that described above, with the following exceptions: layer thickness prior to compaction may be increased to 10" in open areas; and common fill except dike fill, required below water level in peat excavation areas may be placed as one lift, in-the-wet, to an elevation one (1) foot above the water level at the time of filling.
- C. Compaction equipment in open areas shall consist of fully loaded ten-wheel dump trucks, tractor dozers weighing at least 30,000 pounds and operated at top speed, or by vibratory roller.
- D. Areas adjacent to structures and other confined areas inaccessible to the roller or truck, the Common Fill shall be compacted with approved hand guided mechanical compaction equipment. Compaction of the Common Fill by such means shall be to the same degree of compaction as obtained by the rubber-tired equipment. Common Fill compacted by mechanical compactors shall be placed in loose lifts not to exceed 6" maximum thickness and to at least 98% of the standard Proctor maximum dry density.
- E. It is the intention that the fill materials, with respect to moisture, be used in the condition they are excavated insofar as this is practicable. Material which is too wet shall be spread on the fill area and permitted to dry, assisted by harrowing if necessary, until the moisture content is reduced to allowable limits.
- F. If the Owner's Representative shall determine that added moisture is required, water shall be applied by sprinkler tanks or other sprinkler systems, which will ensure uniform distribution of the water over the area

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to be treated, and give complete and accurate control of the amount of water to be used. If too much water is added, the area shall be permitted to dry before compaction is continued.

3.11 GRADING

- A. Grading shall be performed at such places as are indicated on the drawings, to the lines, grades, and elevations shown and shall be made in such a manner that the requirements for formation of embankments can be followed. All unacceptable material encountered, of whatever nature within the limits indicated, shall be removed and disposed of as directed. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the progress or condition of the work.
- B. If at the time of excavation it is not possible to place any material in its proper section of the permanent structure, it shall be stockpiled in approved areas for later use.
- C. The right is reserved to make minute adjustments or revisions in lines or grades if found necessary as the work progresses, due to discrepancies on the drawings or in order to obtain satisfactory construction.
- D. Stones or rock fragments larger than 4" in their greatest dimensions will not be permitted in the top 6" of the subgrade line of all dikes, fills or embankments.
- E. All fill slopes shall be uniformly dressed to the slope, cross-section and alignment on the drawings.
- F. In cuts, all loose or protruding rocks on the back slopes shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the drawings.
- G. No grading is to be done in areas where there are existing pipe lines that may be uncovered or damaged until such lines which must be maintained

**EXCAVATION, BACKFILL, FILL  
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are relocated, or where lines are to be abandoned, all required valves are closed and drains are plugged at manholes.

**3.12 DISPOSAL OF UNSUITABLE SURPLUS MATERIAL**

- A. Unsuitable and surplus activated materials and pavement shall become the property of the Contractor and removed and disposed of by him off the project site.
- B. Suitable excavated materials may be used for fill or backfill if it meets the Specification for common fill. Excavated material so approved may be neatly stockpiled at the site. If space limitations do not permit stockpiling on the site, make arrangements for offsite stockpiling.
- C. Surplus excavated materials may be used to fill depressions or other purposes as the Owner's Representative may direct.

**3.13 DISPOSAL AND REPLACING OF ROCK**

Remove and dispose of all pieces of rock which are not suitable for use in other parts of the work. Rock disposed of by hauling away to spoil area is to be replaced by approved surplus excavation obtained elsewhere on the site, insofar as it is available. Any deficiency in the backfill material shall be made up with acceptable material from outside sources as approved by the Owner's Representative.

**3.14 DEFINITION OF ROCK**

- A. General Excavation - Any material which cannot be excavated with a single-tooth ripper drawn by a crawler tractor having a draw bar pull rated at not less than 56,000 pounds (Caterpillar D8K or equivalent) or excavated by a front-end loader with a minimum bucket breakout force of 25,600 pounds (Caterpillar 977 or equivalent).
- B. Trench Excavation - Any material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 33,000 pounds (Caterpillar 225B or equivalent).

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**SECTION 02221 - PAGE 12**

END OF SECTION

## TEMPORARY EROSION AND SEDIMENT CONTROL

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### SECTION 02276 - PAGE 1

#### PART 1 - GENERAL REQUIREMENTS

##### 1.01 DESCRIPTION

- A. The work specified in this Section consists of providing, maintaining and removing temporary erosion and sedimentation controls as necessary.
- B. Temporary erosion controls include, but are not limited to, grassing, mulching, netting, and watering, and reseeding on-site surfaces and spoil and borrow area surfaces and providing interceptor ditches at ends of berms and at those locations which will ensure that erosion during construction will be either eliminated or maintained within acceptable limits as established by the Owner, City and State.
- C. Temporary sedimentation controls include, but are not limited to, silt fencing, silt dams, traps, barriers, and appurtenances at the foot of sloped surfaces which will ensure that sedimentation pollution will be either eliminated or maintained.
- D. Provide effective temporary erosion and sediment control measures during construction or until final controls become effective.
- E. Erosion, Sedimentation and Pollution Control shall be performed in accordance with Georgia's NPDES Permit No. GAR100000 and as detailed in the drawings.

##### 1.02 WORK SPECIFIED IN OTHER SECTIONS

- A. Excavation, Backfill, Fill and Grading for Pipe: Section 02221.
- B. Seeding: Section 02486.
- C. Silt Fence: Section 02542.

##### 1.03 REFERENCE DOCUMENTS

- A. Georgia Building Code.

## TEMPORARY EROSION AND SEDIMENT CONTROL

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### SECTION 02276 - PAGE 2

- B. Any Soil Erosion and Sediment Control Ordinances in force by the local Government.
- C. State of Georgia, Department of Transportation, Standard Specifications.

### PART 2 - PRODUCTS

#### 2.01 EROSION CONTROL

- A. Seeding
- B. Sodding
- C. Netting - fabricated of material acceptable to the Owner.

#### 2.02 SEDIMENTATION CONTROL

- A. Bales - clean, seed-free cereal hay type.
- B. Netting - fabricated of material acceptable to the Owner.
- C. Filter stone - No. 57 - crushed stone.

### PART 3 - EXECUTION

#### 3.01 EROSION CONTROL

- A. Minimum procedures for grassing are:
  1. Scarify slopes to a depth of not less than 6" and remove large clods, rock, stumps, roots larger than 1/2" in diameter and debris.
  2. Sow seed within 24 hours after the ground is scarified with either mechanical seed drills or rotary hand seeders.
  3. Apply mulch loosely and to a thickness of between 3/4" and 1-1/2".
  4. Apply netting over mulched areas of sloped surfaces.
  5. Roll and water seeded areas in a manner which will encourage sprouting of seeds and growing of grass. Reseed areas which exhibit un-satisfactory growth. Backfill and seed eroded areas.

## TEMPORARY EROSION AND SEDIMENT CONTROL

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### 3.02 SEDIMENTATION CONTROL

- A. Install and maintain silt fencing, silt dams, traps, barriers and appurtenances as shown on the approved descriptions and working drawings. Hay bales which deteriorate and filter stone which is dislodged shall be replaced.

### 3.03 PERFORMANCE

- A. Should any of the temporary erosion and sediment control measures employed fail to produce results which comply with the requirements of the State, immediately take whatever steps are necessary to correct the deficiency.

### 3.04 MONITORING, REPORTING AND RETENTION OF RECORDS

Contractor shall monitor, report and retain records as required by the GA NPDES Permit No. GAR100000. Attached to the end of this section are the minimal reports which should be performed and maintained. The following are the attached reports:

- A. Erosion and Sedimentation Inspection and Maintenance Reports
- B. Daily Rainfall Monitoring Report
- C. Stormwater Monitoring Data

END OF SECTION

Erosion & Sedimentation Inspection and Maintenance Report

To be completed every 7 days AND within 24-hours of a qualifying rainfall event of 0.5-inches or more.

Project: \_\_\_\_\_

Time/date of last rainfall: \_\_\_\_\_ Amount of last rainfall: \_\_\_\_\_ inches

Inspector: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Describe the most recent land disturbance/phase of the project: \_\_\_\_\_

Date of the most recent disturbance: \_\_\_\_\_

Weather:     Cold     Mild     Hot     Clear     Cloudy     Rain     Windy

Erosion Control:

- |                            |                               |                              |                                    |                                      |                                |
|----------------------------|-------------------------------|------------------------------|------------------------------------|--------------------------------------|--------------------------------|
| 1. Construction Exit:      | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient | <input type="checkbox"/> Redress     | <input type="checkbox"/> Other |
| 2. Silt Fence:             | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient | <input type="checkbox"/> Remove Silt | <input type="checkbox"/> Other |
| 3. Sediment Traps:         | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient | <input type="checkbox"/> Remove Silt | <input type="checkbox"/> Other |
| 4. Sediment Ponds:         | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient | <input type="checkbox"/> Remove Silt | <input type="checkbox"/> Other |
| 5. Outlet Protection:      | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient | <input type="checkbox"/> Remove Silt | <input type="checkbox"/> Other |
| 6. Temporary Ground Cover: | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient | <input type="checkbox"/> Remove Silt | <input type="checkbox"/> Other |
| 7. Permanent Vegetation:   | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient | <input type="checkbox"/> Remove Silt | <input type="checkbox"/> Other |

Other Erosion Control Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Has Silt Left the Site:     Yes     Not Apparent     N/A

Drainage:

- |                            |                               |                              |                                    |
|----------------------------|-------------------------------|------------------------------|------------------------------------|
| Detention Pond Grade:      | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient |
| Detention Pond Outlets:    | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient |
| Detention Pond Vegetation: | <input type="checkbox"/> Good | <input type="checkbox"/> N/A | <input type="checkbox"/> Deficient |

Other Drainage Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Other Additional Notes: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Deficiencies:

Is this site in compliance? Y or N If not, complete the following information for each deficiency.

|                     |                 |              |
|---------------------|-----------------|--------------|
| 1. Deficiency(ies): | Location: _____ | Code: I M GC |
| Corrective actions: |                 |              |

|                     |                 |              |
|---------------------|-----------------|--------------|
| 2. Deficiency(ies): | Location: _____ | Code: I M GC |
| Corrective actions: |                 |              |

|                     |                 |              |
|---------------------|-----------------|--------------|
| 3. Deficiency(ies): | Location: _____ | Code: I M GC |
| Corrective actions: |                 |              |

|                     |                 |              |
|---------------------|-----------------|--------------|
| 4. Deficiency(ies): | Location: _____ | Code: I M GC |
| Corrective actions: |                 |              |

Required under the EPD NPDES Construction Permit for sites between 5 and 250 acres.

Photo document deficiencies and retain in permanent file.

Include site map identifying location of all deficiencies.  
Return original reports to construction site file and copy in monthly.  
Permanent office file.

Codes:

**I** Immediate – Must be corrected in 24 hours.  
**M** Minor – Must be corrected within 72 hours.  
**GC** General Condition – Must be maintained





PART 1 - GENERAL

1.01 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. Federal Specifications(Fed. Spec.):

|               |   |
|---------------|---|
| FF-P-101E     | Padlocks & Am 2   |
| RR-F-191J/GEN | Fencing, Wire and Post, Metal(and Gages, Chain-Link Fence Fabric, and Accessories) (General Specifications) |
| RR-F-191/1C   | Fencing, Wire and Post, Metal (Chain-Link Fence Fabric) (Detail Specification)                              |
| RR-F-191/2C   | Fencing, Wire and Post, Metal (Chain-Link Fence Gates) (Detail Specification)                               |
| RR-F-191/3C   | Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) (Detail Specification)         |
| RR-F-191/4C   | Fencing, Wire and Posts, Metal (Chain-Link Fence Accessories) (Detail Specification)                        |

B. American Society for Testing and Materials (ASTM) Publication:

|         |                      |
|---------|----------------------|
| C 94-86 | Ready-Mixed Concrete |
|---------|----------------------|

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop drawings or catalog cuts showing all fencing components and details of fencing, gates, post tops, barbed wire and extension arms, tension bands and bars, sleeves, ties, and clips. These drawings or cuts shall be accompanied by a lay-out drawing showing spacing of posts and location of gate, corner, end, and pull posts.
- B. Certificates of Conformance: Submit certificates from the manufacturer attesting that all materials meet requirements specified herein.
- C. Tests: Test for spelter coat gage for zinc coating shall be performed on each shipment of fencing.

1.03 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 - PRODUCTS

2.01 FABRIC, GATES, POSTS, TOP RAILS, BRACES, AND ACCESSORIES

Fed. Spec. RR-F-191/Gen and detailed specifications as referenced herein.

- A. Concrete: As specified in Section 03300 - Cast-In-Place Concrete.
- B. Fabric: Fed. Spec. RR-F-191/1; Type IV, PVC coated steel, with minimum 9-gage wire core. Mesh size shall be 2-inch. Selvage shall be knuckled at one selvage and twisted and barbed at the other. Height of fabric shall be as indicated in the construction drawings.
- C. Gates: Fed.Spec. RR-F-191/2; Type II, double swing. Shape and size of the gate frame shall be as indicated in the construction drawings. Framing and bracing members shall be round of steel or aluminum alloy. Steel member finish shall be zinc coated. Gate fabric shall be as specified herein for chain-link fencing fabric. Special gate frames shall be as indicated in the construction drawings. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Attach gate fabric to the gate frame by method standard with the manufacturer, except that welding will not be

permitted. Arrange padlocking latches to be accessible from both sides of the gate regardless of latching arrangement.

1. Latches, Hinges, Stops, Keepers, and Accessories: Zinc-coated steel, with weight of zinc-coating not less than 1.2 ounces per square foot.
    - a. Double Gate Latches: Fork type with center drop rod.
  2. Padlocks: Fed. Spec. FF-P-101, Type EPB, 1 3/4-inch size, with chain.
- D. Posts, Top Rails, and Braces: Fed. Spec. RR-F-191/3, zinc-coated steel. Minimum size of top rails and braces shall be as listed in Fed. Spec. RR-F-191/3 for each class and grade.
1. Posts: Class 1, steel pipe, Grade A
  2. Braces: Class 1, steel pipe, Grade A
- E. Accessories: Fed. Spec. RR-F-191/4, zinc-coated steel.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. General: Install fencing to line and grade indicated. Fencing shall conform to the applicable details shown. In lieu of accessory details shown, approved types standard with the manufacturer may be provided.
- B. Grading: Establish a graded fence line prior to the installation of fencing. The grade shall be such that a maximum clearance of 2 inches between the fence fabric and the ground shall be held along the line of the fence. The ground along the line of the fence shall be solid, and dirt fill used to establish the fence line shall be thoroughly compacted. Clear the fence line of all trees, brush, or other obstacles that will interfere with the fencing.
- C. Excavation: Excavate for concrete embedded items to dimensions specified in Table "I", except in bedrock. If bedrock is encountered before reaching the required depth, continue the excavation to the depth in Table "I" or 18 inches into the bedrock, whichever is less, and shall be a

**FENCE, CHAIN LINK**

**SECTION 02444 - PAGE 4**

minimum of 2 inches larger in diameter than the outside diameter of the post. Clear post holes of loose material. Dispose of waste material on the work site, as directed.

TABLE I

| <u>Types of Post</u> | <u>Fabric Height</u> | <u>Hole Diameter</u> | <u>Hole Depth</u> | <u>Post Embedment</u> |
|----------------------|----------------------|----------------------|-------------------|-----------------------|
| Line and Terminal    | 3'-0" to 4'-0"       | 6"                   | 26"               | 24"                   |
| Line and Terminal    | 5'-0"                | 8"                   | 32"               | 30"                   |
| Line and Terminal    | 6'-0" to 9'-0"       | 12"                  | 38"               | 36"                   |
| Line and Terminal    | 10'-0" to 12'-0"     | 18"                  | 38"               | 36"                   |
| Line and Terminal    | 13'-0" to 18'-0"     | 24"                  | 42"               | 40"                   |

D. Posts:

1. Post Spacing: Space posts at intervals not to exceed 10 feet center to center. Space posts as necessary for the size of gate openings. Straight runs between braced posts shall not exceed 500 feet.
2. Post Setting: Set posts plumb. After the posts have been set, fill holes with concrete, except that where bedrock is encountered fill the holes with grout. Compact concrete to eliminate voids and crown to shed water. Work grout into holes to eliminate voids and crown to shed water. Allow concrete and grout to set a minimum of 72 hours before further work is done on posts.
3. Posts Set in Concrete Slabs: Set into zinc-coated sleeves, previously set in the concrete slab, to a minimum depth of 12 inches. Set posts plumb and fill sleeve joints with lead or other approved material. Set posts for support of removable fence sections into sleeves that provide a tightsliding joint and hold the posts in aligned and plumbed positions without the use of lead or setting material.
4. Terminal Posts, Including End, Corner, Gate and Pull Posts: Set and space as specified herein- before, brace to the nearest post with a horizontal brace used as a compression member, and a diagonal truss rod and truss tightener used as a tension member. Consider changes in direction of fence line of 30 degrees or more as corners. Use pull posts at all abrupt changes in grade.

**FENCE, CHAIN LINK**

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**SECTION 02444 - PAGE 5**

- E. Tension Wire: Install prior to the installation of chain-link fabric and pull taut. Install bottom tension wire on all fences, and place within 8 inches of the bottom of the fabric line. Install top tension wire on fences where top rail is not required and place within 8 inches of the top of the fabric line.
- F. Fabric: Set not more than 2 inches above the ground, and install on the side of the fence as directed. Cut fabric at all terminal posts and attach each span independently thereon. Pull fabric taut and secure to each supporting post. Fastening to terminal posts shall be at 15 inches maximum intervals using stretcher bars and stretcher bar bands or other approved devices standard with the manufacturer. Rolls of fence fabric to be joined shall have a strand of fabric woven through the ends of rolls to form a continuous mesh.
- G. Extension Arms: Install arms as recommended by the manufacturer. In addition to manufacturer's standard connections, permanently fasten arms to posts to prevent easy removal with hand tools. Studs driven by low-velocity powder-actuated tools may be used with steel, wrought iron, ductile iron, or malleable iron. Studs driven by any powder-actuated tool will not be used with gray iron or other material that may be fractured.
- H. Barbed Wire: Install on arms above fence posts, and on arms or end frame extensions above gates. Pull each strand taut, and secure to each arm or end frame extension in a manner recommended by the manufacturer.
- I. Fastening: All fastening and hinge hardware shall be secured in place by peening or welding to allow proper operation of components, but to prevent disassembly of fencing or removal of gates. Fastenings, hardware, and all other connections which have been peened or welded shall be covered with a heated re-galvanizing alloy.
- J. Top Rails: Install prior to chain-link fabric and pass through intermediate post tops to form a continuous brace from end to end of each stretch of fence. Join top rails with expansion couplings spaced to adequately allow for expansion and contraction of fence. Attach top rail to each gate, pull, brace, corner and end post.

3.02 CLEANUP

Remove waste fencing materials and other debris from the fencing site.

**FENCE, CHAIN LINK**

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**SECTION 02444 - PAGE 6**

3.03 GROUNDING FOR FENCING

Ground as indicated in the construction drawings.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall furnish all labor, materials, equipment and incidentals necessary and place seed and maintain all seeded areas as shown on the Drawings and as specified herein including all areas disturbed by the Contractor's operations.
- B. Furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete lawn installation.
- C. All areas which have been graded or otherwise disturbed during construction and not occupied by structures, pavement, sidewalk or other improvements shall be planted or seeded as shown on the drawings or directed by Engineer.

1.02 SUBMITTALS

- A. Submit signed copies of vendor's statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination and weed seed. Statement shall certify that each container of seed delivered is fully labeled in accordance with Federal Seed Act and equals or exceeds specification requirements.
- B. Submit copies of invoices for all fertilizer lime and mulch used on project showing grade furnished. Each lot of fertilizer and lime is to be subject to sampling and testing, at discretion of Engineer, in accordance with current methods of Association of Official Agricultural Chemists. Upon completion of project, a final check of total quantities of fertilizer lime and mulch used will be made against total area seeded, and if minimum rates of application have not been met, Engineer may require distribution of additional quantities to make up minimum application specified.

1.02 RELATED WORK

- A. Section 02100: Site Preparation
- B. Section 02221: Excavation, Backfill, Fill and Grading for Pipe

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Fertilizer shall be a complete commercial fertilizer of 10-10-10 analysis, meeting applicable State and Federal requirements. Cyanamic compounds or hydrated lime are not permitted in mixed fertilizers. It shall be delivered to the site in the original unopened containers each showing the manufacturer's guaranteed analysis. Store fertilizer so that when used it shall be dry and free flowing. If liquid fertilizer is used, it shall be kept agitated during application and shall be applied in amounts sufficient to provide the same value of nutrients per acre as specified for dry fertilizer. If liquid fertilizer is used in a hydroseeder, Contractor shall apply material on a poundage basis and mix with the same volume of water as used with dry fertilizer.
  - 1. Hydroseeding is allowed only with the approval of the Authority Manager. Specifications for hydroseeding shall be submitted and approved by the Authority Manager. After the soil has been properly prepared, the seed shall be planted.
- B. Lime shall be agricultural grade granulated limestone containing not less than 85 percent calcium and magnesium carbonates, with 60 percent passing a 50 mesh sieve and 95 percent passing a 10 mesh sieve.
- C. Furnish grass seed consistent with season in which planting is undertaken in accordance with the Georgia Erosion Control Manual at a rate of 4 pounds per 1000 square feet. Seed shall be from the same or previous year's crop; each variety of seed shall have a percentage of germination not less than 90, a percentage purity of not less than 85, and shall have not more than one percent weed content. Furnish seed in sealed standard containers labeled with producer's name and seed analysis. Any seed that has become wet, moldy, or otherwise damaged in transit shall not be used. Provide vendor's certified statement of composition, mixture and percentages of purity, germination and weed seed for each grass seed species required.
- D. Furnish clean, seed-free hay or threshed straw of wheat or other locally available mulch material approved by Engineer. Do not use mulch that

**SECTION 02486 - PAGE 3**

contains excessive quantities of matured seeds of noxious weeds or other species that will grow or be detrimental to overseeding, or provide a menace to surrounding land. Mulch material which is fresh or excessively brittle, or which is decomposed and will smother or retard the growth of the grass shall not be used.

- E. Provide emulsified asphalt as per State DOT specifications.
- F. Water used shall be free of oil, acid, alkali, salt and other substances which are detrimental to the growth of the grass.
- G. The mixture for lawn areas shall consist of seed proportioned by weight as indicated on the drawings.

**PART 3 - EXECUTION**

**3.01 APPLICATION**

- A. Lime shall be applied at the rate of 50 pounds per 100 square feet, or as shown on the drawings.
- B. Fertilizer shall be applied at the rate of 50 pounds per 100 square feet, or as shown on the drawings.

**3.02 SITE PREPARATION**

- A. Soils shall be analyzed at an approved soils laboratory prior to all topsoiling and finish grading operations completing. Laboratory report shall be submitted with recommendations for pH adjustment by lime addition, total, nitrogen, total phosphorous and potassium needs as well as other trace elements required for the type of seeding and grassing to be undertaken.
- B. Work shall be arranged and coordinated such that preparation shall be limited to the areas which are to be seeded soon after preparation.
- C. Areas to be seeded shall be prepared in accordance with:
  - 1. Slopes 3:1 or flatter shall be loosened to a depth of approximately three inches by disking, harrowing or other approved methods.

2. Loosening of slopes steeper than 3:1 will not be required except to eliminate hard or crusted surfaces.
  3. Embankment slopes steeper than 3:1 and shoulders shall be loosened to a depth of approximately one inch. All clods, loose stones and other foreign materials larger than three inches in any dimension shall be removed and disposed of as directed by Engineer.
  4. All gullies, washes or disturbed areas that develop subsequent to final dressing shall be repaired before such areas are seeded.
  5. Topsoil shall be loosed and friable when seed is sown. Topsoil disturbed or lost due to erosion shall be replaced prior to seeding.
  6. Seeding shall not be permitted on hard or crushed soil surfaces.
- D. Loosen surface to a minimum depth of four inches. Remove stones, over one inch in any dimension, and sticks, roots, rubbish and other extraneous material.
- E. Furnish and spread lime uniformly over specified areas at specified rate. All lawn areas shall be plowed and cross plowed to a depth of six inches to ensure lime is thoroughly mixed through topsoil layer and worked into the soil. Soil shall be pulverized with a roller type pulverizer with four inch tines.

### 3.02 INSTALLATION

- A. The subgrade of all areas to be seeded shall be raked and all rubbish, sticks, roots and stones larger than 2 inches shall be removed.
- B. Lime shall be spread evenly over surface and thoroughly incorporated with loam by heavy raking to at least 2 inches deep.
- C. Fertilizer shall be uniformly spread and immediately mixed with the upper 2 inches of the soil.

**SECTION 02486 - PAGE 5**

- D. Immediately following this presentation the seed shall be uniformly applied and lightly raked into the surface. Lightly roll the surface and water with a fine spray. Seed shall be sown in a favorable season, as approved by the Owner's representative.
- E. The Contractor shall keep all seeded areas watered and in good condition, if and when necessary until a good, healthy, uniform growth is established over the entire area seeded, and shall maintain these areas in an approved condition until final acceptance of the Contract.
- F. On slopes, the Contractor shall provide against washouts. Any washout which occurs shall be re-graded and re-seeded at the Contractor's expense until good sod is established.
- G. The Contractor shall maintain the areas in grass in a neat manner by watering, mowing, raking clippings and leaves, and appurtenances until the project is completed.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The work covered by this Section consists of furnishing all materials, equipment, and labor and performing all operations in connection with the construction of the Silt Fence System in accordance with the Contract Documents.
- B. The surfaces to be protected shall be prepared and graded to the extent that they are normally stable in the absence of erosion forces. All stones, roots, and other waste material exposed on the slopes which could disturb the finished mat profile shall be removed. The fabric shall be positioned over these surfaces.

1.02 RELATED WORK

- A. Division 2 - Site Work.

1.03 QUALIFICATIONS

- A. Installation shall be by an experienced applicator approved by the manufacturer of the material supplied.
- B. Applicator shall have a minimum of one year experience.
- C. Submit written proof of qualifications to the Engineer.
- D. The woven fiber filter and appurtenances specified under this Section shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacture of the fabric furnished. The woven fiber filter and all related appurtenances shall be designed, constructed and installed with the best practices and methods.
- E. The woven fiber filter and appurtenances shall be as manufactured by Carthage Mills, Cincinnati, Ohio, Staff Industries, Inc., Upper Montclair, or approved equal.

1.04 SUBMITTALS

- A. Furnish sample 36 by 36 inches for each fabric, as specified in Section 01340.
- B. Final acceptance of fabric shall be contingent upon approval of samples.
- C. Furnish an affidavit that all materials comply with these Specification requirements.

1.05 DELIVERY AND STORAGE

- A. Prevent damage during delivery and handling.
- B. Store all fabric in undamaged condition as packaged by the manufacturer, with manufacturer's seals and labels intact.
- C. Store all materials in a clean, dry storage area.
- D. Do not store fabric in an upright position.
- E. Storage area temperature shall be maintained above 40 degrees F. with normal humidity.

PART 2 - PRODUCTS

2.01 FABRIC

- A. The filter fabric shall be designed to control water seepage of the fine particle and or soil without clogging under varying water flow conditions, thereby serving as a soil stabilizer.
- B. The filter fabric shall be chemically resistant to prolonged exposure to fresh water, and either alkaline or acidic soil conditions.

|                            |                       |
|----------------------------|-----------------------|
| C. Physical Properties:    | <u>TEST METHOD</u>    |
| 1. Color                   | Black -----           |
| 2. Weight, oz./sq. ft.     | 0.8 ASTM D-1910       |
| 3. Equivalent opening size | 70-100 CE-1310        |
| 4. % open area             | 4-10 CE-1310          |
| 5. Tensile Strength, #     | 400 x 280 ASTM D-1682 |

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|     |   |                         |
|-----|---|-------------------------|
| 6.  | Elongation, %   | 34 x 32 ASTM D-1682     |
| 7.  | Trapezoidal tear strength, #                            | 92x 40 ASTM D-2263      |
| 8.  | Mullen burst, psi                                       | 510 ASTM D-751          |
| 9.  | Puncture Strength, #                                    | 150 ASTM D-751-M        |
| 10. | Abrasion resistance                                     | ASTM D-01175-71         |
|     | Abraded strength, #                                     | 80 ASTM D-1682          |
| 11. | Weather-Ometer strength retention, %                    | 90 ASTM E-42-69         |
| 12. | Water permeability, water flow rates*, milliliters/min. |                         |
|     | 6" head   | 460-520 Canvas Products |
|     | 8" head   | 620-760 Assn.Intern'l   |
|     | 36" head  | 2510-2790 Test Method   |
|     |   | (for canvas)            |

\*Water flow perpendicular to fabric

- D. The upper level of the fabric form work edges shall be structured so as to accommodate the type of anchorage to be utilized at that point.
- E. Individual mill-width panels shall be cut to suitable lengths, and the two layers of fabric separately jointed, edge-to-edge, by means of heavy, double-stitched nylon thread. The tensile strength of stitched joints shall not be less than 100 lbs/inch.

**PART 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Installation instructions shall be supplied by the manufacturer. The fabric shall be applied in accordance with the manufacturer's recommendations.

**END OF SECTION**

**PRE-CAST CONCRETE MANHOLES,  
FRAMES, AND COVERS**

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**SECTION 02720 - PAGE 1**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The contractor shall furnish all materials, labor, and equipment and construct manholes consisting of precast section as shown on the drawings and as specified herein.
- B. The manholes shall have an invert channel shaped to correspond with the lower half of the pipe. The top of the shelf shall be at the elevation indicated and shall be sloped to drain toward the flowing-through channel.
- C. The forms, dimensions, concrete, and construction methods shall be approved in advance of construction.
- D. All work shall be as specified herein and conform to the State of Georgia Department of Transportation Standards.

1.02 RELATED WORK

- A. Section 02221: Excavation, backfill, fill, and grading for pipe.

1.03 SUBMITTALS

- A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval representative of the Owner. Such inspection may be made at the place of manufacture, or at the site after delivery, or at both places, and the sections shall be subject to rejection at any time on account of failure to meet any of the specification requirements; even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the job shall be marked for identification and shall be removed from the job at once.
- B. At the time of inspection, the sections will be carefully examined for compliance with the ASTM designation specified below and these specifications, and with the approved manufacturer's drawing. All sections shall be inspected for general appearance, dimension, "scratch-

**PRE-CAST CONCRETE MANHOLES,  
FRAMES, AND COVERS**

**SECTION 02720 - PAGE 2**

strength", blisters, cracks, roughness, soundness. The surface shall be dense and close-textured.

- C. Imperfections may be repaired, subject to the approval after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of seven days and 5,000 psi at the end of 28 days, when tested in 3" x 6" cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs.

**PART 2 - PRODUCTS**

**2.01 PRECAST CONCRETE SECTIONS**

- A. Precast concrete manhole barrel and eccentric top sections shall conform to the specifications for Precast Reinforced Concrete Manhole Sections, ASTM Designation C478, except as otherwise specified below. The method of construction shall conform to the detailed drawings appended to these specifications and the following additional requirements:

- 1. The minimum wall thickness for the various size barrel sections shall be as listed below.

Inside Diameter of Barrel    Minimum Wall Thickness

|     |    |
|-----|----|
| 48" | 5" |
| 60" | 6" |
| 72" | 7" |

- 2. Barrel section shall have tongue and groove joints. Joints shall have round rubber gaskets set in specifically provided indentations. The round rubber "O" ring gasket shall conform to ASTM C443 standard specifications.
- 3. Type II cement shall be used except as otherwise approved.
- 4. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of each precast section.
- 5. Sections shall be cured by an approved method and shall not be shipped until at least five days after having been fabricated.

**PRE-CAST CONCRETE MANHOLES,  
FRAMES, AND COVERS**

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**SECTION 02720 - PAGE 3**

6. Top sections shall be eccentric except that precast concrete slabs shall be used where cover over the top of the pipe is less than 4 feet for all manholes.
7. Precast concrete slabs over top section, where required, shall be capable of supporting the overburden plus a live load equivalent to AASHTO H-20 loading.
8. The tops of bases shall be suitable shaped to make the precast barrel section.

2.02 FABRICATED ITEMS

A. Manhole Frames and Covers:

1. Manhole frames and cover castings shall be good quality, strong, tough, even-grained, cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and subject to hammer inspection. Manhole covers and frame seats shall be machine true to a plane surface. Before shipment from the factory, casting shall be given one coat of coal tar pitch varnish which shall present a coating which is smooth and tough, but not brittle. Sizes shall be as shown on the drawings. Cast iron shall be gray iron casting conforming to the AASHTO Designation M-105 and shall be Class No. 30.
2. Frames and covers shall have a minimum total weight of 460 pounds. Covers shall have a weight not less than 150 pounds.
3. Frames and covers shall be of the "Type W" unless noted otherwise on the drawings. All covers shall have the words "STORM SEWER" in raised 2 inch letters cast into the top. Type "W" shall be the waterproof frame and cover with bolted lid, 1/8 inch neoprene gasket and sufficient counter sunk hexagonal-head cap screws cover to frame to produce a waterproof seal.
4. All manhole frames and covers shall have a minimum of 22 inches clear opening between the innermost ring. The lower flange of the frame shall be at least 6 to 8 inches. The lower flange of the frame shall be at least 6 inches in width. All covers shall be supplied with two concealed watertight pick holes.

B. Manhole Steps:

**PRE-CAST CONCRETE MANHOLES,  
FRAMES, AND COVERS**

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**SECTION 02720 - PAGE 4**

1. Manhole steps shall be Clow Corporation F-3650 or approved equal.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Manholes and other precast structures shall be constructed to the dimensions as shown on the drawings and as specified in these specifications.
- B. The base shall be cast-in-place concrete as specified in Division 3 placed on a thoroughly compacted gravel subbase. The tops of the cast-in-place bases shall be shaped to match the precast barrel section, and shall be adjusted in grade so that the top of the dome section is at the approximately correct elevation.
- C. Precast bases, conforming to all requirements of ASTM C478 and above listed requirements for precast sections, may be used.
- D. Precast concrete structure sections shall be set so as to be vertical and with sections in true alignment with a 1/4" maximum tolerance to be allowed. The outside and inside joint shall be filled with a comparatively dry mortar (one part cement to two parts sand) and finished flush with the adjoining surfaces. Allow joints to set for 24 hours before backfilling. Backfilling shall be done in a careful manner, bringing the fill up evenly on all sides. If leaks appear in the structures, the inside joints shall be caulked with lead wool. The contractor shall install the precast section in a manner that will result in a watertight joint.
- E. Holes in the concrete pipe sections required for handling or other purposes shall be plugged with a non-shrinking grout or by grout in combination with concrete plugs.
- F. Where holes cut in the precast sections to accommodate pipes, cutting shall be done prior to setting them in place to prevent any subsequent jarring which may loosen the mortar joints.

**PRE-CAST CONCRETE MANHOLES,  
FRAMES, AND COVERS**

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**SECTION 02720 - PAGE 5**

- G. Cast iron frames shall be placed, shimmed, and set in portland cement mortar to the specified grade.
- H. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color texture and free from defects impairing strength or durability.
- I. All steel or iron surfaces to come in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bituminous trowelling mastic applied in accordance with the manufacturer's instructions prior to installation.

END OF SECTION

## MISCELLANEOUS WORK AND CLEAN-UP

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### SECTION 02999 - PAGE 1

#### PART 1 – GENERAL

##### 1.01 SCOPE OF WORK

- A. This section includes operations that cannot be specified in detail, as separate items but can be sufficiently described as to the kind and extent of work involved. Furnish all labor, materials, equipment and incidentals to complete the work under this Section.
- B. The work of this Section includes, but is not limited to, the following:
  - 1. Restoring easements and rights of way.
  - 2. Concrete encasements.
  - 3. Cleaning up.
  - 4. Incidental work.

#### PART 2 - PRODUCTS

##### 2.01 MATERIALS

Materials required for this section shall be of the same quality as materials that are to be restored. Where possible, reuse existing materials that are removed and then replaced.

#### PART 3 - EXECUTION

##### 3.01 RESTORING OF SIDEWALKS, DRIVEWAYS, CURBING, AND STREETS

- A. Existing public and private sidewalks, driveways, curbs, and street paving disturbed shall be replaced. Paved sidewalks, drives, and street shall be repaved to the limits and thickness existing prior to construction. Gravel and asphalt drives shall be replaced and regraded.
- B. Existing curbing shall be protected. If necessary, curbing shall be removed and replaced after backfilling. Curbing which is damaged during construction shall be replaced with curbing of equal quality and dimension.

## MISCELLANEOUS WORK AND CLEAN-UP

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### SECTION 02999 - PAGE 2

#### 3.02 CROSSING UTILITIES

- A. This item shall include any extra work required in crossing culverts, water courses, drains, water mains, and other utilities, including all sheeting and bracing, extra excavation and backfill, or any other work required for the crossing, whether or not shown on the drawings.
- B. In no case shall there be less than 0.3 feet between any two pipelines and structures unless otherwise noted on the construction drawings.
- C. Where sewers cross over water mains, they shall be encased in 6" minimum of concrete. Encasement shall be a minimum 5'-0" in length.

#### 3.03 RELOCATIONS OF EXISTING GAS LINES

Notify the proper authority of the utility involved when relocation of gas lines is required. Coordinate all work by the utility so that the progress of construction will not be hampered.

#### 3.04 RESTORING THE EASEMENTS AND RIGHTS-OF-WAY

- A. Portions of the Construction may occur in easements through private property. The Contractor shall be responsible for all damage to private property due to his operations. He shall protect from injury all walls, fences, cultivated shrubbery, pavement, underground facilities, such as water pipe, or other utilities that may be encountered along the easement. If removal and replacement are required, it shall be done in a workmanlike manner so that the replacement is equivalent to that which existed prior to construction.
- B. Existing lawn surfaces damaged by the construction shall be replaced. Cut and replace the sod, or restore the areas with an equivalent depth and quality of loam, seed and fertilizer. These areas shall be maintained and reseeded, if necessary, until all work under this Contract has been completed and accepted.

## MISCELLANEOUS WORK AND CLEAN-UP

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SECTION 02999 - PAGE 3

### 3.05 CLEANING UP

Remove all construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations and shall render the site of the work in a neat and orderly condition. Any salvaged material shall be turned over to Owner for storage as directed. Heavy chlorinated water shall not be discharged into state waters without first reducing the chlorine content to below detectable limits.

### 3.06 INCIDENTAL WORK

Do all incidental work not otherwise specified, but obviously necessary for the proper completion of the contract as specified and as shown on the drawings.

END OF SECTION

***Division 3***

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**Concrete**

## CONCRETE FORMWORK

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### SECTION 03100 - PAGE 1

#### PART 1 – GENERAL

##### 1.01 WORK INCLUDED

- A. The work covered by this Section shall consist of furnishing all labor, equipment and materials required to furnish and install all formwork required for cast-in-place concrete. Formwork design, engineering, and construction shall be the responsibility of the Contractor even though it is subject to review. Design of formwork shall be prepared and sealed by a registered structural engineer.

##### 1.02 RELATED WORK

- A. Division 1: General Requirements.
- B. Section 03200: Concrete Reinforcement.
- C. Division 3: Concrete.

##### 1.03 REFERENCE STANDARDS

- A. American Concrete Institute (ACI) Standard Specification 347, "Recommended Practice for Concrete Formwork", latest edition.
- B. American Plywood Association (APA Form V 345, latest edition, "Plywood for Concrete Forming").

##### 1.04 SUBMITTALS

- A. None are required except for premature removal of forms and shores.

##### 1.05 QUALITY ASSURANCE

- A. General design criteria shall conform to ACI 347.
- B. Design criteria for plywood shall conform to APA Form V 345.
- C. Allowable tolerances shall conform to ACI 347.

## CONCRETE FORMWORK

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### SECTION 03100 - PAGE 2

#### 1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Upon delivery to the job site, place materials in an area protected from the weather.
- B. Store materials above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation.
- C. Materials shall be handled in a manner to prevent damage.

#### PART 2 – PRODUCTS

##### 2.01 UNEXPOSED FINISH

- A. Forms shall be wood except where other materials are reviewed before use.
- B. Lumber shall be #2 common or better, dressed 4 sides, not less than 3/4-inch thick. Plywood shall be Exterior Plyform B-B, Class 1.

##### 2.02 EXPOSED FINISH

- A. Forms, unless otherwise specified, shall be acceptable panel-type material, to form continuous, straight, smooth exposed surfaces; B-B Plyform, sanded, Class 1, EXT-APA Grade trademarked. Treat face and edges with form release coating.
- B. Panels shall be of the largest practical size and of sufficient strength to withstand the pressure of concrete without bow or deflection.

##### 2.03 FORM-RELEASE COATING

- A. Use a proprietary form-release coating which will not bond with, stain, or in any way adversely affect concrete surfaces. The residual coating shall be compatible with the subsequent finishing, and shall be non-toxic.

##### 2.04 FORM TIES

- A. Form ties shall be free of devices which will leave a hole or depression on the surfaces of the concrete larger than one inch in diameter. The ties shall be such that after forms and tie projections have been removed, no

## CONCRETE FORMWORK

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### SECTION 03100 - PAGE 3

metal will be within one inch of the surfaces. Wire or strap ties so utilized that they would be projecting from the hardened concrete will not be permitted. Temporary through-bolts in permanently embedded, full length, plastic sleeves shall not be used for concrete to be exposed to view.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Construct all forms in accordance with ACI Standard Specification 347.
- B. Forms shall conform to the shape, lines, grades and dimensions indicated on the drawings. Forms shall be sufficiently tight to prevent leakage of mortar and properly braced to maintain position and shape. Forms shall not deflect or deform under the fluid pressure or weight of the liquid concrete and construction loads. Except where noted otherwise on the drawings, chamfer strips shall be placed in exterior corners of forms for all concrete work; where the size is not indicated on the drawings, use 3/4" x 3/4" chamfers.
- C. Joints in forms shall be butted tightly and bear on solid construction. Where new concrete is placed above a previous placing, the joint between new and old work and the face of each concrete surface shall be exactly in line.
- D. Form sides of concrete footings where earth is too unstable to suitably serve as a form.
- E. Shores shall be used where necessary. Completed concrete members which will be subjected to additional loads during construction shall be adequately shored to protect the members from distortion and damage.
- F. Forms for exposed surfaces shall be coated with form-release coating which shall be applied before reinforcing steel is placed. Any surplus coating on the form surface shall be removed. Wood forms for unexposed surfaces may be thoroughly wetted with water or oiled in lieu of using the proprietary form-release coating. During freezing weather do not use coatings containing water.
- G. Forms shall be constructed so they can be removed readily without hammering, wedging or prying against the concrete. Suitable openings shall be provided at the base of all wall and column forms for cleaning and

## CONCRETE FORMWORK

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### SECTION 03100 - PAGE 4

inspection and kept open until just before concrete is placed.

- H. Coordinate Location: Consult with all other trades and ascertain whether sleeves, anchors, etc., are required and assist those trades in setting same.
- I. Coordinate Pipes and Ducts: Obtain from the various trades the sizes and locations of all pipes or ducts passing through concrete and provide proper formwork to leave openings to accommodate these installations.
- J. Form-Joint Sealers: Where forms can not be constructed to butt tightly at joints and at ends of forms abutting an irregular surface at the bottom of columns, walls, etc., use resilient foam rubber strips or similar suitable material to avoid leakage of concrete at the joint.

#### 3.02 REMOVAL OF FORMS

- A. Remove forms in a manner that will prevent injury to concrete. Immediately after the forms are removed, all damaged or imperfect work shall be patched or, if the work is severely damaged or unacceptable, it shall be rebuilt. Do not repair honeycombed areas until inspection by the Engineer. The grouting or plugging of form tie holes is specified in Section 03300, Cast-In Place Concrete and Grout.
- B. Do not remove supporting forms or shoring until members have acquired sufficient strength to safely support their weight and any applied load. Unless test cylinders warrant other procedure, do not remove forms before the elapsed time shown in the following schedule.

- |    |  |          |
|----|--|----------|
| 1. | Columns, pedestals, walls,<br>and other vertical faces,<br>not supporting other work | 27 hours |
| 2. | Suspended slabs and beams  | 28 days* |

- \* This elapsed time may be reduced upon request by the Contractor, providing sufficient strength is demonstrated by field-cured test cylinders, and by a structural analysis considering the proposed loads in relation to the field-cured strengths, the strength of the remaining forming and shoring system, and any proposed re-shoring. All of the above items shall be reviewed before any premature removal of forms and shores is done.

## CONCRETE FORMWORK

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### SECTION 03100 - PAGE 5

Even though early removal of forms is allowed, no concrete member shall be subjected to its design loads and forces until the specified 28-day strength has been attained.

- C. Whenever the formwork is removed during the curing period, the exposed concrete shall be cured by one of the methods specified in Section 03300, Cast-In-Place Concrete and Grout.
- D. Forms to be reused shall be thoroughly cleaned and repaired. Split, frayed, delaminated, or otherwise damaged forms shall not be used.
- E. All portions of wood forms shall be completely removed from concrete.

#### 3.03 DEFECTIVE WORK

- A. Should misalignment of forms or screeds, excessive deflection of forms or displacement of reinforcement occur during concrete placing, corrective measures shall be immediately made to insure acceptable lines and surface to required dimensions and cross sections.
- B. If any forms bulge or show excessive deflection, the concrete shall be removed and the work rebuilt, or other corrective measures taken as directed.

END OF SECTION

## CONCRETE REINFORCEMENT

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### SECTION 03200 - PAGE 1

#### PART 1 - GENERAL

##### 1.01 WORK INCLUDED

- A. The work covered by this Section shall consist of furnishing all labor, equipment and materials required to furnish and install all concrete reinforcement and bar supports as specified herein and shown on the Drawings.

##### 1.02 RELATED WORK

- A. Division 1: General Requirements.
- B. Division 3: Concrete

##### 1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM).
- B. American Concrete Institute (ACI).
  - 1. Building Code Requirements for Reinforced Concrete (ACI 318).
  - 2. Manual of Standard Practice for Detailing Reinforced Concrete Structures (ACI 315).
- C. Concrete Reinforcing Steel Institute (CRSI).
  - 1. Manual of Standard Practice.

##### 1.04 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01340, Shop Drawings, Product Data and Samples.
- B. Placing drawings and bar lists shall be in accordance with the latest revision of ACI 315. Shop drawings shall include bar supports.
- C. Submit a certified copy of mill test certificates showing physical and chemical analysis of the steel. The mill tests shall not have been made over 90 days prior to submittal.

## CONCRETE REINFORCEMENT

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### SECTION 03200 - PAGE 2

#### 1.05 STORAGE

- A. Store reinforcement above ground on skids or other supports and in a manner to prevent distortion or surface deterioration of the reinforcing bars.

#### PART 2 -PRODUCTS

#### 2.01 REINFORCING STEEL

- A. Reinforcing bars shall be new ASTM A-615 Grade 60.

#### 2.02 WELDED WIRE FABRIC

- A. Welded wire fabric shall be new, conform to ASTM A-185, and shall not have more rust than a light, tightly adhered coating.

#### 2.03 TIE WIRE

- A. Tie wire shall be black annealed wire, 16 gauge or heavier.

#### 2.04 BAR SUPPORTS

- A. All bar supports shall conform to the CRSI," Manual of Standard Practice." All supports shall be 'Class C - Plastic Protected', except that 'Class A - Bright Basic' may be used where bar supports are not within one inch from the face of concrete, or for unexposed surfaces of concrete inside conditioned-air portions of buildings.

#### PART 3 - EXECUTION

#### 3.01 FABRICATION

- A. All reinforcing shall be fabricated in accordance with the CRSI "Manual of Standard Practice", shall conform accurately to the dimensions shown on the drawings and within the fabricating tolerances shown in the CRSI "Manual of Standard Practice". Reinforcing shall not be fabricated until the shop drawings have been reviewed. Reinforcing bars shall not be fabricated in the field unless shop quality equipment is used and samples of field fabricated bends and hooks are reviewed before the steel is fabricated.

## CONCRETE REINFORCEMENT

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### SECTION 03200 - PAGE 3

- B. Reinforcing bars shall not be bent or straightened in a manner that will injure the material.
- C. All hooks shall conform to bend dimensions defined as "ACI Standard Hooks" in the CRSI "Manual of Standard Practice."
- D. Splices in reinforcing bars are not permitted except in bars noted as continuous (cont.) on the plans. Minimum splice lengths are noted on the plans.

#### 3.02 PLACEMENT

- A. The placement of reinforcement and placement tolerances shall conform to the drawings, the CRSI "Manual of Standard Practice," and the reviewed placing drawings.
- B. All bars shall be securely tied to prevent displacement during the concreting operation and all dowels shall be wired in place before depositing concrete. Tall dowels at walls and columns shall be tied and suitably braced at the top as well as at the bottom.
- C. At the time concrete is placed, metal reinforcement shall be free of hardened concrete, loose rust, mud, oil, or other nonmetallic coatings that adversely affect bonding capacity.
- D. Bars partially embedded in concrete shall not be field bent or straightened except where noted on the drawings.
- E. Except where noted on the drawings, reinforcing steel shall not be welded.
- F. Welded wire fabric splices and sidelaps shall be wire tied and shall be not less than one mesh space. For slabs on earth, support welded wire fabric on concrete supports or chairs with sand plates. Use methods as necessary to maintain fabric in the specified position.
- G. Splices in reinforcing steel shall be as shown on the drawings. Where splice lengths are not shown, use ACI-318 "Class C" tension splice lengths (use splice length for "Top Bars" for horizontal bars in concrete sections having a height greater than 12 inches, and use splice length for "Regular Bars" for vertical bars and horizontal bars in concrete sections

## CONCRETE REINFORCEMENT

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### SECTION 03200 - PAGE 4

less than 12 inches in height).

- H. The dimensions of concrete protection over reinforcing steel shall be as shown on the drawings.

#### 3.03 INSPECTION

- A. Allow sufficient time for completion of the placing of all of the reinforcing for the proposed concrete placement, for allowing inspection, for correcting possible placement errors, and for closing of inspection openings in the forms. The reinforcing steel placement schedule shall allow for the above to be completed by the day before casting the concrete.
- B. Request inspection of the reinforcing steel, at least 24 hours prior to scheduled closing of wall forms and inspection holes. No concrete shall be placed until the placement of the reinforcing has been inspected. Such inspection shall not relieve the Contractor of his responsibility for compliance with the Contract Documents.

END OF SECTION

**CAST-IN-PLACE CONCRETE  
AND GROUT**

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**SECTION 03300 - PAGE 1**

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. Provide all plant, labor, equipment and materials for and perform all operations in connection with cast-in-place concrete work and grout as required by Drawings, and as herein specified.
- B. Coordinate work of all trades to insure that all embedded items are properly installed. Set items not placed in forms in accordance with templates and instructions specified under other Sections.

1.02 RELATED WORK

- A. Division 1: General Requirements.
- B. Division 3: Concrete.
- C. Section 01410: Testing Laboratory Services

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
- B. American Concrete Institute (ACI)
  - 1. Recommended Practices for Hot-Weather Concreting (ACI-305).
  - 2. Recommended Practices for Cold-Weather Concreting (ACI-306).
  - 3. ACI Manual of Concrete Inspection (ACI-SP-2).

1.04 SUBMITTALS

- A. Shop drawings and product data shall be submitted in accordance with the General Requirements section.
  - 1. Submit product data on all admixtures, fly ash, curing compounds, hardeners, waterstops, expansion joint materials and similar items.

**CAST-IN-PLACE CONCRETE  
AND GROUT**

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**SECTION 03300 - PAGE 2**

2. Submit shop drawings for construction joints and other types of joints in concrete work as specified hereinafter.
3. Submit data on concrete aggregates including type, source, gradation, fineness modulus for fine aggregate, and certified statements that the materials are in conformance with ASTM C-33.
4. Submit concrete mix designs as hereinafter specified.

**PART 2 -PRODUCTS**

**2.01 MATERIALS**

- A. Water: Potable, fresh, clean and free from deleterious amounts of oils, acids, alkalis and organic matter.
- B. Portland Cement: ASTM C-150, use Type I or Type II for all concrete except as specified hereinafter. Use Type II for all concrete in structures containing raw/untreated domestic sewage; the specific structures requiring the use of Type II cement shall be as shown in the General Structural Notes on the drawings. Type III cement may be used instead of Type I providing the Engineer is notified in advance. The use of Type III cement modifies only those portions of the specifications pertaining to strength gain.
- C. Fly Ash: ASTM C-18 except that the loss-on-ignition shall not exceed 6.0 %.
- D. Aggregates:
  1. Aggregates for concrete: ASTM C-33.
  2. Fine aggregate: Natural sand having a fineness modulus of not less than 2.30 nor more than 3.00; variation in fineness modulus shall be limited to 0.20 from the average of all tests.
  3. Coarse aggregate: Washed gravel or crushed stone consisting of hard, strong, durable, and uncoated particles; and shall contain neither vegetable matter nor soft, friable, thin, elongated particles in quantities considered deleterious by the Engineer. Gradation shall be Size No. 57, Table II of ASTM C-33.

**CAST-IN-PLACE CONCRETE  
AND GROUT**

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**SECTION 03300 - PAGE 3**

- E. Joint Filler: Premolded expansion joint filler conforming to ASTM D1751.
- F. Curing Compound: A curing, hardening and dustproofing chemical reactive compound with a base composition of sodium silicates; "Acuricon" by The Anti-Hydro Company, "Cure-Hard" by W.R. Meadows, Inc., "Cure & Hard" by Symons Corporation, or equal.
- G. Admixtures:
1. For concrete placed when the air temperature is less than 75 degrees F., use a water reducing, densifying admixture in all concrete: "Eucon WR-75" by the Euclid Chemical Company; "WR-77" by Chem-Masters Corp.; "PSI Normal" by Gifford-Hill & Company, Inc.; "Plastocrete, Sikamix 161-Normal" by Sika Corporation, or equal, conforming to ASTM C-494, Type A.
  2. For concrete placed when the air temperature is above 75 degrees F., use a water reducing, densifying admixture as specified above and a suitable retarder, or use a water reducing, densifying admixture similar to those specified above but containing a retarder, and conforming to ASTM C-494, Type D.
  3. All classes of concrete except Class C shall be air entrained. Use an air entraining agent conforming to ASTM C-260; "Darex AEA", as manufactured by Dewey & Almy Chemical Division of W.R. Grace & Co., "Sika Aer" by Sika Chemical Corp., "Aircon" by Union Carbide Corp., or equal, in the amounts necessary to give required percentage of air entrainment. Agent used shall be compatible with other admixtures used and amount of air that will be entrained by other admixtures shall be taken into consideration.
  4. Calcium Chloride: Calcium Chloride or admixtures containing more than 0.1% chloride ions are not permitted.
  5. High-Range Water Reducing Admixtures (superplasticizers): Eucon 37 by the Euclid Chemical Company or equal, conforming to ASTM C-494, Type F or G.

**CAST-IN-PLACE CONCRETE  
AND GROUT**

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**SECTION 03300 - PAGE 4**

6. Non-Chloride Accelerator: Accelguard 80 by the Euclid Chemical Company, Darex Set Accelerator by W.R. Grace, or equal, conforming to ASTM C-494, Type C or E. The use of a set-accelerating admixture is optional.
  7. Vary the amount of admixtures used to suit job conditions such as temperature, rate of placing, etc., in accordance with the manufacturer's recommendations.
  8. The brand names and amounts of admixtures shall be shown on the concrete design mixes.
- H. Waterstops: Strip type as shown on the drawings, extruded from plasticized polyvinyl chloride as manufactured by Water Seals, Inc., Chicago, Illinois, or equal.

2.02 CONCRETE CHARACTERISTICS

- A. Usage:
1. Class A-1 concrete (with Type I cement) shall be used for all concrete work not specified or indicated otherwise.
  2. Class A-2 concrete (with Type II cement) shall be used for structures containing raw/untreated domestic sewage, as noted on the drawings.
  3. Class B concrete shall be used for exterior concrete pads, walkway foundations, fence post foundations, and as noted on the drawings.
  4. Class C concrete shall be used for concrete thrust blocks, underground pipe encasement, and as noted on the drawings.
  5. Concrete used for secondary pour fill to provide sloping functional surfaces at the bottom of reinforced concrete liquid-holding tanks, flumes and troughs shall have the strength of Class B concrete. Where placement is by methods other than pumping, reduce water content to provide a stiff mix suitable for the indicated slope. Where accessibility is difficult for normal placement methods and

**CAST-IN-PLACE CONCRETE  
 AND GROUT**

**SECTION 03300 - PAGE 5**

a pump is used, add a high-range water reducing admixture to a Class B mix in the amount recommended by the manufacturer.

B. Conform with all of the following requirements:

| Min<br>28-Day<br>Strength<br>Class | Min<br>7-Day<br>Strength<br>PSI* | Max<br>Water<br>Cement Ratio<br>PSI*** | Min<br>Cement<br>Content<br>Lb./Lb.** | Type<br>Bags/Cu.Yd. | Cement  |
|------------------------------------|----------------------------------|--|---------------------------------------|---------------------|---------|
| A-1                                | 4,000                            | ***                                    | 0.50                                  | 5.70                | Type I  |
| A-2                                | 4,000                            | ***                                    | 0.45                                  | 5.70                | Type II |
| B                                  | 3,000                            | ***                                    | 0.62                                  | 5.00                | Type I  |
| C                                  | 1,500                            | -                                      | -                                     | -                   | Type I  |

\* Ultimate compressive strength when tested in accordance with Standard Method of Test for Compression of Molded Concrete Cylinders ASTM C 39 with cylinders having been made and cured in accordance with Standard Method of Making and Curing Concrete Compression Specimens in Field, ASTM C 31.

\*\* Including free moisture on surface of aggregate to be included in mix.

\*\*\* 90 percent of the 7-day tests of cylinder test reports reviewed with the submitted design mix.

C. Slump: Except where placement conditions warrant a stiffer mix or where a high-range water reducing admixture is used, slump for all concrete shall be 4" ± 1", and shall not exceed 5". Measure slump in accordance with ASTM C 143. Make slump tests each time cylinders are made, and when directed to verify slump of other batches. Adjust water content as required to maintain slump within specified limits.

D. For air entraining concrete, entrained air content shall range between 4% and 6% as indicated by tests specified herein.

**CAST-IN-PLACE CONCRETE  
AND GROUT**

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**SECTION 03300 - PAGE 6**

PART 3 - EXECUTION

3.01 PROPORTIONS AND DESIGN OF CONCRETE MIXES

- A. At least 10 days before any concrete is placed on the job, provide design mixes from previous jobs for identical concrete prepared by the ready-mix company or an acceptable testing laboratory. Mix designs shall be supported by records of cylinder breaks that clearly represent the design mixes and were made from concrete having a slump near the high end of the specified slump range. The cylinder breaks shall indicate strengths averaging at least 20 percent higher than the minimum specified. For these preliminary tests provide results of 3 cylinders at age of 7 days and 3 cylinders at age 28 days. Testing and design mix costs under this Article shall be paid by the Contractor. Do not change design mix or ready-mix supplier without approval of the Engineer.
- B. Fly ash may be used in any class of concrete. The maximum amount of fly ash shall be 25% times the weight of cement with an absolute maximum of 120 pounds of fly ash per cubic yard of concrete.
- C. Where necessary to comply with the maximum specified water/cement ratios and provide workable slumps as specified, adjust the amount of water-reducing admixtures or use a superplasticizer admixture.
- D. Acceptance of such preliminary tests will be only a check to assist Contractor in his compliance with specification requirements and will be contingent upon acceptance of final tests of the concrete used in the project will be made during construction by a testing retained by the Contractor.
- E. Concrete used in the work shall have the same characteristics and proportions as the reviewed design mixes, and shall consistently have a compressive strength higher than the minimum strengths specified.
- F. If, during progress of work, tests indicate concrete placed in work is not in accordance with these Specifications, the Engineer may order additional testing and/or full-time inspection of batching at the expense of the Contractor, or removal of any such concrete, and may order changes in concrete materials or their proportions for subsequent work to secure concrete as specified. If so ordered, Contractor shall remove unacceptable concrete from structure and shall replace it with concrete meeting

**CAST-IN-PLACE CONCRETE  
AND GROUT**

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**SECTION 03300 - PAGE 7**

requirements of these Specifications. Removal and replacement of concrete shall be at the Contractor's expense, and he will not be reimbursed for such expense by the Owner. Replace concrete in a manner acceptable to the Engineer.

**3.02 CONCRETE MIXING**

- A. Ready-Mix Concrete: Concrete shall be ready-mixed. Mix and deliver ready-mixed concrete in accordance with requirements of ASTM C 94. Add no water to concrete after it leaves plant except where part of design water was purposely omitted at the plant. Add any such design water only in the presence of the Engineer or laboratory representative. Make test cylinders and slump tests only after all such water has been added and incorporated into the mix.
- B. Neither speed of any mixer nor quantity of material loaded into any mixer shall exceed recommendations of mixer manufacturer. Excessive overmixing, requiring additions of water to preserve required consistency will be cause for rejection of batch. Concrete remaining in a transit mixer or agitator truck more than 90 minutes after water was introduced will not be acceptable for use in work. Immediately remove such concrete from site.
- C. Batch Truck Tickets: Accompany each batch of concrete delivered to the site with a trip ticket that will indicate the following information:
  - 1. Time that water was added to the mix.
  - 2. Class of concrete and 28-day design strength per specifications and supplier's design mix number referenced from the design mix, or all of the following:
    - a. Type of cement, if other than Type I.
    - b. Quantity of cement per cubic yard of concrete.
    - c. Admixtures and amounts used.
    - d. Amount of fly ash, if used.
    - e. 28-day design strength.
  - 3. Planned slump.
  - 4. Name of Supplier.

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5. Date.
6. Make these tickets available to Engineer and laboratory representative for inspection upon request.

**3.03 TESTING**

- A. Concrete testing shall be performed by an independent testing agency selected and paid by the Contractor in accordance with Section 01410.
- B. The laboratory representative shall responsibly observe all cast-in-place concrete work to insure conformance to Specifications pertaining to quality of concrete. He shall be present during the placement of all concrete. He shall have free access to all points where concrete materials are stored, proportioned, mixed and placed. Any materials, equipment and methods used shall be subject to his inspection, test and acceptance.
- C. Laboratory Representative's Duties:
  1. Check trip tickets for every truck to ensure that the mix is as specified for the proposed use.
  2. Make a slump test with each set of cylinders made and as often as conditions indicate.
  3. Make and store test cylinders described below.
  4. Keep accurate records of the location in the structure represented by the tests.
  5. Make tests for amount of air in concrete each time cylinders are taken. Tests will be conducted in accordance with ASTM C 231.
  6. Reject concrete that has not been placed within 90 minutes after the water was added to the other ingredients, concrete not having the specified air content, or concrete that has a slump greater than specified, or notify the Engineer immediately so the Engineer can reject the concrete.

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7. Record the temperature of the air and of the concrete for each ready-mix truck when the ambient temperature is above 90 degrees F. or below 40 degrees F.

D. Cylinder Tests:

1. For initial concrete placements (until the results of two sets of 28-day cylinder tests for each class of concrete are known), a set of 6 cylinders shall be obtained for each 50 cubic yards or fraction thereof for each class of concrete placed each day. Two cylinders shall be tested at seven days, two at 28 days, and two at 56 days.
2. For subsequent concrete placements of each class, providing the concrete placed in the job has been acceptable, reduce the number of cylinders per set to four and omit the 56-day tests.
3. The laboratory shall verbally notify the Engineer promptly of any cylinder break that indicates weaker than specified concrete.

- E. Copies of any tests of any nature made by the laboratory representative will be sent simultaneously to Engineer, Contractor, Concrete Supplier and Owner.

3.04 INSPECTION

Notify Engineer at least 24 hours prior to placing concrete so required observations may be made. Also see Article 3.3, Inspection, in Section 03200, Concrete Reinforcement.

3.05 PLACING CONCRETE

A. General:

1. Remove water, soft or saturated subgrade soil and foreign matter from excavations and forms before placing concrete. Where the subgrade is sand, lightly dampen it. Do not place concrete on frozen subgrade. Do not place concrete when rain is expected to occur within four hours after placement.
2. Place concrete in clean, damp forms that are not hot to the touch. Spray forms and contiguous masonry units with water just prior to

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placing concrete. Secure reinforcement in position before placing concrete. Runways or equipment used to transport or place the concrete shall not rest on the reinforcing steel. Support rebars at correct elevation as indicated. Concrete not placed within 90 minutes from time water is introduced will be rejected and shall be removed from the job. Deposit concrete as nearly as practicable in final position, and do not allow to drop freely more than necessary, in no case more than 10 feet, except in an accepted funnel. Where reinforcing steel above top of concrete being placed becomes coated with laitance or partially set up concrete, remove all such concrete prior to placing concrete around bars.

3. Concrete with a slump greater than specified is to be removed from the job immediately and not to be placed in the forms. Rejected loads shall not be altered and returned to the project.
  4. Concrete shall not be placed by pump unless the pump is 4" or larger and any special design mixes are first reviewed with the Engineer. Pump hoses may be less than 4" diameter only where accessibility of a 4" hose is difficult and a high-range water reducing admixture is used.
- B. **Compaction:** Compact concrete by internal vibration equipment supplemented by hand rodding and tamping as required. Internal vibrator used shall be on the site at least the day before intended use. Do not use vibrators to move concrete laterally inside the forms. Internal vibrators shall maintain a speed of at least 5000 impulses per minute when submerged in concrete. Maintain at least one spare vibrator in working condition at the site at all times. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation, not less than 4 and not more than 8 seconds per square foot of exposed top surface. Constantly relocate vibrator and place it in each specific spot only once.
- C. **Walls:** Place wall concrete in not more than 36 inch lifts before vibration, with first lift preceded by 1-inch minimum layer of 1:2-1/4 cement sand mortar with 6-inch to 8-inch slump, placed on concrete previously placed and hardened, not more than 20 minutes before concrete placement. Clean and wet surface of previously placed hardened concrete before placing mortar.

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- D. Cold Weather Concreting: Do not start concrete placing if the ambient temperature is below 40 degrees F., and falling, without following special procedures as recommended by the American Concrete Institute (ACI - 306), and as directed. The temperature of the hardened concrete shall be 45 degrees F. or higher for the first 3 days after casting. Insulated blankets, heaters and other materials and procedures shall be reviewed with the Engineer before placement of cold-weather concrete.
- E. Hot-Weather Concreting: During hot weather, take precautions as recommended by the American Concrete Institute (ACI 305) and as directed. The temperature of the concrete as it is being placed shall not exceed 90 degrees F. Precautionary measures for mixing, transporting, placing, and curing shall be reviewed with the Engineer well before placing the concrete.
- F. Concrete shall not be placed until reinforcement, pipes, conduits, sleeves, hangers, anchors and other work required to be built into concrete have been inspected by the Engineer.
- G. The rate of placing concrete shall be such that the liquid pressure does not exceed the design pressure of the formwork.

3.06 EMBEDDED ITEMS

- A. In addition to reinforcing steel, build in, set in, or attach all embedded pipes, inserts, and other objects as indicated, specified or directed and thoroughly clean all embedded items, removing all rust, scale, oil and other foreign materials. Protect embedded items from damage and displacement and inspect prior to placing concrete. Embed no wood in concrete. Place concrete carefully and tightly around pipes and other embedded items to secure maximum adhesion. Prevent intrusion of concrete into drains, hollow inserts, and similar items by temporarily sealing them with taped polyethylene sheeting. Coordinate the placement of sleeves for pipes and conduits by the Mechanical trades.
- B. Do not embed pipes, other than electrical conduit, in any structural concrete, except where specifically indicated on structural Drawings. Provide sleeves for pipes to pass through. Embed conduit in concrete only under following conditions.
  - 1. No reinforcing shall be cut or displaced to accommodate conduit.

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2. Conduit shall not be placed between any reinforcing and its minimum concrete cover.
3. Parallel conduit shall be placed apart at least four times the O.D. of conduit.

**3.07 CONSTRUCTION JOINTS, EXPANSION JOINTS AND WEAKENED-PLANE  
CRACK CONTROL JOINTS**

- A. The details and locations of joints in concrete work shall be as shown on the design drawings, except as hereinafter specified. For roughened construction joints made while the concrete is still plastic, see Article 3.10, Finishes, in this Section.
- B. If the Contractor proposes to modify joint details, change locations of joints, or add additional joints, he shall submit shop drawings for review indicating the proposed joint information.
- C. All joints shown on the design drawings, that are clearly not modified by the shop drawings, shall be constructed as shown on the design drawings. All joints shall have a continuous 2X4 key.
- D. Shop drawings for joint modifications shall be submitted sufficiently in advance of formwork construction and reinforcement placement so delay in construction will not occur.
- E. Except where indicated otherwise on the drawings or as directed after Contractor request, a 36-hour minimum delay shall occur in concrete placement at construction joints.
- F. Preparatory Work At Construction Joints: Before depositing new concrete on or against concrete which has hardened, roughen surface of hardened concrete as required, in a manner that will not leave loosened particles of aggregate or damaged concrete at surface. Thoroughly clean surface of foreign matter and laitance and saturate surface with water, and then retighten forms. To insure an excess of mortar at junction of hardened and newly deposited concrete, thoroughly cover cleaned and saturated horizontal surfaces with a coating of 1:2-1/4 rich mortar, as previously specified, not more than 20 minutes before concrete placement. Reinforcement shall continue through the joint with a minimum distance of 36 diameters projecting and 36 diameters embedded unless otherwise

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indicated. Where indicated or required, provide a concrete key or extra dowel bars to increase shear strength.

- G. Waterstops: Except where specifically noted otherwise on the drawings, provide waterstops in all types of joints in all concrete tanks, flumes, troughs, etc. intended to contain or convey water or other liquids. Waterstops shall be installed to provide a continuous waterproof barrier. Bends, corners, splices and junctions shall be made in accordance with the recommendations of the manufacturer of the waterstop. Suitable electric-controlled devices shall be used to make splices and junctions. Waterstops shall be suitably wired or otherwise secured in position so they remain in position during placement of concrete and other construction operations.
- H. Curing at construction joints (Also see Article 3.9, Curing, in this Section):
  - 1. Vertical construction joints shall be wet-cured or damp-form-cured.
  - 2. Horizontal construction joints shall be wet-cured.

**3.08 DIMENSIONAL TOLERANCES**

- A. Tolerances, allowances, and limits in reinforced concrete work shall be as prescribed in the ACI Manual of Concrete Inspection (ACI SP-2).
- B. The limits and tolerances prescribed represent a maximum acceptable deviation from perfectly true and accurate concrete work for individual cases. True and accurate work is expected in every instance, and these tolerances are designed for the purpose of setting forth limits and tolerances governing maxima, rather than an index of acceptability. Work shall be considered unsatisfactory when it consistently approaches these limits through portions of the project.

**3.09 CURING**

- A. Start curing of all concrete as soon as practicable after placing, but not more than 3 hours thereafter. Assemble all necessary curing materials at site prior to starting concrete placing. Review proposed curing methods with Engineer well in advance of concrete placement.

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- B. Curing method definitions.
1. Wet-curing: Cover concrete surfaces with waterproof reinforced sisal kraftpaper, 4-mil minimum polyethylene sheeting, double layer of burlap, 3-inch layer of soil or other approved material. Keep the covered concrete damp by flushing or hosing with water daily or as necessary.
  2. Damp-form-curing: Leave forms in place and keep forms damp by water spraying not less than once each day.
  3. Compound-curing: Spray approved curing compound on the concrete surface in strict accordance with manufacturer's printed instructions.
- C. Minimum length of curing time for wet-curing and damp-form-curing:
1. 7 days for concrete surfaces that will receive direct sunlight after the covering has been removed.
  2. 5 days for concrete surfaces that will not receive direct sunlight after the covering has been removed.
- D. Curing methods for various concrete surfaces.
1. Horizontal or nearly horizontal surfaces:
    - a. Interior floor slabs: compound-curing.
    - b. Sidewalks, bottom slabs of liquid-holding tanks and troughs, exterior slabs: wet-curing or compound-curing.
    - c. Wall footings, and construction joints in walls: wet-curing.
  2. Formed surfaces: damp-form-curing, or wet-curing or compound-curing if forms are removed within the specified minimum length of curing time. If forms are removed before the end of the specified minimum length of curing time and then compound-curing used, the surface shall be kept damp during finishing operations until the compound is applied.

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3.10 FINISHES

- A. Do not repair major areas of honeycomb and other major flaws in concrete until inspected by Engineer and until an accepted method of repair has been agreed upon.
- B. Definitions of finishes.
  - 1. As-cast finish: As soon as forms have been stripped, remove form ties. Remove large fins. Patch minor honeycomb, form-tie holes, and pits larger than 1/2".
  - 2. Rubbed finish: Finish as specified above for as-cast finish except completely remove all fins, grind offsets, wet and rub entire surface with concrete brick, carborundum stone or a similar tool. Fill all small pinholes with the "Paste" resulting from the rubbing. Rub surface so all fins, offsets, patched areas and form marks are brought to a smooth, uniform appearance. To avoid subsequent spalling and delaminations, do not apply a thin layer of mortar over the plane surface. Excess "paste" resulting from the rubbing shall be removed by buffing with a canvas float or similar material. For concrete that will be exposed and not painted, add white portland cement to the patching mortar to result in a color that matches the dry color of the cast concrete.
  - 3. Rough Finish: Either rough float or screed to a true plane surface. No excess water at the surface will be permitted during the finishing process.
  - 4. Raked Surface Substrate for Swept-Grout: Provide a rough finish and while the concrete is still plastic draw a garden rake across the surface in various directions.
  - 5. Roughened Construction Joint (For Horizontal Surfaces): While the concrete is still plastic, rake the surface with a small garden rake or similar pronged tool to result in ridges approximately 3/4-inch apart and 1/4-inch to 3/8-inch deep. The direction of the raked ridges shall be parallel with the length of the proposed wall above the joint. Roughened construction joint shall also be used for the horizontal substrate concrete below secondary pour

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concrete fill; for this location the spacing of the raked ridges may be more than 3/4-inch.

6. Float Finish: Float surface with a wood, rubber, or similar float to a true and uniform plane with no coarse aggregate visible and with a uniform sandy nonslip surface.
  7. Broomed Finish: Float-Finish followed by a broom drawn across the surface normal to the direction of traffic. To establish the desired texture of the broomed surface, review with the Engineer during the brooming of the first area.
  8. Steel Trowel Finish: Obtain by floating a stiff low slump mix without bringing any excess water to the surface and then finish with a two operation steel trowelling. The first steel trowelling shall be only sufficient to produce a smooth surface free of defects, followed by a second steel trowelling after the concrete has become hard enough so no mortar adheres to the edge of the trowel and a ringing sound is produced by the trowelling. Erase all trowel marks. The use of dusted-on finish to absorb excessive surface moisture is not permitted.
- C. Finishes for the various concrete surfaces. Provide the following finishes except where specifically noted otherwise on the drawings.
1. As-Cast: Formed surfaces not exposed to view in the completed work, and interior surfaces of liquid holding tanks not specified to have a Rubbed Finish.
  2. Rubbed Finish: Interior and exterior formed surfaces exposed to view in the completed work, interior formed surfaces of liquid-holding tanks above an elevation that is 12 inches below the minimum operating liquid level, and the entire interior formed surfaces of troughs and flumes. Exposed formed surfaces, against which earth will be placed, shall be finished to 6 inches below finished grade.
  3. Float Finish: Industrial floors (pipe galleries, equipment rooms, pump rooms, storage rooms, walkways, platforms, etc.); base slabs for liquid holding tanks, troughs and flumes; interior and exterior steps, exterior slabs, curbs, top of exposed beams and walls.

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4. Rough Finish: Slabs to receive ceramic tile, quarry tile or similar finishes requiring a mortar bed. Top of footings.
5. Raked Surface Substrate for Swept-Grout: Where swept-grout is noted on the drawings.
6. Roughened Construction Joints: Where indicated on the drawings.
7. Broomed Finish: Sidewalks and exterior concrete ramps.
8. Steel Trowel Finish: Interior exposed office, laboratory and control room floor slabs and floors to receive resilient flooring or carpeting.

3.11 FLOOR HARDENER TREATMENT

(NOT USED)

3.12 SLAB STRAIGHTNESS TOLERANCE

- A. Floors having a steel troweled finish shall be finished to a tolerance of Ff 30 / Fl 20 Minimum Overall; Ff 20 / Fl 14 Minimum Local.
- B. The top surface of all other floors, slabs, liquid-holding tank bottoms, and the surface of swept-grout in tanks, shall be leveled so that depressions between high spots do not exceed ¼" under a 10-foot straightedge.

3.13 EXTERIOR CONCRETE SLAB MINIMUM DRAINAGE SLOPES

- A. Provide 1/16 inch minimum per foot uniform slope unless otherwise indicated, for all exterior concrete surfaces, including treads of stairs, to provide for water drainage.

3.14 GROUT

- A. Grout Pads for Equipment: Grout shall be non-shrinking, non-staining, non-corrosive and nonmetallic. Grouts shall meet or exceed the requirements of Corps of Engineers Specification CRD-C-588. Acceptable materials shall be Crystex by L & M Construction Chemicals; Sealtight 588 by W.R. Meadows, Inc., or equal.

**CAST-IN-PLACE CONCRETE  
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**SECTION 03300 - PAGE 18**

- B. Grout Pads for Structural Steel and Miscellaneous Metal Items: Grout shall be non-shrink, non-staining, non-corrosive and non-metallic. Use a stiff 1:3 cement sand mixture having a very stiff mortar consistency. Grout shall be placed with a tamping stick to ensure complete filling of the space.
- C. Grout for Filling Form Tie Recesses:
  - 1. For Concrete Surfaces Exposed to Water or the Weather: Use non-shrink grout as specified in this Section, and having a stiff mortar consistency.
  - 2. For Concrete Surfaces Not Exposed to the Weather: Use a 1:3 cement sand mixture having a stiff mortar consistency.
  - 3. Grout for Construction Joints in Concrete Work: See specifications for construction joints herein.

3.15 VAPOR BARRIER

(NOT USED)

3.16 PROTECTION

- A. Freshly placed concrete shall be protected from low temperatures as specified elsewhere herein, rain, flowing water, vandalism, and vibrations.
- B. Hardened concrete shall be protected from: vandalism; damage due to form and shore removal; damage from adjacent construction operations; and premature loading as specified in Section 03100, Concrete Formwork.

END OF SECTION

## PRE-CAST BOX STRUCTURES

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SECTION 03460 – PAGE 1

### PART 1 - GENERAL

#### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install precast box structures in the locations as shown on the Drawings.
- B. All structures shall be manufactured and installed in accordance with details included herein, and as shown on Drawings.

#### 1.02 RELATED WORK NOT INCLUDED

- A. Section 02221 - Excavation and Backfill for Pipe.
- B. Section 09900 - Painting
- C. Section 15063 - Ductile Iron Pipe and Fittings.
- D. Division 3 - Concrete

#### 1.03 QUALIFICATIONS

- A. All precast structures shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of items to be furnished. The structures shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

#### 1.04 SUBMITTALS

- A. Submit for approval shop drawings showing details of construction, reinforcing, joints and catch basin connections.

#### 1.05 INSPECTION

- A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval or other representative of the Owner. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places, and the sections shall be subject to rejection at any time on account of failure to meet any of the

## PRE-CAST BOX STRUCTURES

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### SECTION 03460 – PAGE 2

Specification requirements, even though sample section may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to site shall be marked for identification and shall be removed from the site at once. All sections which have been damaged after delivery will be rejected, and if already installed, shall be acceptably repaired, if permitted, or removed and replaced, entirely at the Contractor's expense.

- B. At the time of inspection, the sections will be carefully examined for compliance with the ASTM designation specified below and these Specifications, and with the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, crack, roughness, soundness, etc. The surface shall be dense and close-textured.
- C. Imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of 7 days and 5,000 psi at the end of 28 days, when tested in 3" x 6" cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Owner's representative.

## PART 2 - PRODUCTS

### 2.01 MATERIALS AND DESIGN

- A. Precast structures shall conform to ASTM Designation C478 and meet the following additional requirements:
  - 1. Type II cement shall be used except as otherwise approved.
  - 2. Holes to accommodate pipe shall be precast into the section at the foundry.
  - 3. All sections shall be cured by an approved method and shall not be shipped nor manhole rungs subjected to loading until the concrete compressive strength has attained 3,000 psi and not before 6 days after fabrication and/or repair, whichever is the longer.
  - 4. Precast concrete top slabs shall be designed for an H-20 wheel loading.

## PRE-CAST BOX STRUCTURES

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### SECTION 03460 – PAGE 3

5. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside on each precast unit.
  6. Minimum wall thickness shall be 8".
  8. The precast reinforced base shall be a minimum of 10" thick and be cast monolithically with the bottom section of manhole walls.
  9. Pre-cast sections shall be jointed with either an O-ring type joint or a tongue and groove joint complete with flexible plastic gasket. The O-ring type joints shall be round compression ring of neoprene material set in annular spaces cast into the spigot end of a bellspigot type joint. The ring shall be uniformly compressed between the positioned sections so as to form a watertight joint. After the sections are assembled, the remaining space in the joint shall be point up and filled with a dense cement mortar and finished so as to make a smooth, continuous surface inside and outside the wall sections. The tongue and groove joint shall be sealed with a flexible plastic gasket as manufactured by K.T. Snyder and Sons or approved equal. After the manhole sections have been assembled, the gasket shall completely fill the joint.
  10. If the Owner feels the precast sections do not meet the Specification, the Owner shall require the sections to be tested by a certified testing laboratory. The Owner shall pay for the test if the test shows the Specifications are met and the Contractor shall pay for the tests if the test shows the Specifications are not met.
- B. Base unit, reducer slabs and flat top slabs shall have steel reinforcement as shown in details.
- C. Openings for pipes larger than six (6) inches in diameter are to be precast. A minimum of six (6) inches between the circumference is to remain between any two holes.
- D. The Contractor will furnish the fabricator with the angle of alignment and size of all pipes to enter manhole and the height of structure.
- E. Base units shall have sufficient height to allow for minimum of six (6) inches of wall between top of highest opening for pipes and bottom of joint.

## PRE-CAST BOX STRUCTURES

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### SECTION 03460 – PAGE 4

- F. Pipes are to be extended into structure wall a minimum of four (4) inches, but should not extend beyond interior wall of structure.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Pre-cast structures shall be constructed to the dimensions shown on the Drawings and as specified in these Specifications.
- B. Precast concrete sections shall be set so as to be vertical and with sections in true alignment with a 1/4" maximum tolerance to be allowed. The outside and inside joint shall be filled with a comparatively dry mortar (one part cement and two parts sand) and finished flush with the adjoining surfaces. Allow joints to set for 24 hours before backfilling. Backfilling shall be done in a careful manner, bringing the fill up evenly on all sides. If any leaks appear in the catch basins, the inside joints shall be caulked with lead wool. The Contractor shall install the precast sections in a manner that will result in a watertight joint.
- C. Holes in the concrete pipe sections required for handling or other purposes shall be plugged with a non-shrinking grout or by grout in combination with concrete plugs.
- D. Where holes must be cut in the precast sections to accommodate pipes, cutting shall be done prior to setting them in place to prevent any subsequent jarring which may loosen the mortar joints.
- E. The precast concrete base shall be placed on a gravel base as shown on the Drawings to provide even bearing and grade control.
- F. Pre-cast structure pipe connections:
  - 1. A tapered hole filled with non-shrink waterproof grout after the pipe is inserted is acceptable, providing the grout is placed carefully to completely fill all around the pipe. If this method is used, place concrete encasement around the stub.
- H. The inverts, or channels shall be so constructed as to permit a smooth transition between the up and downstream lines or pipes. The lines or pipes entering the manhole shall be laid to the grade shown on the

## PRE-CAST BOX STRUCTURES

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### SECTION 03460 – PAGE 5

Drawings. Channels shall be constructed of cement grout and shall be shaped as shown on the Drawings and troweled to render a smooth finish.

#### 3.02 COATINGS

- A. Interior of pre-cast box structures shall be coated in accordance with Section 09900: Painting.

END OF SECTION

## *Division 9*

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## **Finishes**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work covered by this Section includes furnishing all materials, equipment and labor to accomplish all surface preparation, painting and related work for satisfactory completion of the project.
- B. The terms "paint" or "painting" as used in this Section, includes the use of emulsions, enamels, paints, sealers and other coatings organic or inorganic whether used as prime, intermediate, or finish coats.
- C. Unless otherwise specified in the detailed equipment specifications, shop painting shall conform to the requirements of this Section.
- D. It is the intent of these Specification to field paint the following:
  - 1. All miscellaneous metals except as noted, structural steel, equipment, piping, fitting, valves and specials.
  - 2. Work under this Section shall also include touch-up or repair of any damaged or defective painted surface.
  - 3. Building surfaces in accordance with the schedule in the Drawings.
- E. Aluminum and stainless steel shall not be painted unless specifically indicated.
- F. Mechanical equipment and electrical equipment on which a baked-on enamel finish is specified will not require field painting. Any damage or injury to such finishes shall be repaired to the satisfaction of the Engineer by the Contractor at no additional cost to the Owner prior to final acceptance.
- G. The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the Specifications.
- H. Surfaces to be painted that presently have a coating of paint that is not deteriorated or damaged as determined by the Engineer will not be required to have a prime coat.

1.02 RELATED WORK

Division 1: General Requirements

1.03 REFERENCE STANDARDS

Steel Structures Painting Council (SSPC)

1.04 SUBMITTALS

- A. Product data and samples shall be submitted in accordance with Section 01340. The submission shall include but not be limited to the following:
  - 1. A painting schedule listing the manufacturer, type of paint, and the manufacturer's recommendations for surface preparation, application and dry film thickness.
  - 2. A complete specification for each component used.
  - 3. Color chart.
- B. Operation and maintenance data shall be submitted. The data shall include, but not be limited to, the following:
  - 1. Product name and number.
  - 2. Name, address and telephone number of the manufacturer and the local distributor.
  - 3. Detailed procedures for routine maintenance and cleaning.
  - 4. Detailed procedures for light repairs such as dent, scratches and staining.

1.05 WORKMANSHIP

- A. It is intended that all painting work shall be of good quality. Materials shall be evenly spread without runs or sags. There shall be an easily perceptible difference in shades of successive coats of paint.
- B. The painter shall examine the Specifications for the various other trades

whose work is to be finished under this Section. Any materials requiring painting, which are left unfinished by the requirements for such other trades, shall be painted to completion under this Section unless specifically excluded. Any defects in such work which would have an adverse effect on the finish shall be corrected before any painting is started.

**1.06 DELIVERY, STORAGE AND HANDLING**

- A. All materials shall be brought to the job site in the original sealed and unbroken, labeled containers of the paint manufacturer and shall be subject to inspection by the resident engineer on the job.
- B. All materials used in the work shall be stored in an approved location. Such storage space shall be kept neat and clean and all damage thereto or to its surroundings shall be repaired prior to completion of the work. Oily rags, waste and similar articles shall be removed every night. The storage space shall be heated to the extent necessary to prevent damage to the materials by freezing. Every precaution shall be taken to avoid danger of fire. An approved fire extinguisher shall be provided in this storage area. Proper outside containers shall be provided by the Contractor to be used for disposing of painting wastes. No plumbing fixtures shall be used for this purpose.

**1.07 JOB CONDITIONS**

- A. The manufacturer's recommendations concerning environmental conditions under which a material can be applied shall be strictly followed. No finishes shall be applied in areas where dust is being generated.
- B. The Contractor shall cover or otherwise protect the finished work of other trades, surfaces not being painted concurrently, and/or surfaces which are not to be painted. Any injury or damage to such surfaces shall be remedied to the satisfaction of the Engineer at the expense of the Contractor before final acceptance, and no separate payment therefor will be made.
- C. Adequate ventilation shall be provided in all areas where painting is being conducted to protect workers against injurious or explosive concentrations of fumes, gases, dusts, or mists.

1.08 TESTING EQUIPMENT

- A. The Contractor shall furnish and make available to the Engineer the following items of testing equipment for use in determining if the requirements of this Section are being satisfied. The following specified equipment shall be available for use at all times when field painting or surface preparation is in progress.
1. Wet film gauge.
  2. Surface thermometer.
  3. Keane-Tator surface profile comparator.
  4. Set of National Association of Corrosion Engineers (NACE) visual standards.
  5. Holiday (pin hole) detector.
  6. Sling-Psychrometer.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. The paints and paint products shall be as manufactured by Tnemec Company, Inc. or approved equal.
- B. Products of manufacturers other than those named, which are comparable in quality to that specified, will be considered if said paints are offered by the Contractor with satisfactory data on past performance of similar applications, composition, direction for use and other information required.
- C. The painting schedule lists finishes acceptable for use in the work. The schedule is for identification as to type and quality of materials, and shall be strictly followed unless the Contractor submits an alternate schedule to the Engineer for review. A painting schedule shall be submitted for review. Paint applied contrary to the specified schedule shall be corrected as directed by the Engineer. All rejected paint shall be removed from the job, and surfaces shall be repainted in strict accordance with the schedule

and such other directions, as deemed necessary by the Engineer. Unless noted otherwise, each coat of paint shall be applied by appropriate methods to obtain the minimum dry film thickness recommended by the manufacturer for the intended use. The submitted schedule shall contain the manufacturers' recommendations for wet and dry film thickness.

2.02 PAINTING SCHEDULE

- A. The following paint systems are intended to include surfaces to be painted. Any surface or item not specifically named herein but obviously required to be painted, shall be included under the system selected by the Engineer or otherwise painted as directed by the Engineer. The dry film thicknesses shall be within the limits indicated in the manufacturer's specifications. Surface preparation shall be as specified herein and in accordance with the manufacturer's recommendations.
- B. Metal Submerged, Subject to Splash or Buried in Ground: These items require surface preparation SSPC-SP10, "Near White Blast Cleaning" as recommended by the paint manufacturer. Non-submerged metal brackets used to hold grating require SSPC-SP5, "White Blast Cleaning".
1. Primer: Tnemec – Series 161-1211 @ 4-6 mils
  2. 1<sup>st</sup> Coat:
    - a. Tnemec Series 69-Color @ 4-6 mils\*\*
    - b. Tnemec Series 120 @ 12-18 mils (for metal brackets)\*\* For potable water contact, use Series 20 Pota-Pox in lieu of Series 69.
  3. Field Finish:
    - a. Tnemec Series 69-Color @ 4-6 mils\*\*
    - b. Tnemec Series 120 @ 12-18 mils (for metal brackets)\*\* For potable water contact, use Series 20 Pota-Pox in lieu of Series 69.
- C. All Non-Submerged Metal: Machinery, above ground piping, fittings and valves.
1. Primer: Tnemec – Series 161-1211 @ 3-4 mils
  2. 1<sup>st</sup> Coat: Tnemec Series 69 @ 2-3 mils
  3. Finish: Tnemec Series 73 @ 2-3 mils

- D. Submerged Concrete Surfaces:
  - 1. Finish: 2 coats of Tnemec Series 104 @ 6-8 mils per coat
  
- E. Exposed Galvanized, Aluminum and other Non-Ferrous Metals: Interior piping, fittings, valves, stands. These items require surface preparation SSPC-SP1, "Solvent Cleaning" as recommended by the paint manufacturer. Surfaces must be clean, dry and free of all contaminants.
  - 1. 1<sup>st</sup> Coat: Tnemec Series 69 @ 3 mils minimum
  - 2. Finish: Tnemec Series 73 @ 2-3 mils dry

### 2.03 MAINTENANCE MATERIAL

The Contractor shall provide the Owner at final inspection one gallon of each type and final color of paint used on the project.

## PART 3 - EXECUTION

### 3.01 PREPARATION OF SURFACE

- A. All surfaces to be painted shall be prepared with the objective of obtaining a smooth, clean and dry surface. Surfaces which are not shop painted or which were improperly shop painted, and all abraded or rusted shop painted surfaces, which are to be painted shall be prepared as specified herein and shall be dry and clean before painting. Blast cleaning, where required, shall be done in a manner that will not contaminate other work. Blast cleaning is not required of any surfaces which have been properly shop painted previously. No painting shall be done in the field before the prepared surfaces are approved by the Engineer.
  
- B. Non-submerged ferrous metal surfaces to be painted shall be thoroughly cleaned using SSPC SP-6 Commercial Blast Cleaning in accordance with the Specifications of the Steel Structures Painting Council. Motors and like items that may be damaged by blast cleaning shall be prepared by other approved means.
  
- C. Equipment and Metal Submerged, Subject to Splash or Buried in the Ground:

1. Surface preparation and special coatings shall be done only by crews experienced in this work and who have been approved by the Engineer. A representative of the paint company shall be present when work begins to instruct personnel in sandblasting and application techniques; that instruction shall be made in the presence of the Engineer.
  2. Surfaces to be coated shall be sandblasted to the equivalent of "SSPC-SP-10, Near-White Metal Blast Cleaning" of the Steel Structures Painting Council. The Contractor shall furnish the Engineer a Sample No. 10 blast cleaning plate, suitably sealed in plastic and purchased from the Steel Structures Painting Council, to be used as a field guide. Under no circumstances shall sandblasted surfaces be permitted to rust or have condensation to form thereon prior to coating. Surfaces sandblasted shall be coated the same day; if surfaces are allowed to remain uncoated overnight or longer, they shall be re-sandblasted before coating. All cleaning and coating application shall be performed only during daylight hours. No coating shall be applied when the temperature is below 50 degrees F, nor when the relative humidity is greater than 75 percent, nor when condensation is present on base and coated surfaces, nor when ambient air temperature is falling.
  3. The following items subjected to the environments herein described shall receive the surface preparation specified in this subparagraph.
    - a. All submerged pumping equipment.
    - b. All flow and level control equipment.
    - c. All exposed pipe, valves and fittings.
    - d. All ferrous metal gates and/or appurtenances.
    - e. All buried valves.
  4. This does not include ductile iron piping in sewage or buried in the ground.
- D. Metals coated with tar or bituminous products to be painted shall be clean and dry and free of oil and grease and shall be given two coats of Koppers Tar Stop or Tnemec No. 707 Tar Bar before application of the specified finish coat.

- E. Concrete and grout surfaces to be painted shall have all uneven work, sharp corners and projections smoothed down. All defective surfaces showing aggregate or visible holes shall be cut out and coated with a special bonding coat and filled with grout. Surfaces shall be dry and cleaned from all dust, form oil, curing compounds and other objectionable matter.
- F. Galvanized metal surfaces to be painted shall be thoroughly cleaned using SSPC-SP-1 Solvent Cleaning in accordance with Specifications of Steel Structures Painting Council.
- G. Metal windows, doors, and frames shall have all rust and loose scale removed with a wire brush and surfaces shall be wiped clean. Caulk around frames and trim, allow to set, then smooth up for primer coat.
- H. Use special care to leave all nameplates and non-ferrous finished trim unpainted. Complete instructions as to equipment requiring painting shall be obtained from the Engineer before starting the work. Control centers, meter panels, and pump control panels shall not be painted in the field. The painter shall apply clear plastic by spray can or brush to all metallic nameplates.
- I. Equipment, such as motors, pumps and other such items, which when installed, become an integral part of a system and which may be delivered fully factory-finished, that is, having finish coats in addition to the prime coating, shall be patch painted where damaged, sanded to a dull gloss and then painted with two coats of the specified finish material or as directed.
- J. All copper piping shall be cleaned and polished to a bright uniform sheen and then painted with two coats of clear vinyl. Polishing shall be performed using an approved type of copper polish compound which will not abrade or scratch the surface of the pipe. The use of sandpaper or emery cloth will not be permitted for polishing.

### 3.02 PRIMING

Each coat of paint, as well as the required surface preparation, shall be considered as an essential part of a complete system of surface treatment. The painting work specified herein shall include spot-priming, shop-priming and other initial treatments necessary as recommended by the manufacturer of the finishing paint.

In all cases, the priming material shall be compatible with the finishing material as recommended by the paint manufacturer. Prime coats specified herein will not be required on items which are delivered with prime or shop coats already applied; however, the Contractor shall determine that such primers are compatible with the specified finish coats. Where the priming material is not specifically indicated, and where a finishing material different from the specified material is approved for use in the work, then the primer shall be of the type recommended by the manufacturer for such material as applied to the particular surface. If any item, which is to be painted under this Contract, is delivered to the site bearing a prime coat which is incompatible with the specified finishing material or is improper for the purpose, then such prime coat shall be removed and the surface prepared for painting as recommended by the manufacturer and reviewed by the Engineer.

### 3.03 APPLICATION OF PAINT

- A. On metal surfaces the painter shall apply each coat of paint at the rate specified by the manufacturer to the minimum dry film thickness required by the manufacturer. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. In other words, one gallon of paint as originally furnished by the manufacturer must not cover a greater square foot area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of additional coats of paint. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by increasing the coverage rate or by applying additional coats of paint.
- B. Paint shall not be applied when the temperature of the air or of the surface is below 50 degrees F. or above 95 degrees F. nor when the relative humidity is greater than 75 percent, nor when condensation is present on base and coated surfaces, nor when ambient temperature is falling.
- C. Drying time shall be construed to mean "Under normal conditions." Where conditions are other than normal because of the weather or because painting must be done in confined spaces, longer drying time will be necessary. Additional coats of paint shall not be applied, nor shall units be put in service until paints are thoroughly dry.
- D. Where thinning is necessary, only the products of the manufacturer furnishing the paint, and for the particular purpose, shall be allowed and

all such thinning shall be done strictly in accordance with the manufacturer's instructions as well as with the full knowledge of the Engineer.

**3.04 CONTRACTOR'S INSPECTION**

- A. The Contractor shall use a wet film gauge to check each application, about every 15 minutes in order to correct low or heavy film build immediately.
- B. A dry film gauge shall be used to check each coat when dry, and the total system when completed.
- C. The Contractor shall use a holiday or pin hole detector on metal systems to detect and correct voids.
- D. A sling-psychrometer shall be used for periodic checks on relative humidity and temperature.
- E. The temperature of the substrate shall be checked at regular intervals to be certain the surface is 5 degrees F above the dew point.

**3.05 CLEAN-UP**

At the completion of the work, the Contractor shall remove all paint spots and oil or grease stains caused by this work from floors, walls, fixtures, hardware and equipment, leaving their finishes in a satisfactory condition. All materials and debris shall be removed and the site of the work left in a clean condition so far as this work is concerned.

**3.06 FINAL INSPECTION**

The Contractor shall protect all painted surfaces against damage until the date of final acceptance of the work. The Engineer will conduct a final inspection of all work and the Contractor will be required to repaint or retouch any areas found which do not comply with the requirements of this Section.

**END OF SECTION**

***Division 11***

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***Equipment***

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**PART 1 – GENERAL**

**1.01 SCOPE**

Furnish and install one (1) Flygt Model C3231/735 heavy-duty submersible wastewater pump specially designed for pumping highly contaminated liquid and sludge having higher than normal values of viscosity and/or density. At design point pump shall be capable of pumping 2,250 GPM at 200 ft. total dynamic head without exceeding HP rating of motor.

**1.02 QUALITY ASSURANCE**

- A. The pump manufacturer shall perform the following inspections and test on each pump before shipment from factory:
1. Impeller, motor rating and electrical connections shall first be checked for compliance to the customer's purchase order.
  2. A motor and capable insulation test for moisture content and/or insulation defects shall be made.
  3. Prior to submergence, the pump shall be run dry to establish correct radiation and mechanical integrity.
  4. The pump shall be run submerged in water to a minimum of six (6) ft.
  5. After operational test No. 4, the insulation test (No. 2) is to be performed again.
- B. A written report stating the foregoing steps have been done shall be supplied with each pump at the time of shipment.

**1.03 WARRANTY**

- A. The pump manufacturer shall warrant the units being supplied to the owner against defection workmanship and material for a period of five (5) years or 10,000 hour under the Municipal Wastewater - Permanent Installation Warranty Policy under normal use, operation and service. The warranty shall be in printed form and apply to all similar units.

**1.04 SUBMITTALS**

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- A. The manufacturer shall furnish six (6) sets of standard Submittal Drawings, Operating and Maintenance Instruction Manuals and Parts Lists.
- B. Standard submittals will consist of:
  - 1. Pump Outline Drawing
  - 2. Control Drawing and Data
  - 3. Access Frame Drawing
  - 4. Typical Installation Guides
  - 5. Technical Manuals
  - 6. Parts Lists
  - 7. Applicable Printed Warranty
  - 8. Manufacturer's Equipment Storage Recommended Start-up Procedure Data Form.

**PART 2 – PRODUCTS (SWP – 100)**

**2.01 REQUIREMENTS**

- A. Furnish and install one (1) submersible non-clog wastewater pump. The pump shall be equipped with a close coupled 250 HP, submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz electrical service with 40 linear feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards. Also, 40 linear feet of multi-conductor submersible cable (SUBCAB) will be used to convey pump monitoring device signals. The pump shall be supplied with a mating cast iron 8-inch discharge connection and be capable of delivering 2,250 GPM at 200 FT. TDH. The pump shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump shall bear directly on the sump floor. The

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pump shall be fitted with 40 feet of lifting chain or stainless steel cable. The working load of the lifting system (JIB-100) shall be 50% greater than the pump unit weight.

- B. Power and pilot cable supports shall be provided and consist of a wire braid sleeve with attachment loops or tails to connection to the under side of the access frame.

2.02 PUMP CONSTRUCTION

- A. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
- B. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit. Rectangular cross sectioned rubber, paper or synthetic gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

2.03 COOLING SYSTEM

- A. Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the filtered pump media, through the cooling system. Two cooling liquid

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supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. An air evacuation tube shall be provided to facilitate air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non-clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4"Ø located 180° apart. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104°F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.

2.04 CABLE ENTRY SEAL

- A. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2.05 MOTOR

- A. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator

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shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) with an 80°C temperature rise and capable of at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Pumps using 9xx series drive units are capable of 8 evenly spaced starts per hour.

- B. Thermal switches shall be embedded in the stator end coils to monitor the temperature of each phase winding. One PT-100 type temperature sensor shall be installed in the stator winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. A mechanical float switch (FLS) shall be mounted in the junction chamber to signal if there is water intrusion. A pump memory module shall be provided and mounted in the junction chamber to record pump run time, number of starts as well as contain the motor unit performance and manufacturing data and service history. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.
- C. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.
- D. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The motor and cable shall be capable of

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continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

- E. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

2.06 PILOT CABLE

- A. The pilot cable shall be designed specifically for use with submersible pumps and shall be type SUBCAB (SUBmersible CABLE). The cable shall be multi-conductor type with stainless steel braided shielding, a chlorinated polyethylene rubber outer jacket and tinned copper conductors insulated with ethylene-propylene rubber. The conductors shall be arranged in twisted pairs. The cable shall be rated for 600 Volts and 90°C (194°F) with a 40°C (104°F) ambient temperature and shall be approved by Factory Mutual (FM). The cable length shall be adequate to reach the junction box without the need for splices.

2.07 BEARINGS

- A. The pump shaft shall rotate on at least three grease-lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.
- B. The minimum L<sub>10</sub> bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed.
- C. The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

2.08 MECHANICAL SEAL

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- A. The pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance or adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. For special applications, other seal face materials shall be available.
- B. Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.
- C. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.
- D. The pump shall be provided with an lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate continuously while non-submerged without damage while pumping under load.
- E. Seal lubricant shall be FDA Approved, nontoxic.

2.09 PUMP SHAFT

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- A. Pump and motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of carbon steel ASTM A 572 and shall be completely isolated from the pumped liquid. Shaft material on 6x5 and 7x5 drive units shall be stainless steel – ASTM A479 S43100-T.

2.10 IMPELLER

- A. The impeller shall be of gray cast iron, Class 35B, dynamically balanced, multiple vaned, double shrouded non-clogging design having long throughlets without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Impeller shall be keyed to the shaft, retained with an expansion ring and shall be capable of passing a minimum 3-inch diameter solid. All impellers shall be coated with an acrylic dispersion zinc phosphate primer.

2.11 WEAR RINGS

- A. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a Nitrile rubber coated steel or brass ring insert that is drive fitted to the volute inlet.
- B. The pump shall also have a stainless steel impeller wear ring heat-shrink fitted onto the suction inlet of the impeller.

2.12 VOLUTE

- A. Pump volutes shall be single-piece gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

2.13 PROTECTION

- A. All stators shall incorporate three thermal switches, connected in series, to provide over temperature protection of the motor winding. Should high

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temperature occur, the thermal switches shall open, stop the motor and activate an alarm. The stator shall also include one PT-100 type temperature probe to provide for monitoring of the stator temperature

- B. A lower bearing temperature sensor shall be provided. The sensor shall directly contact the outer race of the thrust bearing providing for accurate temperature monitoring.
- C. Two leakage sensors shall be provided to detect water intrusion into the stator chamber and junction chamber. A Float Leakage Sensor (FLS), a small float switch, shall be used to detect the presence of water in either the stator chamber or junction chamber. When activated, the FLS will stop the motor and activate an alarm. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS SHALL NOT BE ALLOWED.
- D. The solid-state pump memory unit, three thermal switches, two FLS switches, PT-100 stator temperature monitor and the lower bearing PT-100 temperature monitor shall all be connected to a MAS (Monitoring and Status) monitoring unit. The MAS shall be designed to be mounted in the control panel and shall come with an Operator Panel that is dead-front panel mounted. The Operator Panel shall have soft-touch operator keys and provide local indication of the status of the alarms within the connected pump unit by means of an LCD screen read-out. Local MAS system change shall be made by use of the soft-touch keypad or local connection by means of a laptop computer. Remote indication of pump unit status shall be possible with connection to customer PLC or via LAN.

2.14 ACCESS FRAME AND COVER

(Not Used)

2.15 CONTROLS

- A. Furnish and install one (1) Flygt Model F3000 automatic pump control center in NEMA 3R enclosure for 460 volts, 3 phase, 60 hertz power supply. For each pump motor, there shall be included: a combination

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circuit breaker/overload unit providing overload protection, short-circuit protection, reset and disconnect for all phases, overload device to be precalibrated to match motor characteristics, and factory sealed to insure trip setting is tamper proof; across-the-line magnetic contactors; hand/off/automatic pump operation selector switch; the over temperature switch circuit from each pump shall be wired to a contact on a coil of the overload circuit in a manner preventing motor restart without a manual resetting operation. A 24 volt control circuit transformer, with disconnect circuit breaker and overload protection shall be included. An automatic electric alternator shall be provided for multiple pump stations. Terminal boards for connection of line pump(s) and level sensors shall be provided.

- B. The following additional items shall be furnished with the panel:
  - 1. High Level Alarm
    - a. Alarm bell;
    - b. Alarm light;
  - 2. Condensation heater;
  - 3. Running time meters (one for each pump)
  - 4. Pump run lights (one for each pump)
  - 5. Lightning arrestor;
  - 6. Pole mounting bracket.

2.16 LIQUID LEVEL SENSORS

- A. Furnish and install four (4) Flygt Model ENH-10 liquid level sensors each with 40 feet of electrical cable. Level sensors shall be a non-floating, displacement type. Level sensors shall be rated for operation at milliwatt levels. Floats or restrained floats shall not be considered as equal.

2.17 CHECK VALVES

- A. Furnish and install two (2), 4 inch Flygt HDL Ball Check Valve. The valve shall consist of three components; body, cover and ball (one moving part). The design of the valve shall be such that it keeps solids, stringy material, grit, rags, etc., moving without the need for back flushing. In the operating mode, the ball shall not significantly impeded flow through the valve, and shall provide full flow equal to the nominal size of the valve.

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- B. The check valve shall be non-clog. There shall not be outside levers, weights, springs, dash pots or other accessories required. The ball shall be hollow steel with an exterior of nitrile rubber, it shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentrations of acids and alkalines (pH 4-10), tearing and abrasion. The body and cover shall be of gray cast iron, Class 35. Flange drilling shall be according to AISI B16.1, Class 125.

2.18 GATE VALVES

- A. Gate valves unless otherwise specified or approved, shall be iron body, bronze mounted, solid wedge gate valves, or AV & H full revolving D.D. gate valves with flanged ends and conforming to the AWWA Standard Specification for Gate Valves for Ordinary Water Works Service, Designation C500, insofar as applicable.
- B. Valves shall be outside screw and yoke type unless noted to be inside-screw with non-rising stem.
- C. Face to face dimension shall conform to ANSI Standard Face to Face and End to End Dimensions of Ferrous Valves, (ANSI B16.10) for 125-lb. cast-iron valves.
- D. Bronze gate rings shall be fitted into grooves of dovetail or similar shape in the gates. For grooves or other shapes, the rings shall be firmly attached to the gates with bronze rivets.
- E. Handwheels or chain wheels shall be turned counterclockwise to open the valves. Handwheels shall be of ample size and shall have an arrow and the work OPEN cast thereon to indicate the direction of opening.
- F. Stuffing box follower bolts shall be of steel and the nuts shall be of bronze.
- G. The design of the valves shall be such as to permit packing the valves without undue leakage while they are wide open and in service. O-ring stuffing boxes may be used.

2.19 CAM LOCK FITTING

**SUBMERSIBLE WASTEWATER  
PUMPING STATION**

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**SECTION 11303 – PAGE 12**

- A. The Cam Lock fitting shall be cast iron body, Model 633-F Male N. PT to Cam Lock adaptor as manufactured by OPW, or equal.
- B. The Cam Lock fitting shall be equipped with a cast iron cap, Model 634-B as manufactured by OPW or equal.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Install submersible pump as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
- B. Pump - Set pump in sump. Connect discharge piping as shown on drawings with check valve and union.

**3.02 ADJUSTING AND CLEANING**

- A. Alignment - Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- B. Start-Up - Start-up in accordance with manufacturer's instructions.
- C. Cleaning - Clean factory-finished surfaces. Repair any marred or scratched surfaces.

**END OF SECTION**

***Division 13***

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**Control Systems**

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

- A. Instruments to be located in the Wet wells are to be rated for hazardous locations Class I Div. 1.
- B. Instruments to be located in all other locations are to be rated NEMA 4X.
- C. Instrument Enclosures shall be provided and installed with appropriate sunshield, heaters, cooling, insulation, etc. as needed to keep equipment within its manufacturer recommended environmental ratings.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturers standard details and catalog data demonstrating compliance with referenced standards. Provide installation and calibration instructions.
- B. Shop Drawings: Show electrical connections and mounting details.

PART 2 PRODUCTS (CGD-100, CGD-101)

1.03 EQUIPMENT

- A. Combustible Gas Detector
  - a. Type: Infrared type to measure percent LEL of petroleum vapors.
  - b. Sensor: Infrared with remote calibration.
  - c. Sensor enclosure shall be suitable for mounting out-of-doors and in Class I, Division 1, Group D rated area.
  - d. Provide suitable mounting hardware.
  - e. Provide adequate length of sensor/transmitter interconnection cable.
  - f. Transmitter: Remote mounted up to 50 feet from the sensor.
  - g. Transmitter housing shall be NEMA 4X (minimum). Transmitter housing shall be rated for Class I, Division 1, Group D rated area when mounting in a hazardous area.
  - h. Unit shall be capable of being calibrated at the transmitter by the introduction of zero and span gas.
  - i. Transmitter Output: 4-20mA.
  - j. Power: 24VDC, 3-wire. Provide suitable power supply housed in NEMA 4X (minimum) enclosure or mount power supply in a conditioned space.
  - k. Transmitter Mounting: Mounting of transmitter shall be wall mounted or 2 inch pipe stand.

## COMBUSTIBLE GAS DETECTOR

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### SECTION 13000 - PAGE 2

- l. Provide adequate sunscreen for transmitter and power supply for units located out-of-doors.
- m. Calibration Kit: Provide calibration kit including zero gas and span gas, required fittings, gauges, handheld calibration devices, etc.
- n. Acceptable Manufacturers: Bacharach (EIT), MSA, or Draeger.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Instrument Tagging
  1. Provide stainless steel identification tags attached with stainless steel wire or screws for all field instruments.

#### 3.02 FIELD QUALITY CONTROL

- A. Tests And Calibration
  1. Perform continuity and insulation resistance tests on instrumentation conductors.
  2. Calibrate each instrument to its published accuracy. Submit calibration sheets including the instrument tag number or name, the date, name of individual performing calibration, procedures and equipment used, and results obtained.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required, to install, complete and ready for operation, the chart recorder depicted on the Drawings.

1.02 RELATED WORK

- A. Section 13420 – Electromagnetic Flowmeter

1.03 SUBMITTALS

- A. Submittals shall be prepared and transmitted to the Engineer for approval in compliance with these Specifications. In addition, shop drawings shall include the following information:
  - 1. Provide catalog cut sheets and wiring diagrams.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Instruments shall be blocked and tied to prevent damage during shipment.
- B. Accessories, drawings, instruction bulletins, etc., shall be packed and shipped with the panel.

PART 2 – PRODUCTS (CHT-100, CHT-101)

2.01 CHART RECORDER

- A. Type
  - 1. Electronic input and output.
- B. Functional/Performance
  - 1. Input/Output - Microprocessor-based; Input - 4-20 mADC into 250 ohms (max); Output - 4-20 mADC into 640 ohms (min).

**CHART RECORDER**

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**SECTION 13325 - PAGE 2**

2. Accuracy - Plus or minus 0.5 percent of span.
3. Chart recorder shall be Eurotherm Chessell model 392. The unit shall have the following options:
  - a) 4-20 mA (with shunt) channels
  - b) 120 VAC
  - c) Four output relays
  - d) 1-Totalizer
  - e) Level 1 mathematical capabilities
  - f) 1 Analog retransmission. The pen shall be for effluent flow.

C. Physical

1. Circular chart recorder.
2. Mounting - Flush panel or surface mount, suitable for high density mounting arrangement.

D. Manufacturer

1. Eurotherm Chessell or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The chart recorder shall be installed at as directed by the manufacturer.

END OF SECTION

## ELECTROMAGNETIC FLOWMETER

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SECTION 13420 - PAGE 1

### PART 1 - GENERAL

#### 1.01 SYSTEM DESCRIPTION

1. System consists of all field and panel mounted instrumentation devices as noted, complete with all necessary signal converters, isolators, amplifiers, power supplies, and other appurtenances necessary for interfacing with other components.
2. Flow meter must record and totalize in English units.

#### 1.02 SUBMITTALS

1. Submit product data with panel layout and schematic diagrams.

### PART 2 – PRODUCTS (MAG-100, MAG-101)

#### 2.01 ELECTROMAGNETIC FLOWMETER

##### 1. DESCRIPTION

- A. Electromagnetic flow meter suitable for fixed-site measurement of bi-directional flow in a full pipe. The flow meter shall consist of a flow tube and a flow transmitter, which shall indicate, totalize and transmit flow. The flow tube shall use a spool piece configuration with field-interchangeable sensors containing coils and electrodes.

##### 2. PRIMARY FLOW HEAD

- A. Each meter shall have a stainless steel metering tube and a non-conductive liner suitable for the liquid being metered. End connections shall be steel flanged for sizes 1/2" and greater, ANSI Class 150#, for meter sizes up to 24" and AWWA Class B or D for meters larger than 24". The housing shall be epoxy coated steel, welded at all joints. Bolted coil enclosures shall not be acceptable.
- B. The field coils of the meter shall be supplied with a precisely adjusted bi-polar direct current.
- C. There shall be no electronic components on the primary flow head. Coil drive power shall be supplied by an integral or remote signal converter. Output signal from the primary shall be fed through 'DS' proprietary cable supplied with the meter to the signal converter.

## ELECTROMAGNETIC FLOWMETER

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### SECTION 13420 - PAGE 2

- D. The Primary Flowhead shall have a housing rated for:
    - i. Weatherproof, NEMA 4X and NEMA 6
    - ii. Complete Submergence NEMA 6P (IP68).
  - E. Electrode material shall be compatible with the process fluid.
  - F. Liner material will be hard rubber.
  - G. Meter will have field replaceable electrodes with access ports.
  - H. The instrument shall be manufactured in an ISO 9001 approved facility.
  - I. When installed in lined or non-metallic piping, the meter shall be provided with corrosion resistant grounding rings. Grounding electrodes shall not be acceptable.
  - J. Meter calibration shall be performed by a direct volumetric comparison method. A calibration certificate shall accompany each meter. Calibration facility shall be certified to 0.03% accuracy, and be traceable to national standards.
  - K. The meter shall be Krohne Model ENVIROMAG series.
2. SPOOL PIECE FLOW TUBE AND SENSORS
- A. The nominal diameter of the flow tube shall be as shown on the Drawings.
  - B. The spool piece flow tube shall be made of carbon steel and shall be powder coated with a corrosion resistant electrostatic epoxy finish inside and outside, and shall include Type 316 stainless steel bolts. O ring seals shall be made of Viton, and standpipe gaskets shall be made of nitrile rubber.
    - i. The flow tube shall require an insulating liner. The flow tube liner shall be AWWA approved epoxy enamel that conforms to National Sanitation Foundation Standard 61 for use with potable water and American Water Works Association Standard C652-86 for use with potable water. Accuracy shall be not be affected by cuts or scratches in the flow tube liner.

## ELECTROMAGNETIC FLOWMETER

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### SECTION 13420 - PAGE 3

- ii. The flow tube shall be supplied with raised face carbon steel flanges to ANSI 150rf.
- C. Each flow sensor shall contain a coil, a pair of sensing electrodes, and an integral grounding electrode. External grounding rings and straps shall not be necessary. The sensors shall use solid state design, with the coils, electrodes, and other sensor components encapsulated in Kynar polyurethane that conforms to National Sanitation Foundation Standard 61 for use with potable water for nominal diameters of 16 in. (400 mm) and above. The sensors shall be field-replaceable and field-interchangeable without the need for recalibration.
  - i. The electrodes shall be made of Type 316 stainless steel.
  - ii. The flow tube shall use unipolar pulsed AC electromagnetic excitation, with typical magnetizing current of not less than 1 A base to peak, and frequency of not less than 2/3 of power supply frequency (40 Hz for a 60 Hz power supply frequency), to ensure a high signal-to-media noise ratio.
- D. The minimum media conductivity shall be 0.5 microS/cm.
- E. The maximum media temperature shall be 175 degrees F (80 degrees C).
- F. The flow meter shall include multiple sensors to measure mean velocity in full pipes.
  - i. The mean velocity measurement range shall be from 0 to 2 feet per second (0 to 0.6 meters per second) to 0 to 50 feet per second (0 to 15 meters per second).
  - i. The minimum detectable mean velocity shall be 0.02 feet per second (0.006 meters per second).
  - iii. The mean velocity shall be measured with a maximum error of +/- 0.005 feet per second (+/- 0.0015 meters per second) over a range of less than 1 foot per second (0.3 meters per second), and +/-0.5% of flow rate over a range of 1 to 50 feet per second (0.3 to 15 meters per second). A mean velocity of 0.1 foot per second (0.03 meters per second) shall be measured with a maximum error of +/-5% of reading. Accuracy shall be traceable to the US National Institute of Standards and Technology (NIST), and shall be guaranteed on-site for applications such as drinking water, raw sewage, and similar media,

## ELECTROMAGNETIC FLOWMETER

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### SECTION 13420 - PAGE 4

even with a permanent coating of raw sewage or similar on the electrodes, provided that specification parameters and installation recommendations are met. A NIST traceable calibration certificate shall be provided with each flow meter.

- iv. The temperature coefficient shall be less than 0.05% per 10 degrees F (0.09% per 10 degrees C).
  - v. A non-full pipe condition shall be indicated by a user-supplied signal into one of the contact inputs on the flow transmitter.
  - vi. Maximum pressure shall be 150 psi (10 bar).
  - vii. The flow tube shall be capable of including a sealed differential pressure transducer to measure the pressure of the liquid. The maximum pressure measurement range of the pressure transducer shall be from 0 to 150 psi (0 to 10 bar). Pressure shall be measured with a maximum error of +/-0.5% of full scale.
- G. The wiring from the flow transmitter to the sensors shall be 2 separate 2-conductor cables, 16 gauge, twisted and shielded. The wiring from the flow transmitter to the sensors shall be 30 feet (9 m) long.
- H. The flow tube and sensors shall exceed the NEMA 6P (IP68) submersibility standard, and shall be submersible to 33 feet (10 m).
- I. The flow tube shall have a 10-year warranty, and the sensors a 5-year warranty.
- J. The flow tube assembly shall be certified to conform with UL and CSA standards for use in ordinary locations, and in Class 1 Division 2 explosive areas, with the transmitter to be located in the safe area.

### 3. FLOW TRANSMITTER

- A. The flow transmitter shall be microprocessor-based, and shall contain a local graphical display (back-lit white), 128 x 64 pixels with three separate display pages; pages 1 and 2 shall each allow viewing from 1 to 3 lines of measured values (user assignable) in engineering units or with 0-100% bar graph. User selectable measurements (i.e. flow rate, counter 1 and/or 2 (+, -, or sum), diagnostics, etc.) on either display page and display line. Display page 3 shall show all diagnostics that are currently active or occurred since last acknowledgement. The LCD shall display flow rate and/or total flow in user-

## ELECTROMAGNETIC FLOWMETER

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### SECTION 13420 - PAGE 5

selectable units of measure. The flow transmitter shall be capable of displaying forward, reverse, net and grand total flows, and the totalizers shall be password protect able to prevent unauthorized resetting. The counters shall maintain their accumulated values even with power loss, and continue counting when power resumes.

- B. The flow transmitter shall include 2 isolated contact inputs, activated by contact closure or transistor, programmable to acknowledge alarms, reset totalizers, select the current flow rate range in forward flow/multi range mode, or indicate non-full pipe condition, rated 25 volts DC, 15 mA.
  
- C. The flow transmitter shall include an isolated, internally powered 4 to 20 mA output into a maximum of 500 ohms. The 4 to 20 mA output shall be programmable to operate in either forward flow rate, forward flow rate/multi range, bidirectional flow rate, or bidirectional flow rate/split range mode.
  - i. In forward flow rate mode, 4 mA shall represent zero flow rate, and 20 mA shall represent the programmable maximum forward flow rate.
  - ii. In forward flow rate/multi range mode, up to 3 different flow rate ranges shall be programmable, with the current range selected by user-supplied signals applied to the contact inputs.
  - iii. In bidirectional flow rate mode, independent maximum forward and reverse flow rates shall be programmable, with flow direction indicated by a relay output.
  - iv. In bidirectional flow rate/split range mode, 4 mA shall represent the programmable maximum reverse flow rate, 12 mA shall represent zero flow rate, and 20 mA shall represent the programmable maximum forward flow rate.
  
- B. The flow transmitter shall include a 2 wire solid state pulse output, internally powered, rated 25 volts DC, 80 mA. The pulse output shall be programmable to operate in either scaled or frequency mode.
  - i. Scaled mode shall be used for totalizing, with a programmable maximum frequency of 5, 10 or 100 Hz and a corresponding pulse width of 100, 50 or 5 ms, respectively.
  - ii. Frequency mode shall be used for rate indication, with a square wave output programmable from 0 to 1,000 Hz to 0 to 10,000 Hz.

## ELECTROMAGNETIC FLOWMETER

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### SECTION 13420 - PAGE 6

- C. The flow transmitter shall include 2 isolated, normally open relay contacts, activated based on reverse flow, high or low flow rate, total flow, or diagnostic errors, rated 60 volts DC, 30 volts AC RMS, 3 A resistive.
- D. The flow transmitter shall be Factory Mutual (FM) Approved for use in ordinary locations.
- E. The flow transmitter shall operate on 120 VAC, 60 Hz line power. Typical power consumption shall be 10 W, including the sensors.
- F. The flow transmitter shall be housed in a rugged, watertight, dust-tight, corrosion resistant (NEMA 4X and IP65) cast aluminum, epoxy painted enclosure suitable for conduit connections. The enclosure shall include a polycarbonate window for viewing the LCD without opening the enclosure.
- G. The flow transmitter shall have a 2-year warranty.
- H. Acceptable Manufacturers: Khrono Model OptiFlux IFC300.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- 1. Instrument Tagging
  - A. Provide stainless steel identification tags attached with stainless steel wire or screws for all field instruments.

#### 3.02 FIELD QUALITY CONTROL

- 1. Tests and Calibration
  - A. Perform continuity and insulation resistance tests on instrumentation conductors.
  - B. Calibrate each instrument to its published accuracy. Submit calibration sheets including the instrument tag number or name, the date, name of individual performing calibration, procedures and equipment used, and results obtained.

END OF SECTION

***Division 14***

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**Conveying Systems**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals to install, test and place in satisfactory operation the electric jib crane with controls and appurtenances, as indicated on the Drawings and as herein specified.

1.02 RELATED WORK

- A. Division 16: Electrical

1.03 DESIGN REQUIREMENTS

- A. Design and Deflection Requirements:
  - 1. Live Load Rated capacity plus hoist/trolley weight.
  - 2. Dead Load Component weights
  - 3. Impact Factor 25 percent
  - 4. Deflection L/450
- B. Jib Crane designs shall be in conformance with CMAA-70.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Jib Crane and accessories shall be delivered to the site painted, except as otherwise specified.
- B. Jib Crane and accessories at the site shall be stored off the ground, in an enclosed area, and stored/handled in such a manner as to prevent soiling, corrosion, and/or damage.

1.05 SUBMITTALS

- A. Provide the following:
  - 1. Shop and installation drawings shall show all quantities, sizes, dimensions, components, fasteners, welds, connections, bearings, pivots, fittings, etc. for the fabrication and installation of the jib crane.

2. Product information showing compliance with these Specifications.
3. Inspection test reports concerning installation of jib crane and accessories.
4. Jib crane operations and maintenance manual.

**PART 2 – PRODUCTS (JIB-100)**

**2.01 EQUIPMENT**

A. Electric jib crane shall be manufactured by Wallace Products Corp. or approved equal.

**B. Base Mounted Jib Crane**

1. Capacity: 3 ton
2. Height under beam: 14-feet
3. I-Beam Depth: 21-inches (W21 x 62 lbs./ft.)
4. Span: 15-feet
5. Construction: Steel
6. 360 degree manual rotation

**C. Electric Chain Hoist with Push Trolley**

1. Capacity: 3 ton
2. Lifting Speed: 16 fpm
3. Control: 2 button hand held pendant
4. Control Drop: 8-feet
5. Hand Chain Drop: 40-feet
6. Power Cord Length: 29-feet
7. Voltage: 460V/3 Phase/60 Hz.
8. Amps @ 230/460V: 9.2 at full load/output horsepower (4.7)

**2.02 FABRICATION**

- A. Sheared and flame cut edges shall be true to line and free from rough corners and projections.
- B. Re-entrant cuts/corners shall be filleted to a radius of not less than 1/2 inch.
- C. Holes shall be punched, subpunched and reamed, or drilled in accordance with Section 1.23.4 of AISC “Specifications for Structural Steel.” Holes shall not be

made by flame cutting.

- D. Holes shall be 1/16 inch larger than the nominal bolt diameter.
- E. Bent plate shall be in accordance with AISC “Minimum Radius for Bending.”
- F. Welding shall be done in a sequence which minimizes distortion and shrinkage.

#### 2.03 FINISHES

- A. Jib crane, except bushings, bearings, pivot pins, and grease fittings shall be painted.

#### 2.04 MARKING

- A. Booms shall have load capacity signs of 6,000 pounds both sides.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. At the time of installation, all provisions for support and stabilization of the jib crane shall be complete.

#### 3.02 INSTALLATION

- A. Jib crane shall be located so as to conform accurately with the Drawings within the allowable tolerances and installed in accordance with the manufacturer’s written instructions and specifications.
- B. Connections shall be to concrete column as shown on the Drawings and in accordance with manufacturer’s requirements.
- C. Verify all dimensions and clearances in field prior to erection and be responsible for proper fitting and operation of equipment.
- D. Install crane in strict conformance with recommendations of the manufacturer and under direct supervision of manufacturer’s representative.

- E. Obtain approval before attaching any rigging or hoisting equipment to any part of building structure.

**3.03 FIELD QUALITY CONTROL**

- A. Perform field tests before final acceptance under supervision of manufacturer's representative.
- B. Test crane after installation is complete to insure compliance with specification and standard. The crane shall be tested at 125% of its rated capacity. Furnish test load. The crane functions such as hoisting and lowering, trolley travel, locking and safety devices shall be tested to determine that the equipment will perform satisfactorily and safely without failure of any parts. Any defects in the equipment indicated by the tests shall be replaced/corrected and retested.
- C. A certificate from the equipment manufacturer stating that the installation has been inspected and is satisfactory and that the equipment is ready for operation shall be submitted to the Owner.

**3.04 ADJUSTING**

- A. After- installation, the Contractor shall adjust all components and fittings as required for proper functioning.
- B. After installation, the Contractor shall check and adjust all lubrication as required for proper functioning.

**3.05 REPAIR AND CLEANING**

- A. Abraded and scarred areas on painted surfaces, including bolt heads and nuts, shall be repaired with all repairs equal to the original finish and not visible.
- B. At time of final cleanup, all exposed surfaces shall be cleaned.

**3.06 DEMONSTRATIONS**

**HOISTS AND CRANES**

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**SECTION 14300 - PAGE 5**

- A. After installation, the jib crane supplier shall demonstrate operation of the crane to owner and shall review operating and maintenance manuals with owner and maintenance personnel.

END OF SECTION

*Division 15*

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**Mechanical**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work under this section includes pressure testing of all piping systems, and includes requirements common to all mechanical systems herein. Provide all labor, tools, instruments, etc., as required to completely test the systems.
- B. All work provided under these specifications shall be subject to constant inspections and final approval of Engineer and all Code authorities having jurisdiction. Tests, in addition to those specified herein, required to prove Code compliance, shall be provided as required by the authorities without additional cost to Owner. All work found to be defective or indicating leakage shall be repaired or replaced with new materials, as directed by Engineer. Tests shall be repeated until all work is proven to have been installed properly.

1.2 QUALITY CONTROL

All tests shall be conducted by qualified personnel. When requested, qualifications of individuals shall be submitted to Engineer for approval.

1.3 NOTIFICATION

- A. The Engineer shall be notified prior to all tests.
- B. Code authorities having jurisdiction shall be notified prior to all tests.

PART 2 - PRODUCTS

2.1 GENERAL

Provide all materials, test equipment, instruments and labor required for the tests. All instruments shall be properly calibrated and shall have records on calibration.

PART 3 - EXECUTION

3.1 CONCEALED WORK

All concealed work must remain uncovered until required tests have been completed; however, in the event the project schedule requires, the Contractor shall make arrangements for prior tests on the portion of the work involved. The costs of all tests shall be borne by the Contractor.

3.2 DUCTILE IRON PRESSURE PIPING SYSTEMS

Ductile iron pressure piping systems shall be hydrostatically tested at 150 psi for 2 hours.

3.3 PVC PRESSURE PIPING SYSTEMS

PVC pressure piping systems shall remain undisturbed for 24 hours prior to pressure testing to achieve full joint strength. Systems shall be air tested at full operating pressure 12 hours.

3.4 CARBON STEEL PIPING SYSTEMS

Carbon steel piping systems shall be air tested at 25 psi for 2 hours, during which time each exposed joint shall be soap tested for visible leaks.

END OF SECTION

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 1

#### PART 1 - GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals necessary to install, all ductile iron piping, fittings, and appurtenances as indicated on the drawings and specified herein.
- B. Furnish all concrete thrust blocks, excavation, backfilling, sheeting, slope protection, drainage, concrete work, rip rap, grading and all other work necessary to complete the construction, installation and testing of the piping.

##### 1.02 RELATED WORK

- A. Division 2: Excavation, Backfill, Fill and Grading for Pipe.
- B. Division 3: Concrete.
- C. Division 15: Valves and Appurtenances.
- D. Division 15: Pipe Hangers and Supports.

##### 1.03 DESCRIPTION OF SYSTEMS

- A. Buried piping shall include all ductile iron piping below grade in contact with the soil or concrete encased.
- B. Piping inside structures shall include all ductile iron piping and fittings below grade inside vaults, tanks, manholes, boxes, or similar structures but not in contact with the soil.
- C. Exposed piping shall include all ductile iron piping and fittings above grade exposed to view.
- D. The equipment and materials specified herein is intended to be standard types of ductile iron pipe and fittings for use in transporting sewage, sludges, and water.

##### 1.04 QUALIFICATIONS

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 2

All of the ductile-iron pipe and fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

#### 1.05 SUBMITTALS

- A. Submit to the Engineer within thirty (30) days after Notice to Proceed a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.
- B. All ductile-iron pipe and fittings to be installed under this Contract shall be inspected and tested at the foundry as required by the standard Specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results. In addition, all ductile-iron pipe and cast-iron fittings to be installed under this Contract may be inspected at the foundry for compliance with these Specifications by an independent testing laboratory selected by the Owner. The manufacturer's cooperation shall be required in these inspections. The cost of foundry inspection of all pipe approved for this Contract, plus the cost of inspection of a reasonable amount of the disapproved pipe, will be borne by the Owner, as outlined in the General Conditions.
- C. Shop drawings including layouts within, and under buildings and structures shall be submitted to the Engineer for approval in accordance with General Conditions and shall include dimensioning, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.

#### PART 2 - PRODUCTS

##### 2.01 MATERIALS

- A. Pipe
  - 1. Buried piping shall be ductile iron conforming to ANSI/AWWA C151/A21.51, Class 52, with push-on joints or mechanical joints.
  - 2. Piping inside structures and exposed piping shall be ductile iron flanged pipe conforming to ANSI/AWWA C115/A21.15, with a pressure rating of 250 psi. Flanges shall be factory-applied

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 3

screwed long hub-type. Flanges shall be faced and drilled after being screwed on the pipe with flanges true to 90 degrees with the pipe axis and shall be flush with the end of the pipe.

B. Pipe Fittings:

1. Buried fittings shall be ductile iron conforming to ANSI/AWWA C110/A21.10, minimum pressure rating of 150 psi, with mechanical joints. Provide restrained joints where indicated.
2. Fittings inside structures and exposed fittings shall be flanged ductile iron conforming to ANSI/AWWA C110/A21.10, with a minimum pressure rating of 150 psi.

C. Joints (Unless otherwise indicated):

1. Mechanical joints shall conform to ANSI/AWWA C111/A21.11 with rubber gaskets, ductile iron glands, and alloy steel tee head bolts and hex nuts.
2. Push Joints shall conform to ANSI/AWWA C111/A21.11 with rubber gaskets.
3. Flange Joints shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C115/A21.15 with rubber gaskets.
4. Provide restrained joints where indicated.

D. Joints (For oily water service):

(NOT USED)

E. Piping Accessories:

1. Ductile iron wall castings shall be of the size and type shown on the drawings, manufactured to be compatible with the pipe and joints as specified herein.
2. Link Seals shall be provided where indicated on the drawings and shall be as manufactured by Thunderline Corp., Wayne Michigan, or equal.

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 4

#### F. Factory-applied Linings and Coatings

1. All ductile iron pipe and fittings shall be internally lined with factory-applied cement mortar and a bituminous seal coat in accordance with ANSI/AWWA C104/A21.4.
2. Buried pipe and fittings and pipe and fittings inside of structures shall be externally factory coated with an asphaltic coating in accordance with applicable ANSI/AWWA standards for pipe, flanged pipe, and fittings.
3. Exposed Pipe and fittings shall be shop primed on the outside with one coat Rust Inhibitive Primer as specified in Division 9. All other pipe and fittings shall be shop coated on the outside with coal tar enamel in accordance with the above referenced ANSI Specifications and will not require any other coating. Should portions of the exposed piping inadvertently be given the outside coating of coal tar enamel instead of the rust inhibitive primer as required for exposed piping the surfaces shall be sealed with a non-bleeding sealer coat such as Inertol Tar Stop, or Mobil Anti-Bleeding Aluminum Sealer. Sealing shall be a part of the work of this Section.

#### 2.02 MANUFACTURERS

Ductile iron pipe and fittings shall be manufactured by American Ductile Iron Pipe Company, U.S. Pipe and Foundry Company, Clow Corporation, or McWayne Pipe Foundry.

### PART 3 - EXECUTION

#### 3.01 HANDLING PIPE AND FITTINGS

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Engineer.

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 5

- B. All pipe and fittings shall be subjected to a careful inspection and hammer test just prior to being laid or installed.
- C. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the Owner. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.

#### 3.02 INSTALLING DUCTILE-IRON PIPE AND FITTINGS INSIDE STRUCTURES AND IN EXPOSED LOCATIONS

- A. All piping and fittings shall be installed true to alignment and rigidly supported thrust anchors shall be provided where required. Any damage to linings shall be repaired to the satisfaction of the Engineer before the pipe is installed. Each length of pipe shall be cleaned out before erection.
- B. Sleeves shall be installed of proper size for all pipes passing through floors or walls as shown on the Drawings. Where indicated on the Drawings or for liquid or gas-tightness the pipe shall be sealed with a mechanical seal.
- C. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and jointing method and their locations shall be verified from approved piping layout drawings and the structural Drawings. Pipe hangers and supports are specified in Section 15094.
- D. Flanged joints shall be made with bolts, bolt studs with a nut on each end, or studs with nuts, where flange is tapped. The number and size of bolts shall conform to the same American Standard as the flanges. Bolts and nuts shall, except as otherwise specified or noted on the Drawings, be Grade B conforming to ASTM Standard Specification for Low-Carbon Steel, Externally and Internally Threaded Standard Fasteners, Designation A307-68. Bolt studs and studs shall be of the same quality as machine bolts. Gaskets shall be ring gaskets of rubber with cloth insertion. Gaskets 12-in. in diameter and smaller shall be 1/16-in. thick; larger than 12-in. in diameter and 3/32-in. thick.

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 6

- E. All valves, fittings, equipment, and appurtenances needed upon the pipelines shall be set and jointed as indicated on the Drawings or as required.
- G. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufactures have indicated requirements that piping loads shall not be transmitted to their equipment, a certification shall be submitted stating that such requirements have been complied with.

#### 3.03 INSTALLING BURIED DUCTILE IRON PIPE

- A. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 except as otherwise provided herein. A firm, even bearing throughout the length of the pipe shall be constructed by tamping selected material at the sides of the pipe up to the springline. **BLOCKING WILL NOT BE PERMITTED.**
- B. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by manufacturer. Fittings, in addition to those shown on the plans, shall be provided, if required, in crossing utilities which may be encountered upon opening the trench.
- C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.
- D. Jointing Ductile-Iron Pipe:
  - 1. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 7

2. Mechanical joints at valves, fittings and where designated on the drawings and/or as specified shall be in accordance with the "Notes On Method of Installation" under ANSI Specification A21.11 and the instructions of the manufacturer. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torque. Under no condition shall extension wrenches or pipe over handle or ordinary ratchet wrench be used to secure greater leverage.
- E. Ball joints, where designated on the Drawings and/or as specified, shall be installed in strict accordance with the manufacturer's instructions. Where ball joint assemblies occur at the fact of structures or tanks, the socket end shall be at the structure or tank and the ball end assembled to the socket.
- F. All valves, fittings and other appurtenances needed upon the pipe lines shall be set and jointed as indicated on the Drawings or as required by the manufacturer.

#### 3.04 VALVES AND VALVE BOXES

Valves and valve boxes shall be installed as shown on the drawings. Mechanical joints shall be made in the standard manner. Valve stems shall be vertical in all cases. Place cast iron box over each stem with base bearing on compacted fill and top flush with final grade. Boxes shall have sufficient bracing to maintain alignment during backfilling. Knobs on cover shall be parallel to pipe.

#### 3.05 THRUST BLOCKS

- A. Longitudinal thrust along pipe lines of bends, tees, reducers, and caps or plugs shall be counteracted by thrust blocking. Where the bends are in a vertical plane, the thrust shall be counteracted by enough weight of concrete to counterbalance the vertical thrust forces. Where undisturbed trench walls are not available for thrust blocking, the Contractor shall furnish and install suitable pipe harnesses or ties designed and manufactured specifically for this purpose.
- B. Joints shall be protected by felt roofing paper prior to placing concrete.

## DUCTILE IRON PIPE AND FITTINGS

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### SECTION 15063 - PAGE 8

- C. Bearing area of thrust blocks shall be adequate to prevent any movement of the fitting and shall be of the size and dimensions as shown on the drawings.
- D. Concrete for thrust blocking shall be no leaner than 1 part cement, 1-1/2 parts sand and 5-1/2 parts stone. Concrete shall be placed against undisturbed material, and shall not cover joints, bolts or nuts, or interfere with the removal of any joint. Wooden side forms shall be provided for thrust blocks.
- E. In lieu of thrust blocking and with prior approval, pipe harnesses and/or ties or restrained push-on or restrained mechanical joints may be used.

#### 3.06 SURFACE PREPARATION AND PAINTING

- A. All piping and fittings exposed to view shall have its surface prepared and be painted as specified in Division 9. Surface preparation and shop priming is a part of the work of this Section. Pipe marking is included in Division 9, but it shall be part of the work of this Section to assist as required by the Engineer in identifying pipe contents, direction of flow and all else required for proper marking of pipe.

END OF SECTION

## VALVES AND APPURTENANCES

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### SECTION 15101 - PAGE 1

#### PART 1 - GENERAL

##### 1.1 WORK INCLUDED

- A. The work covered by this section includes furnishing all labor, equipment, and materials required to furnish and install all metal valves, including operators, boxes, and accessories as specified herein, shown on the Drawings, or required for proper completion of the work under these Contract Documents.
- B. The Contractor's attention is called to the fact that all valves, especially in the smaller sizes, are not necessarily shown completely on the Drawings, which are more or less schematic. However, the Contractor shall furnish and install all valves indicated or required for proper operation of the equipment or services requiring such valves.
- C. The equipment shall include, but not be limited to, the following:
  - 1. Eccentric plug valves
  - 2. Check Valves
  - 3. Gate Valves

##### 1.2 SUBMITTALS

- A. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the requirements of the Contract Documents.
- B. Submit complete operation and maintenance data on the valves in accordance with the requirements of the contract documents.

##### 1.3 DESCRIPTION OF SYSTEMS

All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of sewage, sludges, water, air or chemicals, depending on the applications.

##### 1.4 QUALIFICATIONS

## VALVES AND APPURTENANCES

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### SECTION 15101 - PAGE 2

All of the types of valves and appurtenances shall be products of well established reputable firms who are fully experienced, reputable and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

#### 1.5 TOOLS

Special tools, if required for normal operation and maintenance, shall be supplied with the equipment.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. All castings, regardless of material, shall be free from surface defects, swells, lumps, blisters, sandholes, or other imperfections.
- B. All valves shall have the name of the manufacturer, rated working pressure, and size of the valve cast upon the body or bonnet in raised letters. Alternately, the name of the valve manufacturer, rated working pressure, and size may be stamped on a stainless steel identification plate permanently attached to the valve body or bonnet. Valves specified to conform to AWWA requirements shall have the letters "AWWA" cast upon the valve body or bonnet in raised letters.
- C. Valves and operating mechanisms shall be of the proper size and dimensions to fit the pipe connections thereto and shall be installed in the position and within the space shown on the Drawings.
- D. Unless otherwise specified, the direction of rotation of the operator to open the valve shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.
- E. A union or coupling shall be provided within 2 feet on each side of a threaded end valve unless the valve can be otherwise easily removed from the piping.

## VALVES AND APPURTENANCES

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### SECTION 15101 - PAGE 3

- F. All exposed bolts and nuts on buried or submerged valves and operators shall be brass or stainless steel for corrosion resistance. Exposed bolts and nuts on exposed valves and operators shall be of corrosion-resistant materials or shall be zinc or cadmium plated.
- G. Valves and operators shall be of the proper size to fit the pipe connections and shall fit in the position and space as shown on the Drawings.
- H. Valve operators shall be of sufficient size and capacity to seat, unseat, and operate the valve under the maximum specified differential pressure. Where no maximum differential pressure is specified, the operator shall be designed for a differential pressure equal to the maximum working pressure of the valve. Additional allowances shall be made for the lubricating and/or scale forming tendencies of the fluid.

#### 2.2 ECCENTRIC PLUG VALVES

- A. Plug valves shall be of the non-lubricated, eccentric type with resilient plugs and screwed, flanged, or mechanical joint ends as shown on the Drawings. Valves shall be designed for 150 psi working pressure. Port areas of valves shall be 100 percent of full pipe area.
- B. Valve bodies shall be ductile iron with raised seats. Seats shall have a welded-in overlay of not less than 90 percent pure nickel on all surfaces contacting the plug face. Valves shall have stainless steel permanently lubricated upper and lower plug stem bushings. Packing shall be adjustable. All exposed nuts, bolts, and washers shall be stainless steel.
- C. Valves 12-inch and larger shall have gear wheel actuator. Valves smaller than 12-inch shall have lever actuator.
- D. Valves shall be installed with valve stem in horizontal position so that plug rotates to the top when open.
- E. Valves shall be manufactured by Milliken or approved equal.

#### 2.3 CHECK VALVES (FLEXIBLE SWING-TYPE)

- A. Unless otherwise shown or specified. Check valves shall be of the flexible swing-type suitable for use in horizontal. Disc shall swing entirely clear of the path of flow when

## VALVES AND APPURTENANCES

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### SECTION 15101 - PAGE 4

in the open position. All internal parts shall be readily accessible and easily replaced in the field. Flexible Swing-Type check valves shall have the following features

1. The valve body shall have full flow equal to nominal pipe diameter at any point, through the valve. The seating surface shall be on a 45 degree angle to minimize disc travel. The top access port shall be full size, allowing removal of the disc without removing the valve from the pipeline. The access cover shall be domed in shape, to allow the disc to be fully operational in lines containing a high solids content.
2. The disc shall be all one piece construction, precision molded with an integral o-ring type sealing surface and contain steel and nylon reinforcements in disc areas. The flex portion of the disc shall be warranted for twenty-five years.
3. The disc shall have non-slam closing characteristics.
4. Backflow capabilities shall be available by means of a screw type backflow actuator. The actuator shall be field installable without modification to the valve, a need for special tools or removal of the valve from line.
5. The valve body and cover shall be ASTM A126, Class B cast iron. The disc shall be Buna-N (NBR), ASTM D2000-BG.
6. The interior of the valve shall be coated with an epoxy suitable for potable water. The exterior shall be coated with a universal primer.
7. The valve shall be cycle tested 1,000,000 times with no signs of wear or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The tests results shall be independently certified.
8. Flexible Swing-type check valves shall be series 500 as manufactured by Val-Matic Valve and Manufacturing Corporation or approval equal.

#### 2.4 GATE VALVES

- A. Unless otherwise specified, all gate valves used in wastewater applications shall be of the single disc, double-seated, solid tapered wedge type. Iron body gate valves for

## VALVES AND APPURTENANCES

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### SECTION 15101 - PAGE 5

potable water lines shall be of the double disc type. Valves shall have non-rising stems and shall be capable of being repacked under pressure when valve is fully open.

- B. Gate valves 2-1/2 inches in size and smaller shall be bronze body; bronze fitted valves, and shall have 150-pound, cast bronze body, union bonnet, Teflon-impregnated asbestos packing, and threaded ends per ANSI B2.1. Bronze shall conform to ASTM B 62. Brass for nuts and gland shall conform to ASTM B 16. Valve discs shall be reversible. Bronze gate valves shall be Stockham Fig. B-130, Nibco Fig. T-136, or equal. For use in copper plumbing, gate valves shall be furnished with solder ends per ANSI B16.18.

### PART 3 - EXECUTION

#### 3.1 FACTORY TESTS

- A. All valves shall be tested at the point of manufacture for proper and unobstructed operation and for leakage and adequacy of design.
- B. Iron body gate valves shall be tested in accordance with AWWA C500, Section 29.
- C. Iron body check valves shall be tested in accordance with AWWA C508, Section 5.
- D. All other valves shall be given an operation test, a leakage test at rated pressure differential, and a hydrostatic test at two times rated pressure. During the hydrostatic test, there shall be no leakage through the metal, the end joints, or the shaft or stem seal, nor shall any part be permanently deformed. During the leakage test, leakage shall not exceed that permitted by ANSI B16.104, Class IV, for metal seated valves and Class VI for resiliently seated valves.

#### 3.2 INSTALLATION

- A. All valves shall be installed in strict conformance with the Drawings and approved shop drawings and manufacturer's instructions. All valves and appurtenances shall be true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed
- B. Swing check valves shall be installed only in a horizontal position. Lever shall be free

## VALVES AND APPURTENANCES

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### SECTION 15101 - PAGE 6

to operate without obstruction.

- C. All underground valves shall be installed using a concrete valve box with cast iron frame and cover or in a cast iron valve box as specified herein.
- D. Valves shall be installed in such a way that operators and packing are easily accessible. Valves with field replaceable seats shall be installed with sufficient clearance to permit removal of valve bonnet and stem without removing valve from the line.
- E. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.
- F. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe Sections in Division 15.
- G. Buried flanged or mechanical joints shall be made with cadmium plated bolts. All exposed bolts shall be made with cadmium plated bolts. All exposed bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.
- H. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing section then shall be placed. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to metal, without excessive bolt tension. Special care shall be taken in assembly of couplings in lines to be cleaned by hot water to provide the proper end clearance.
- I. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8-in. Soapy water may be used as a gasket lubricant. A

## VALVES AND APPURTENANCES

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### SECTION 15101 - PAGE 7

follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6-in. from the end, and the middle ring shall be placed on the already laid pipe end until it is properly centered over the joint. The other pipe end shall be inserted into the middle ring and brought to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares. After the bolts have been inserted and all nuts have been made up fingertight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint, preferable by use of a torque wrench of the appropriate size and torque for the bolts.

#### 3.3 SHOP PAINTING

Ferrous surfaces of valves and appurtenance shall receive a coating of rust-inhibitive primer as specified in Division 9. All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

#### 3.4 FIELD PAINTING

All metal valves and appurtenances specified herein and exposed to view will be painted as part of the work in Division 9

#### 3.5 FIELD INSPECTION AND TESTING

- A. Following installation, all valves shall be tested by the Contractor under the anticipated operating conditions. The ability of the valves to operate properly without leakage, binding, sticking, fluttering, or excessive operating torque shall be demonstrated to the satisfaction of the Engineer. The Contractor shall at his own expense adjust and/or replace any valve as necessary to assure satisfactory operation.
- B. Following installation and testing, all ferrous and non-machined surfaces of exposed valves, operators, floorstands, and stem guides shall be field primed and painted as specified herein.

END OF SECTION

***Division 16***

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**Electrical**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. The electrical work commences with the point of electrical service where shown on the Drawings and includes furnishing all material and labor for a complete electrical installation.
- B. The requirements of Division I apply to all work hereunder. The General and Special Conditions are a part of this Division of the Specifications and all provisions contained therein which affect this work are as binding as though incorporated herein.

**1.02 DEFINITIONS**

- A. Provide: Furnish, install, and connect.
- B. Product Data: Catalog cuts and descriptive literature.
- C. Shop Drawings: Factory prepared specific to the installation.
- D. Indicated: Shown on the Drawings.
- E. Noted: Indicated or specified elsewhere.

**1.03 SYSTEM DESCRIPTION**

See One Line Diagrams.

**1.04 SUBMITTALS**

- A. Make all submittals in accordance with the requirements of Division I. Approval drawings consist of shop drawings, product data and other information as noted in the individual equipment sections. Except as noted, submittal information is for approval and equipment may not be installed until submittals have been returned with stamped approval.
- B. Information required "for reference" such as product samples, similar unit test reports and time current curves is for the purpose of determining the suitability of a product, selecting breaker settings, etc. This information is to be submitted at the same time as approval data; however, this information will not be returned and stamped approval is not required prior to installation.

## ELECTRICAL POWER AND SYSTEMS

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### SECTION 16000 - PAGE 2

- C. Except as noted, installation instructions are not required to be submitted. However, it is the Contractor's responsibility to obtain installation information from the manufacturer for all equipment prior to installing the equipment.

#### 1.05 QUALITY ASSURANCE

- A. Provide the complete electrical installation in accordance with the National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), and in accordance with applicable local codes. Obtain all necessary permits and have all work inspected by appropriate authorities.
- B. All products shall be designed, manufactured, and tested in accordance with industry standards. Where applicable date for industry standards is that in effect on the date of Advertisement of the Project.
  1. American National Standards Institute (ANSI)
  2. American Society for Testing and Materials (ASTM)
  3. Federal Specifications (FS)
  4. Institute of Electrical and Electronics Engineers (IEEE)
  5. Insulated Cable Engineers Association (ICEA)
  6. National Electrical Manufacturers Association (NEMA)
  7. National Fire Protection Association (NFPA)
  8. Underwriters Laboratories, Inc. (UL)

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship products to the job site in their original packaging. Receive and store Products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times.
- B. Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

#### 1.07 PROJECT/SITE CONDITIONS

- A. Power will be supplied by the utility company overhead distribution system. Verify and comply with all power company requirements. Make necessary arrangements with the power company for temporary service requirements.
- B. Telephone, security, energy management and fire alarm will be tied into the Owner's existing system. Refer to the Drawings for conductors and interface requirements.

## ELECTRICAL POWER AND SYSTEMS

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### SECTION 16000 - PAGE 3

#### PART 2 PRODUCTS

##### 2.01 MATERIALS (NOT FURNISHED)

- A. Unless otherwise noted, the following are furnished and installed under other Divisions:
  - 1. Motors
  - 2. Electric heating and air conditioning equipment
  - 3. Building energy management systems
  - 4. Electrical heat tracing
  - 5. Pilot and control devices for the above equipment
- B. Power wiring and equipment connections for the above items are included in this Division. Also included in this Division is control wiring to the extent shown on the Electrical Drawings; other control wiring is furnished under the applicable Mechanical Division.

##### 2.02 MANUFACTURED UNITS

- A. Provide only new products of the manufacturer's latest design.

##### 2.03 EQUIPMENT

- A. Where the words "equal to" follow or precede the listed acceptable manufacturers, equal products of other manufacturers are acceptable and request for substitution may be made during submittal stage.
- B. Where the words "or equal" follow the listed acceptable manufacturers, products of other manufacturers must be submitted and approved prior to the Bid, in accordance with the Instructions to Bidders of the Contract Documents.

##### 2.04 SOURCE QUALITY CONTROL

- A. Furnish record drawings in accordance with the requirements of Division I. Record drawings consist of submittal data as listed above, operation and maintenance data, and as-built drawings. Record drawings are to reflect the final installation, including any changes during approval, manufacturing tests, and installation.
- B. In addition to other required sets, furnish one set of operation and maintenance data for all apparatus requiring service. This set is to be bound in hardback, 3-ring binder(s) located in a hinged metal cabinet in the main electrical room and shall include:
  - 1. Title page with project name; installing contractor's name, address and telephone number; date of installation and warranty period.
  - 2. Index sheet.

## ELECTRICAL POWER AND SYSTEMS

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### SECTION 16000 - PAGE 4

3. Complete manufacturer's operation and maintenance data with tabs (corresponding to the index) separating each item or system. Include the name, address, and phone number of the nearest sales and service organization for each item.
  4. Coordination Study.
- C. As-Built Drawings: Furnish one set of prints maintained at the job site at all times with all changes during construction marked thereon. Include on the as-built drawings sufficient dimensions to permit location of underground conduits.
- D. Submit the results of any tests required in the individual equipment sections.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. The complete installation is to be accomplished by skilled electrical tradesmen, with certified or suitably qualified individuals performing all special systems installation and testing. All workmanship shall be of the highest quality, sub-standard work will be rejected.
- B. Schedule the work and cooperate with all trades to avoid delays, interferences, and unnecessary work. If any conflicts occur necessitating departures from the Drawings and Specifications, details of departures and reasons therefore shall be submitted immediately for the Engineer's consideration.
- C. Prior to final inspection, clean all dirt, mud and construction debris from all boxes, cabinets, manholes and equipment enclosures.

#### 3.02 FIELD QUALITY CONTROL

- A. Description: Submit a coordination study with recommended settings for all fault protective devices within the scope of the study. The study shall be prepared by a registered professional engineer, who is not an employee of the Contractor, equipment supplier, or other party having a financial interest in the results of the study. The preparer shall certify that the protective device settings recommended represent a reasonable engineering compromise between equipment protection and selective coordination.
- B. Documentation: Provide tabulations of recommended settings and time current curves showing the degree of coordination obtained with the recommended settings. Also show equipment inrush characteristics and applicable protection limits such as motor stall times, transformer ANSI damage limits, cable heating limits and NEC overcurrent protection requirements. Include manufacturing tolerance and damage bands in plotted fuse

## ELECTRICAL POWER AND SYSTEMS

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### SECTION 16000 - PAGE 5

characteristics. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current seen by the device.

- C. Scope: The study extends from the service entrance equipment down to, and including, the low voltage motor control centers. Panelboards and other equipment downstream from the low voltage motor control centers need not be included, except as required to obtain settings for equipment within the study scope.
- D. Fault Currents: Maximum three phase symmetrical values for all major busses will be supplied by the Engineer. For high voltage busses, both momentary and interrupting network values will be supplied. Any other values needed are to be calculated as part of the study. Values supplied by the Engineer are to be used solely for determination of device settings - equipment ratings are as elsewhere noted.
- E. Study Data: The Contractor is responsible for providing field data (conductor materials, existing device types, nameplate information, etc.) to the study preparor. The Contractor is also responsible for providing to the study preparor shop drawing data on new equipment. The study preparor is responsible for obtaining all other needed data (equipment data, time current curves, etc.).
- F. Submittal Requirements: Submit the coordination study prior to, or concurrent with, distribution equipment within the study scope. This is to allow suggested improvements (relay ranges, CT ratios, etc.) that may arise in performing the study to be incorporated prior to equipment fabrication. Review procedures are as specified in Article 1.04 above.

### 3.03 DEMONSTRATION

- A. Prior to request for final review, test all systems and repair or replace all defective work. Submit, with request for final review, written certification that all electrical systems are complete and operational.
- B. Unless otherwise specified, a 1,000 Volt megohmmeter shall be used for resistance measurements.
- C. Insulation resistance measurements shall be made on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, NEMA or ANSI standards for the equipment or material being tested, unless otherwise specified. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.
- D. Insulation resistance measurements shall format similar to Form 16000-A, contained Insulation with resistance of less than 10 megohms is not

## ELECTRICAL POWER AND SYSTEMS

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### SECTION 16000 - PAGE 6

1. Conductor And Cable Tests: The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected, except that solid state equipment shall be disconnected unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.
  2. Motor Tests: The Installed Motor Test Form, 16000-B, contained in Section 01999, shall be completed for each motor after installation. All motors shall have their insulation resistance measured before they are connected. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.
- E. At the time of final review of electrical work, demonstrate the operation of electrical systems. Furnish labor, apparatus and equipment for systems' demonstration.
- F. After final review and acceptance, turn over to the Owner all keys for electrical equipment locks. Present to the Owner or the Owner's designated representative, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

END OF SECTION

**ELECTRICAL POWER AND SYSTEMS**

**SECTION 16000 - PAGE 7**

FORM 16000-A  
WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.: \_\_\_\_\_ Temperature, F \_\_\_\_\_

| Location of Test | Insulation Resistance<br>Megohms |
|------------------|----------------------------------|
|------------------|----------------------------------|

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.
- 13.
- 14.
- 15.

|                  |             |
|------------------|-------------|
| Certified _____  | Date: _____ |
| Contractor's Rep |             |
| Witnessed _____  | Date: _____ |
| Owner's Rep      |             |

**ELECTRICAL POWER AND SYSTEMS**

**SECTION 16000 - PAGE 8**

FORM 16000-B  
INSTALLED MOTOR TEST FORM

Motor Equipment Number \_\_\_\_\_ Date of Test \_\_\_\_\_

Equipment Driven \_\_\_\_\_ MCC Location \_\_\_\_\_

Ambient Temperature \_\_\_\_\_

Resistance:

Insulation resistance phase-to-ground megohms:

Phase A \_\_\_\_\_ Phase B \_\_\_\_\_ Phase C \_\_\_\_\_

Current at Full Load:

Phase A, Current \_\_\_\_\_ Phase B, Current \_\_\_\_\_

Phase C, Current \_\_\_\_\_

Thermal Overload Device:

Manufacturer/catalog number \_\_\_\_\_ Amperes \_\_\_\_\_

Circuit Breaker (MCP) setting: \_\_\_\_\_

Motor Nameplate Markings:

Mfr \_\_\_\_\_ Mfr type \_\_\_\_\_ Frame \_\_\_\_\_ HP \_\_\_\_\_

Volts \_\_\_\_\_ Phase \_\_\_\_\_ RPM \_\_\_\_\_ Service Factor \_\_\_\_\_

Amps \_\_\_\_\_ Freq \_\_\_\_\_ Ambient temp. rating \_\_\_\_\_

Time rating \_\_\_\_\_ Design letter \_\_\_\_\_  
(NEMA 1-10.35) (NEMA MG-1.16)

Code Letter \_\_\_\_\_ Insulation class \_\_\_\_\_

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

Contractor's Rep

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

Owner's Rep

**NATURAL GAS GENERATOR SET AND  
AUTOMATIC TRANSFER SWITCH**

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**SECTION 16100 - PAGE 1**

PART 1 General

1.01 References

- A. The equipment covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards of ANSI, NEC, ISO, U.L., IEEE and NEMA.

1.02 Related Sections

- A. Division 3 – Concrete
- B. Division 15 - Mechanical

1.03 Work Included

- A. The work includes supplying a complete integrated emergency generator system. The system consists of a natural gas fueled generator set and automatic transfer switch with related component accessories as specified herein.
- B. The CONTRACTOR shall be responsible for connecting all fuel piping and any necessary auxiliary equipment (gas regulators, etc.) for a fully operational fuel system.
- C. A complete system load test shall be performed after all equipment is installed.
- D. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a MANUFACTURER who has 25 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.

1.04 Acceptable Manufacturers

- A. There shall be one source responsibility for warranty, parts and service through a local representative with factory trained service personnel.
- B. Generator Set
  - 1. Cummins / Onan
- C. Automatic Transfer Switch
  - 1. Cummins / Onan

1.05 Substitution

- A. Proposed deviations from the specifications shall be treated as follows:

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 2

1. Requests for substitutions shall be made a minimum of ten (10) days prior to bid date. Manufacturers catalog data shall accompany each request and authorized acceptance shall be by addenda only.
2. The emergency power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel and exhaust components have all been sized and designed around Cummins / Onan equipment. Should any substitutions be made, the CONTRACTOR shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs, which may result from such substitutions.

#### 1.06 Submittals

- A. Engine-generator submittals shall include the following information
  1. Factory published specification sheet indicating standard and optional accessories, ratings, etc.
  2. Manufacturer's catalog cut sheets of all auxiliary components such as Automatic Transfer Switches, battery charger, control panel, enclosure, main circuit breaker, etc.
  3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.
  4. Weights of all equipment.
  5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.
  6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, jacket water heater, remote alarm indications.
  7. Engine mechanical data including heat rejection, exhaust gas flows, combustion air and ventilation air flows, noise data, fuel consumption, etc.
  8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
  9. Generator resistances, reactances, and time constants.

**NATURAL GAS GENERATOR SET AND  
AUTOMATIC TRANSFER SWITCH**

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**SECTION 16100 - PAGE 3**

10. Generator motor starting capability.
11. Control panel schematics.
12. Oil sampling analysis, laboratory location, and information.
13. Manufacturer's and dealer's written warranty.

1.07 Warranty

- A. The manufacturer's standard warranty shall in no event be for a period of less than five (5) year from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified will be rejected in their entirety.

1.08 Parts and Service Qualifications

- A. The engine-generator supplier shall have service facilities within 75 miles of the project site and maintain 24-hour parts and service capability. The distributor shall stock parts as needed to support the generator set package for this specific project.
- B. The dealer shall maintain qualified, factory trained service personnel that can respond to an emergency call within 1 hour of notification, 24 hours per day.

PART 2 Products (GEN-100)

2.01 General Requirements

- A. The generator set shall be Standby rated at 20 ekW, 25 kVA, 1800 RPM, 0.8 power factor, 230 V, 3 phase, 60 hertz, including radiator fan and all parasitic loads.
- B. All materials and parts comprising the unit shall be new and unused.

2.02 Natural Gas Engine

- A. The engine shall be spark ignition type natural gas fueled, four (4) cycle, water-cooled, vertical in-line or vee-type, operating with nominal speed not exceeding 1800 RPM.
- B. The engine shall have a battery charging DC, alternator with a transistorized voltage regulator. Starting shall be a solenoid shaft, electric starter.

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 4

- C. Engine speed shall be governed by an isochronous electronic governor to maintain 0% droop from no load to full load and +/- 0.25% steady state frequency variation.
- 2.03 Generator
- A. The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling.
  - B. The insulation material shall meet NEMA standards for Class H insulation and be vacuum impregnated with epoxy varnish to be fungus resistant. The excitation system shall be of brushless construction.
  - C. The brushless exciter shall be independent of main stator windings (either permanent magnet or auxiliary windings) and shall consist of a three-phase armature and a three-phase full wave bridge rectifier mounted on the rotor shaft. Surge suppressors shall be included to protect the diodes from voltage spikes. Generator shall have the ability to sustain short circuit current of 300% of rated current to allow protective devices to operate.
  - D. The automatic voltage regulator (AVR) shall maintain generator output voltage within +/- 0.5% for any constant load between no load and full load. The regulator shall be a totally solid state design which includes electronic voltage buildup, volts per Hertz regulation, over-excitation protection, shall limit voltage overshoot on startup, and shall be environmentally sealed.
- 2.04 Circuit Breaker
- A. Provide a generator mounted circuit breaker, molded case or insulated case construction, 100 Amp Trip, 3 pole. Breaker shall be ABB or equal and utilize a thermal magnetic trip. steel NEMA 1 enclosure mounted on a separate support stand vibration isolated from the engine / generator arrangement. Bus bars, sized for the cable type shown on drawing, shall be supplied on the load side of breaker.
- 2.05 Controls
- A. Generator Mounted Control Panel
    - 1. Provide a generator set mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation, cycle cranking, AC metering with phase selector switch, shutdown sensors and alarms with horn and reset, adjustable cooldown timer and emergency stop push-button.

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 5

2. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Components shall be housed in a NEMA 1/IP22 enclosure with hinged door. The panel itself shall be mounted on a separate support stand isolated from the engine / generator arrangement. Panel / breaker arrangements mounted on the generator set in such a way that access to the AC Generator terminal box is restricted in any way whatsoever are not acceptable.
3. Provide the following readouts:
  - Engine oil pressure
  - Coolant temperature
  - Engine RPM
  - System DC Volts
  - Engine running hours
  - Generator AC volts
  - Generator AC amps
  - Generator frequency
4. Control Panel Annunciation - Provide the following indications for protection and diagnostics according to NFPA 110 level 1:
  - Low oil pressure
  - High water temperature
  - Low coolant level
  - Overspeed
  - Overcrank
  - Emergency stop depressed
  - Approaching high coolant temperature
  - Approaching low oil pressure
  - Low coolant temperature
  - Low voltage in battery
  - Control switch not in auto. position
  - Low gas pressure

**NATURAL GAS GENERATOR SET AND  
AUTOMATIC TRANSFER SWITCH**

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**SECTION 16100 - PAGE 6**

Battery charger ac failure

High battery voltage

Two (2) Spare

- B. Provision for remote indication for generator status.

2.06 Cooling System

- A. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110°F (43°C) ambient air entering the room or enclosure (If an enclosure is specified). The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

2.07 Fuel System

- A. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted.
- B. Flexible fuel lines shall be rated for 300 degrees F and 100 PSI.

2.08 Exhaust System

- A. A critical grade exhaust muffler (minimum), companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the manufacturer's recommendation.
- B. The silencer shall be mounted so that its weight is not supported by the engine.
- C. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer.

2.09 Starting System

- A. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.
- B. The heater Watt rating shall be sized by the manufacturer to maintain jacket water temperature at 90 °F minimum, and shall be a (120/208/240) Volt, single phase, 60 hertz.
- C. Batteries: A lead-acid storage battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The battery set shall be rated no less than 75 ampere hours. Necessary cables and clamps shall be provided.

**NATURAL GAS GENERATOR SET AND  
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**SECTION 16100 - PAGE 7**

- D. A battery tray shall be provided for the batteries and shall conform to NEC 480-7(b). It shall be treated to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over battery electrolyte shall be contained within the tray to prevent a direct path to ground.
  - E. Battery Charger: A current limiting battery charger shall be furnished to automatically recharge batteries. The charger shall be dual charge rate with automatic switching to the boost rate when required. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than ten (10) amperes. On outdoor units the battery charger shall be mounted inside the genset enclosure.
- 2.10 Generator Set Enclosure – Sound Attenuated and Weather-Protective
- A. The complete engine generator set, including generator control panel, and engine starting batteries, shall be enclosed in a factory assembled, sound attenuated enclosure.
  - B. The enclosure shall be constructed of galvalite (corrosion resistant) steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of 67 dBA at 23 feet with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.
  - C. Number of doors on enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment and replacements, hose replacements, access to the control panels, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be reinforced for rigidity.
  - D. Handles shall be key lockable, all doors keyed alike, and hinges shall be zinc die cast or stainless steel. Fasteners shall be zinc plated or stainless steel. Doors shall be of a lift off design allowing one person to remove door if necessary.
  - E. Air handling will be sized and designed by the manufacturer for 0.5” static pressure drop through enclosure. Intake openings shall be screened to prevent the entrance of rodents.
  - F. Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves. Radiator access shall be through a hinged,

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 8

lockable cover on enclosure. Cooling fan and charging alternator shall be fully guarded to prevent injury.

- G. Enclosure manufacturer shall internally mount the exhaust silencer(s) and maintain the weather resistant integrity and aesthetic appearance of the system. Externally mounted silencers will not be permitted for safety and aesthetic reasons.
- H. Lifting points shall be provided on base frame suitable for lifting combined weight of base tank, generator set and enclosure.

#### 2.11 Automatic Transfer Switch

##### A. GENERAL

1. The transfer switch shall be rated for the voltage and ampacity as shown on the plans and shall have 600 volt insulation on all parts in accordance with NEMA standards.
2. The current rating shall be a continuous rating when the switch is installed in an unventilated enclosure, and shall conform to NEMA temperature rise standards. Designs which require cabinet ventilation are unacceptable and do not meet this specification.
3. The unit shall be rated based on all classes of loads, i.e., resistive, tungsten, ballast and inductive loads. Switches rated 400 amperes or less shall be UL listed for 100% tungsten lamp load.
4. As a precondition for approval, all transfer switches complete with accessories shall be listed by Underwriters Laboratories, under Standard UL 1008 (automatic transfer switches) and approved for use on emergency systems.
5. The withstand current capacity of the main contacts shall not be less than 20 times the continuous duty rating when coordinated with any molded case circuit breaker established by certified test data.
6. Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.
7. Transfer switches shall comply with the applicable standards of UL, CSA, ANSI, NFPA, IEEE, NEMA and IEC.
8. The transfer switches shall be supplied with a solid state control panel as detailed further in these specifications.

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 9

#### B. SEQUENCE OF OPERATION

1. The ATS shall incorporate adjustable three phase under-voltage sensing of the normal source.
2. When the voltage of any phase of the normal source is reduced to 80% of nominal voltage, for a period of 0-10 seconds (programmable) a pilot contact shall close to initiate starting of the engine generator.
3. The ATS shall incorporate adjustable single phase under-voltage sensing of the emergency source.
4. When the emergency source has reached a voltage value within 10% of nominal voltage and achieved frequency within 5% of the rated value, the load shall be transferred to the emergency source after a programmable time delay.
5. When the normal source has been restored to not less than 90% of rated voltage on all phases, the load shall be re-transferred to the normal source after a time delay of 0 to 30 minutes (programmable). The generator shall run unloaded for 5 minutes (programmable) and then automatically shut down. The generator shall be ready for automatic operation upon the next failure of the normal source.
6. If the engine generator should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of proper voltage (90%) on the normal source.
7. The transfer switch shall be equipped with a solid state control panel. The control panel shall perform the operational and display functions of the transfer switch. The display functions of the control panel shall include ATS position and source availability.
8. The control panel shall include indicators for timing functions, and ATS test switch.
9. The control panel shall be provided with calibrated pots (accessible only by first opening the lockable cabinet door) to set time delays, voltage and frequency sensors. The ATS shall be capable of being adjusted while the controls are energized and the unit in automatic mode. Designs which force a "programming mode" or require the controls be de-energized during adjustment are unacceptable.
10. The control panel shall be opto-isolated from its inputs to reduce susceptibility to electrical noise and provided with the following inherent control functions and capabilities:

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 10

An LED display for continuous monitoring of the ATS functions.

Built-in diagnostic display.

Test switch to simulate a normal source failure.

Time delay to override momentary normal source failure prior to engine start. Field programmable 0-10 seconds (continuously adjustable via a calibrated potentiometer factory set at 3 seconds.

Time delay on retransfer to normal source, continuously adjustable 0-30 minutes, factory set at 30 minutes. If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.

Time delay on transfer to emergency, continuously adjustable 0-15 seconds, factory set at 1 second.

An in-phase monitor or time-delayed neutral shall be provided to prevent excessive transient currents from switching motor loads.

An interval-type automatic clock exerciser with load/no load selectability shall be incorporated in the ATS.

#### C. CONSTRUCTION AND PERFORMANCE

1. The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.
2. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.
3. For switches installed in systems having ground fault protective devices, and/or wired so as to be designated a separately derived system by the NEC, a 4th pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients. Add-on or accessory poles that are not of identical construction and withstand capability are not acceptable.
4. The contact structure shall consist of a main current carrying contact, which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes above 400 Amps.

**NATURAL GAS GENERATOR SET AND  
AUTOMATIC TRANSFER SWITCH**

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**SECTION 16100 - PAGE 11**

5. The transfer switch manufacturer shall submit test data for each size switch required for this project, showing that it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity. Minimum UL listed withstand and close into fault ratings shall be as follows:

Any Molded Case Breaker\*:

| Size (Amps) | (RMS Symmetrical) |
|-------------|-------------------|
| Up to 200   | 10,000            |
| 201 - 260   | 35,000            |
| 261 - 400   | 35,000            |
| 401 - 1200  | 50,000            |
| 1201 - 4000 | 100,000           |

Specific Coordinated Breaker\*:

| Size (Amps) | (RMS Symmetrical) |
|-------------|-------------------|
| Up to 150   | 30,000            |
| 151 - 260   | 42,000            |
| 261 - 400   | 50,000            |
| 401 - 800   | 65,000            |
| 801 - 1200  | 85,000            |
| 1201 - 4000 | 100,000           |

Current Limiting Fuse\*:

| Size (Amps) | (RMS Symmetrical) |
|-------------|-------------------|
| Up to 4000  | 200,000           |

\*All values 480 volt, RMS symmetrical, less than 20% power factor.

Note: Actual necessary current withstand ratings for this project may be higher than the minimums listed above. Refer to electrical plans for exact requirements.

6. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capacities for 50 cycles of operation between normal and emergency source that are 120 degrees out of phase at 480 volts, 600% of rated current at .50 power factor. This certification is to ensure that there will be no current flow between the two isolated sources during switching.

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 12

7. All relays shall be continuous duty industrial type with wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, relays, timers and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness and keyed disconnect plugs for maintenance.
8. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.
9. A manual handle shall be provided for maintenance purposes with the switch de-energized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.
10. The switch shall be mounted in a NEMA 1 indoor enclosure unless otherwise indicated on the plans.
11. Switches composed of molded case breakers, contactors or components thereof not specifically designed as an automatic transfer switch will not be acceptable.
12. To afford the advantage of a single source of supply to the owner, the automatic transfer switch shall be supplied by the manufacturer of the engine generator set and covered under the same warranty program.

### PART 3 Execution

#### 3.01 Installation

- A. Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes. Installation of the system includes but is not limited to pouring a concrete pad for the generator set and automatic transfer switch, receiving and offloading the equipment, providing all labor, permits and material to install the total system.

#### 3.02 Start-Up and Testing

- A. Coordinate all start-up and testing activities with the Engineer and Owner.
- B. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:
  1. Verify that the equipment is installed properly.

## NATURAL GAS GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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### SECTION 16100 - PAGE 13

2. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote annunciator, etc.
  3. Test all alarms and safety shutdown devices for proper operation and annunciation.
  4. Check all fluid levels.
  5. Start engine and check for exhaust, oil, fuel leaks, vibrations, etc.
  6. Verify proper voltage and phase rotation at the transfer switch before connecting to the load.
  7. Connect the generator to building load and verify that the generator will start and run all designated loads in the plant.
- C. Perform a 4-hour load bank test at full nameplate load using a load bank and cables supplied by the local generator dealer. Notify the City inspector prior to test and provide a certification letter from the manufacturer upon test completion. Observe and record the following data at 15 minute intervals:
1. Service meter hours
  2. Volts AC - All phases
  3. Amps AC - All phases
  4. Frequency
  5. Power factor or Vars
  6. Jacket water temperature
  7. Oil Pressure
  8. Ambient temperature
- D. Operation and Maintenance Manuals
1. Provide three (3) sets of operation and maintenance manuals covering the generator, automatic transfer switch, and auxiliary components. Include parts manuals, final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.
- E. Training
1. Provide one day of on-site training to instruct the owner's personnel in the proper operation and maintenance of the equipment. Review

**NATURAL GAS GENERATOR SET AND  
AUTOMATIC TRANSFER SWITCH**

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**SECTION 16100 - PAGE 14**

operation and maintenance manuals, parts manuals, and emergency service procedures.

END OF SECTION

## DIESEL GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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SECTION 16200 - PAGE 1

### PART 1 General

#### 1.01 References

- A. The equipment covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards of ANSI, NEC, ISO, U.L., IEEE and NEMA.

#### 1.02 Related Sections

- A. Division 3 – Concrete
- B. Division 15 - Mechanical

#### 1.03 Work Included

- A. The work includes supplying a complete integrated emergency generator system. The system consists of a diesel generator set and automatic transfer switch with related component accessories as specified herein.
- B. The CONTRACTOR shall provide a full tank of diesel fuel for the completion of all testing.
- C. A complete system load test shall be performed after all equipment is installed.
- D. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a MANUFACTURER who has 25 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.

#### 1.04 Acceptable Manufacturers

- A. There shall be one source responsibility for warranty, parts and service through a local representative with factory trained service personnel.
- B. Generator Set
  - 1. Cummins / Onan
- C. Automatic Transfer Switch
  - 1. Cummins / Onan

#### 1.05 Substitution

- A. Proposed deviations from the specifications shall be treated as follows:

## **DIESEL GENERATOR SET AND AUTOMATIC TRANSFER SWITCH**

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### **SECTION 16200 - PAGE 2**

1. Requests for substitutions shall be made a minimum of ten (10) days prior to bid date. Manufacturers catalog data shall accompany each request and authorized acceptance shall be by addenda only.
2. The emergency power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel and exhaust components have all been sized and designed around Cummins / Onan equipment. Should any substitutions be made, the CONTRACTOR shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs, which may result from such substitutions.

#### 1.06 Submittals

- A. Engine-generator submittals shall include the following information
  1. Factory published specification sheet indicating standard and optional accessories, ratings, etc.
  2. Manufacturer's catalog cut sheets of all auxiliary components such as Automatic Transfer Switches, battery charger, control panel, enclosure, main circuit breaker, etc.
  3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.
  4. Weights of all equipment.
  5. Concrete pad recommendation, layout and stub-up locations of electrical and fuel systems.
  6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, jacket water heater, remote alarm indications.
  7. Engine mechanical data including heat rejection, exhaust gas flows, combustion air and ventilation air flows, noise data, fuel consumption, etc.
  8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
  9. Generator resistances, reactances, and time constants.

## **DIESEL GENERATOR SET AND AUTOMATIC TRANSFER SWITCH**

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**SECTION 16200 - PAGE 3**

10. Generator motor starting capability.
11. Control panel schematics.
12. Oil sampling analysis, laboratory location, and information.
13. Manufacturer's and dealer's written warranty.

### 1.07 Warranty

- A. The manufacturer's standard warranty shall in no event be for a period of less than five (5) year from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified will be rejected in their entirety.

### 1.08 Parts and Service Qualifications

- A. The engine-generator supplier shall have service facilities within 75 miles of the project site and maintain 24-hour parts and service capability. The distributor shall stock parts as needed to support the generator set package for this specific project.
- B. The dealer shall maintain qualified, factory trained service personnel that can respond to an emergency call within 1 hour of notification, 24 hours per day.

## PART 2 Product (GEN-101)

### 2.01 General Requirements

- A. The generator set shall be Standby rated at 450 ekW, 563, 1800 RPM, 0.8 power factor, 480Y/277 V, 3 phase, 4 wire, 60 hertz, including radiator fan and all parasitic loads.
- B. All materials and parts comprising the unit shall be new and unused.

### 2.02 Diesel Engine

- A. The engine shall be as manufactured by Cummins / Onan or equal. The engine shall be water-cooled inline or vee-type, four cycle compression ignition diesel. It shall meet specifications when operating on number 2 domestic burner oil. Two cycle engines will not be considered. The engine shall have air cleaner, coolant, fuel and oil filters with replaceable elements; lube oil cooler and a fuel lift pump.

## **DIESEL GENERATOR SET AND AUTOMATIC TRANSFER SWITCH**

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### **SECTION 16200 - PAGE 4**

- B. The engine shall have a battery charging DC, alternator with a transistorized voltage regulator. Starting shall be a solenoid shaft, electric starter.
- C. The complete engine block shall be machined from one casting. Designs incorporating multiple blocks bolted together are not acceptable.
- D. The engine shall utilize a gear-type, positive displacement, full pressure lubricating oil pump and water-cooled lube oil cooler.
- E. Fuel filter and serviceable fuel system components shall be located to prevent fuel from spilling onto generator set batteries.
- F. For gensets rated less than 125kW, engine speed shall be governed by a mechanical governor to maintain steady state alternator frequency within +/- 0.8% of rated frequency. Speed droop will be a maximum of 4% from no load to full load. The governor shall be equipped with speed adjustment.
- G. For gensets rated 125kW or greater, engine speed shall be governed by an isochronous electronic governor to maintain 0% droop from no load to full load and +/- 0.25% steady state frequency variation.

#### 2.03 Generator

- A. The generator shall meet the necessary kW/kVA rating as described above with a maximum temperature rise of 105°C over a 40°C ambient. This should cause the alternator to be oversized (vs. standard 130°C standby rating) for improved motor starting capability.
- B. The synchronous generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling.
- C. The insulation material shall meet NEMA standards for Class H insulation and be vacuum impregnated with epoxy varnish to be fungus resistant. The excitation system shall be of brushless construction.
- D. The brushless exciter shall be independent of main stator windings (either permanent magnet or auxiliary windings) and shall consist of a three-phase armature and a three-phase full wave bridge rectifier mounted on the rotor shaft. Surge suppressors shall be included to protect the diodes from voltage spikes. Generator shall have the ability to sustain short circuit current of 300% of rated current to allow protective devices to operate.
- E. The automatic voltage regulator (AVR) shall maintain generator output voltage within +/- 0.5% for any constant load between no load and full load. The regulator shall be a totally solid state design which includes electronic voltage

## **DIESEL GENERATOR SET AND AUTOMATIC TRANSFER SWITCH**

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### **SECTION 16200 - PAGE 5**

buildup, volts per Hertz regulation, over-excitation protection, shall limit voltage overshoot on startup, and shall be environmentally sealed.

#### **2.04 Circuit Breaker**

- A. Provide a generator mounted circuit breaker, molded case or insulated case construction, 800 Amp Trip, 3 pole. Breaker shall be ABB or equal and utilize a thermal magnetic trip. steel NEMA 1 enclosure mounted on a separate support stand vibration isolated from the engine / generator arrangement. Bus bars, sized for the cable type shown on drawing, shall be supplied on the load side of breaker.

#### **2.05 Controls**

##### **A. Generator Mounted Control Panel**

1. Provide a generator set mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation, cycle cranking, AC metering with phase selector switch, shutdown sensors and alarms with horn and reset, adjustable cooldown timer and emergency stop push-button.
2. Critical components shall be environmentally sealed to protect against failure from moisture and dirt. Components shall be housed in a NEMA 1/IP22 enclosure with hinged door. The panel itself shall be mounted on a separate support stand isolated from the engine / generator arrangement. Panel / breaker arrangements mounted on the generator set in such a way that access to the AC Generator terminal box is restricted in any way whatsoever are not acceptable.
3. Provide the following readouts:
  - Engine oil pressure
  - Coolant temperature
  - Engine RPM
  - System DC Volts
  - Engine running hours
  - Generator AC volts
  - Generator AC amps
  - Generator frequency

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4. Control Panel Annunciation - Provide the following indications for protection and diagnostics:

- Low oil pressure
- High water temperature
- Low coolant level
- Overspeed
- Overcrank
- Emergency stop depressed
- Approaching high coolant temperature
- Approaching low oil pressure
- Low coolant temperature
- Low voltage in battery
- Control switch not in auto. position
- Low fuel main tank
- Battery charger ac failure
- High battery voltage
- Two (2) Spare

- B. Remote Annunciator NFPA 110

1. Remote Annunciator Panel - The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn. Provide alarm indication for "generator ground fault" on solidly grounded wye systems of more than 150 volts to ground and circuit breakers rated 1000 amp or more, to meet NEC.

### 2.06 Cooling System

- A. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 122°F (50°C) ambient air entering the room or enclosure (If an enclosure is specified). The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

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2.07 Fuel System

- A. Filter/Separator - In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine.
- B. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted.
- C. Flexible fuel lines shall be rated for 300 degrees F and 100 PSI.

2.08 Fill Boxes:

- A. Spill-container type enclosing a fill cap assembly with camlock hose connector with closure coordinated with fittings used by fuel supplier.
- B. Watertight assembly, cylindrical body, quick-opening corrosion-resistant watertight sealable cover, polyethylene spill containment compartment with minimum 5 gallon capacity. Integral drain valve with discharge to fill pipe.
- C. Fill cap shall be lockable, tight-fill design with provision for padlock on the top of the cap. Fill cap shall screw onto threaded adapter that can be removed without removing fill box. Entire assembly shall seal tight with no leakage during filling and when cap is in place.
- D. Provide special tools necessary for opening fill boxes and fill caps.
- E. Protect spill container from traffic by ramped, drain-slotted cast iron body ring and cover. Design shall prevent transmission of traffic loads to the underground tank. Spill-container type not required at locations designated only for sounding tanks.

2.09 Exhaust System

- A. A critical grade exhaust muffler (minimum), companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the manufacturer's recommendation.
- B. The silencer shall be mounted so that its weight is not supported by the engine.
- C. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer.

2.10 Starting System

- A. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.

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- B. The heater Watt rating shall be sized by the manufacturer to maintain jacket water temperature at 90 °F minimum, and shall be a (120/208/240) Volt, single phase, 60 hertz.
  - C. Batteries: A lead-acid storage battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The battery set shall be rated no less than 900 Cold Cranking Amps, and 200 ampere hours. Necessary cables and clamps shall be provided.
  - D. A battery tray shall be provided for the batteries and shall conform to NEC 480-7(b). It shall treated to be resistant to deterioration by battery electrolyte. Further, construction shall be such that any spillage or boil-over battery electrolyte shall be contained within the tray to prevent a direct path to ground.
  - E. Battery Charger: A current limiting battery charger shall be furnish to automatically recharge batteries. The charger shall be dual charge rate with automatic switching to the boost rate when required. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. Ac input voltage shall be 120 volts, single phase. Amperage output shall be no less than ten (10) amperes. On outdoor units the battery charger shall be mounted inside the genset enclosure.
- 2.11 Generator Set Enclosure – Sound Attenuated and Weather-Protective
- A. The complete diesel engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated enclosure mounted on the fuel tank base.
  - B. The enclosure shall be constructed of galvatite (corrosion resistant) steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of 70 dBA at 7 meters with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.
  - C. A dual wall fuel tank base of 660 gallon capacity shall be provided as an integral part of the enclosure. It shall be contained in a rupture basin with 110% capacity. The tank shall be pressure tested for leaks prior to shipment and have all necessary venting per UL142 standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided. The device contacts shall be connected to the generator control panel terminals for telemetry.

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- D. Number of doors on enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment and replacements, hose replacements, access to the control panels, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be reinforced for rigidity. Side access doors and a rear control door shall be provided.
- E. Handles shall be key lockable, all doors keyed alike, and hinges shall be zinc die cast or stainless steel. Fasteners shall be zinc plated or stainless steel. Doors shall be of a lift off design allowing one person to remove door if necessary.
- F. Air handling will be sized and designed by the manufacturer for 0.5" static pressure drop through enclosure. Intake openings shall be screened to prevent the entrance of rodents.
- G. Lube oil and coolant drains shall be extended to the exterior of the enclosure and terminated with drain valves. Radiator access shall be through a hinged, lockable cover on enclosure. Cooling fan and charging alternator shall be fully guarded to prevent injury.
- H. Enclosure manufacturer shall internally mount the exhaust silencer(s) and maintain the weather resistant integrity and aesthetic appearance of the system. Externally mounted silencers will not be permitted for safety and aesthetic reasons.
- I. Lifting points shall be provided on base frame suitable for lifting combined weight of base tank, generator set and enclosure.
- J. Provide vibration isolations as required.
- K. Generator shall be mounted far enough away from obstructions to allow all doors to open 90°. All conduits and gas lines shall be installed underground.

#### 2.12 Automatic Transfer Switch

##### A. GENERAL

- 1. The transfer switch shall be rated for 480/277V, 3P, 4W, 225A and shall be housed in a NEMA 4x enclosure.
- 2. The current rating shall be a continuous rating when the switch is installed in an unventilated enclosure, and shall conform to NEMA temperature rise standards. Designs which require cabinet ventilation are unacceptable and do not meet this specification.

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3. The unit shall be rated based on all classes of loads, i.e., resistive, tungsten, ballast and inductive loads. Switches rated 400 amperes or less shall be UL listed for 100% tungsten lamp load.
4. As a precondition for approval, all transfer switches complete with accessories shall be listed by Underwriters Laboratories, under Standard UL 1008 (automatic transfer switches) and approved for use on emergency systems.
5. The withstand current capacity of the main contacts shall not be less than 20 times the continuous duty rating when coordinated with any molded case circuit breaker established by certified test data.
6. Temperature rise tests in accordance with UL 1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.
7. Transfer switches shall comply with the applicable standards of UL, CSA, ANSI, NFPA, IEEE, NEMA and IEC.
8. The transfer switches shall be supplied with a solid state control panel as detailed further in these specifications.

#### **B. SEQUENCE OF OPERATION**

1. The ATS shall incorporate adjustable three phase under-voltage sensing of the normal source.
2. When the voltage of any phase of the normal source is reduced to 80% of nominal voltage, for a period of 0-10 seconds (programmable) a pilot contact shall close to initiate starting of the engine generator.
3. The ATS shall incorporate adjustable single phase under-voltage sensing of the emergency source.
4. When the emergency source has reached a voltage value within 10% of nominal voltage and achieved frequency within 5% of the rated value, the load shall be transferred to the emergency source after a programmable time delay.
5. When the normal source has been restored to not less than 90% of rated voltage on all phases, the load shall be re-transferred to the normal source after a time delay of 0 to 30 minutes (programmable). The generator shall run unloaded for 5 minutes (programmable) and then

## DIESEL GENERATOR SET AND AUTOMATIC TRANSFER SWITCH

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automatically shut down. The generator shall be ready for automatic operation upon the next failure of the normal source.

6. If the engine generator should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of proper voltage (90%) on the normal source.
7. The transfer switch shall be equipped with a solid state control panel. The control panel shall perform the operational and display functions of the transfer switch. The display functions of the control panel shall include ATS position and source availability.
8. The control panel shall include indicators for timing functions, and ATS test switch.
9. The control panel shall be provided with calibrated pots (accessible only by first opening the lockable cabinet door) to set time delays, voltage and frequency sensors. The ATS shall be capable of being adjusted while the controls are energized and the unit in automatic mode. Designs which force a "programming mode" or require the controls be de-energized during adjustment are unacceptable.
10. The control panel shall be opto-isolated from its inputs to reduce susceptibility to electrical noise and provided with the following inherent control functions and capabilities:

An LED display for continuous monitoring of the ATS functions.  
Built-in diagnostic display.

Test switch to simulate a normal source failure.

Time delay to override momentary normal source failure prior to engine start. Field programmable 0-10 seconds (continuously adjustable via a calibrated potentiometer factory set at 3 seconds.

Time delay on retransfer to normal source, continuously adjustable 0-30 minutes, factory set at 30 minutes. If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.

Time delay on transfer to emergency, continuously adjustable 0-15 seconds, factory set at 1 second.

An in-phase monitor or time-delayed neutral shall be provided to prevent excessive transient currents from switching motor loads.

An interval-type automatic clock exerciser with load/no load selectability shall be incorporated in the ATS.

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### **C. CONSTRUCTION AND PERFORMANCE**

1. The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 6 cycles or less.
2. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.
3. For switches installed in systems having ground fault protective devices, and/or wired so as to be designated a separately derived system by the NEC, a 4th pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients. Add-on or accessory poles that are not of identical construction and withstand capability are not acceptable.
4. The contact structure shall consist of a main current carrying contact, which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes above 400 Amps.

The transfer switch manufacturer shall submit test data for each size switch required for this project, showing that it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity.

5. All relays shall be continuous duty industrial type with wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, relays, timers and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness and keyed disconnect plugs for maintenance.
  6. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.
- D. A manual handle shall be provided for maintenance purposes with the switch de-energized. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.

## **DIESEL GENERATOR SET AND AUTOMATIC TRANSFER SWITCH**

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### **PART 3 Execution**

#### **3.01 Installation**

- A. Install equipment in accordance with manufacturer's recommendations, the project drawings and specifications, and all applicable codes. Installation of the system includes but is not limited to pouring a concrete pad for the generator set and automatic transfer switch, receiving and offloading the equipment, providing all labor, permits and material to install the total system.

#### **3.02 Start-Up and Testing**

- A. Coordinate all start-up and testing activities with the Engineer and Owner.
- B. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:
  - 1. Verify that the equipment is installed properly.
  - 2. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote annunciator, etc.
  - 3. Test all alarms and safety shutdown devices for proper operation and annunciation.
  - 4. Check all fluid levels.
  - 5. Start engine and check for exhaust, oil, fuel leaks, vibrations, etc.
  - 6. Verify proper voltage and phase rotation at the transfer switch before connecting to the load.
  - 7. Connect the generator to building load and verify that the generator will start and run all designated loads in the plant.
- C. Perform a 4-hour load bank test at full nameplate load using a load bank and cables supplied by the local generator dealer. Notify the City inspector prior to test and provide a certification letter from the manufacturer upon test completion. Observe and record the following data at 15 minute intervals:
  - 1. Service meter hours
  - 2. Volts AC - All phases
  - 3. Amps AC - All phases
  - 4. Frequency
  - 5. Power factor or Vars

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6. Jacket water temperature
  7. Oil Pressure
  8. Fuel pressure
  9. Ambient temperature
- D. Operation and Maintenance Manuals
1. Provide three (3) sets of operation and maintenance manuals covering the generator, automatic transfer switch, and auxiliary components. Include parts manuals, final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.
- E. Training
1. Provide one day of on-site training to instruct the owner's personnel in the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals, and emergency service procedures.

END OF SECTION

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Rigid metal conduit and fittings.
- B. Flexible metal conduit and fittings.
- C. Liquidtight flexible conduit and fittings.
- D. Non-metallic conduit and fittings.
- E. Electrical metallic tubing and fittings.
- F. Outlet boxes.
- G. Pull and junction boxes.

**1.02 SUBMITTALS**

- A. Provide product data.

**PART 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Conduit: Allied, Republic, Triangle or Wheatland.
- B. PVC Coated Conduit and Fittings: Perrnaeote, Robroy or Occidental.
- C. PVC Conduit: Amoco, Carion or Certainteed.
- D. Flexible Conduit: Anaconda, Thomas & Betts, Electric Flex or Triangle.
- E. Fittings: Appleton, Crouse-Hinds, Oz or Thomas & Betts.
- F. Boxes shall be equal to Appleton, Crouse Hinds, Raco, or Steel City,
- G. Substitutions: Products equal to those listed.

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#### 2.02 MATERIALS

- A. Rigid Metal Conduit and Fittings
1. Rigid Steel Conduit: UL 6; ANSI C80. 1; hot dip galvanized; minimum size 3/4-inch.
  2. PVC Coated Conduit: NEMA RN- I or UL-6 rigid steel conduit with factory applied external 40 mil PVC coating and urethane interior coating. Prior to coating, treat conduit with a heat polymerizing adhesive so the bond between metal and coating is greater than the tensile strength of the coating. Minimum size 3/4-inch.
  3. Fittings and Conduit Bodies: NEMA FB-1; zinc coated; taper-threaded type, material to match conduit. Where PVC coated conduits are indicated all couplings, fittings, conduit bodies, pipe straps, U bolts, beam clamps, flex connections and other accessories shall have factory applied PVC coating. Use PVC coated hubs for connection of coated conduits - locknuts are not acceptable.
- B. Flexible Metal Conduit and Fittings
1. Conduit: UL 1; FS WW-C-566; single steel continuous strip with galvanized coating; minimum size 3/8-inch.
  2. Fittings and Conduit Bodies: NENIA FB-1; malleable iron squeeze type.
- C. Liquidtight Flexible Conduit and Fittings
1. Conduit: UL listed liquidtight consisting of extruded thermoplastic. Minimum size 3/4-inch. Exception: Where connected to devices with manufacturer supplied 1/2 match conduit size to hub size.
  2. Fittings and Conduit Bodies: NEMA FB-1; compression type with O-ring. Where PVC coated conduits are indicated, provide PVC coated fittings for flex connections.
- D. Rigid Nonmetallic Conduit and Fittings
1. Conduit: NEMA TC-2; Schedule 40 PVC. Minimum size 1".
  2. Fittings and Conduit Bodies: NEMA TC-3.
- E. Electrical Metallic Tubing (Emt) and Fittings
1. EMT: ANSI C80.3; hot dip galvanized mild strip steel; minimum size 1/2-inch.
  2. Fittings and Conduit Bodies: NEMA FB-1; steel or malleable iron, compression type with insulated throat. Indenter or set screw type connectors are not acceptable.

## CONDUIT

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- F. Outlet Boxes
1. Sheet Metal Outlet Boxes: NEMA OS-1; galvanized steel, with ½ inch male fixture studs where required.
  2. Nonmetallic Outlet Boxes: NEMA OS-2.
  3. Cast Boxes: Cast ferrous alloy with galvanized or cadmium finish, deep type, gasketed cover, threaded hubs.
  4. Floor Boxes: Full adjustable, cast iron, water and concrete tight.
- G. Pull and Junction Boxes
1. Sheet Metal Boxes: NEMA OS-1; galvanized steel. Boxes larger than 12-inches in any dimension are hinged enclosure as specified under Section 16160.
  2. Cast Metal Boxes: NEMA 250; Type 4, galvanized cast iron box and cover, neoprene gasket, stainless steel cover screws, UL listed as raintight. Provide flat-flanged type for surface mounting and outside flange recessed cover type for underground use. Boxes for sidewalk or other traffic areas to have appropriate duty cover with non-skid finish.
  3. Corrosion Resistant Boxes: UL 508 Type 4X, gasketed screw cover. For boxes larger than 12-inches in any dimension provide hinge on one side and stainless steel toggle latches (equal to Hoffman A-FC412SS) on the other three sides. Equal to Type 304 stainless steel equal to Hoffman Bulletin A-51.
  4. Fiberglass Handholes for Underground Installations: Die-molded with pre-cut 6 x 6-inch cable entrance at center bottom of each side; fiberglass weatherproof cover with non-skid finish.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Coordination of Box Locations
1. Provide boxes as shown on Drawings, and as required for splices, taps, wire pulling and equipment connections.
  2. Box locations shown on the Drawings are approximate unless dimensioned. Verify box locations prior to rough-in. Coordinate mounting heights and locations of outlet mounted above counters, benches, backsplashes, and other furnishings. Locate outlet boxes to permit handicap access per ANSI A117.1. Any outlet may be relocated by up to 10 feet before it is permanently installed without incurring additional cost.

## CONDUIT

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#### 3.02 INSTALLATION

##### A. Conduit Installation

1. Cut conduit square using a saw or pipecutter and de-burr cut ends. Paint threads with zinc compound. Bring conduit to the shoulder of fittings and couplings and fasten securely. All connections are to be wrench tightened and electrically continuous. No running threads are permitted.
2. Use conduit hubs for fastening conduit to cast boxes, and for fastening conduit to sheet metal boxes in damp or wet locations. Use conduit bodies to make sharp changes in direction. For sizes 2-inches and larger, use 'LD" or similar fittings to permit a straight pull from either direction.
3. The maximum length between pull points is 400 feet. This length shall be reduced by one foot for each degree of bend.
4. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2-inch size. Crushed or deformed conduits may not be installed.
5. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.
6. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture. Install threaded PVC end caps on conduits stubbed up for future use.
7. Provide a 200 pound tensile strength polyolefin line pulled through and tied off at each end of all empty conduits.
8. Install expansion joints where conduit crosses building expansion joints and for straight runs in excess of 100 feet.
9. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.
10. Provide watertight seals, equal to OZ type WSK or FSK, where conduit penetrates exterior walls and where conduit passes between spaces normally at different temperatures. Seal duct bank and underground conduit entry with GE or Dow silicone sealant.
11. Provide silicone sealant equal to Dow or GE for conduit entry in outlet boxes and equipment enclosures (all conduit ends except pull boxes and fittings) for the following areas:
  - a. Chlorine Room
  - b. Fluoride Room
  - c. Ammonia Room
12. In locations where the conduit cannot be turned, provide three piece threaded rigid couplings. Provide clamp backs for conduits on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.
13. Route conduits in slabs above the bottom reinforcing and below the top reinforcing. Maximum size for conduits in slabs above grade is 1-inch. Route so conduits in slabs above grade do not cross.
14. Protect conduit threads from rust and damage during construction.

## CONDUIT

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15. PVC Conduit Bends: Do not use methods which will deform or change the physical characteristics of the conduit. Use PVC-coated rigid steel factory elbows for bends  
in runs longer than 100 feet, and in runs which have more than two bends, regardless of length. Exception: Where concrete encased in slab or ductbank, GRS elbows may be used in lieu of PVC coated.
  16. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.
  17. PVC Coated Conduit: Exercise care not to damage the coating during cutting, threading, bending, and assembly. Follow the manufacturer's installation instructions. Use vise jaws, bending equipment, strap wrenches, and other tools which are specifically designed for coated conduits. Do not use chain vise, pipe wrench, channel locks or the like. Nicks or small damaged areas (1/2-inch maximum) may be repaired with a manufacturer approved compound. Replace items if coating is damaged in excess of 1/2-inch.
  18. Conductor Protection: Provide bushings on metallic and bell ends on PVC conduits unless conduit terminates in a hub or similar fitting.
- B. Conduit Arrangement and Support
1. Arrange conduit to maintain headroom and present a neat appearance. Run exposed conduits parallel or perpendicular to building surfaces and adjacent piping. Group conduit in parallel runs where practical and provide rack space for 25 percent additional conduits. Use concentric bends for parallel runs.
  2. Avoid sources of heat when possible. Where unavoidable, maintain 3-inch clearance when crossing hot pipes and 12-inch clearance between parallel hot pipes, flues, heating appliances and other heat sources.
  3. Support conduits to prevent distortion of alignment by wire pulling operations. Fasten single conduits with one hole malleable iron straps. For multiple runs use channel and clamps. Wire, perforated pipe straps and the like are not acceptable support means.
  4. Support conduit at a maximum of seven feet on center and within three feet of each box, cabinet, or fitting. Hang trapeze assemblies with threaded rods not less than 3/8-inch diameter. Remove all temporary supports prior to pulling conductors.
- C. Underground Duct Bank Installation
1. Install top of duct bank minimum 24-inches below finished grade with plastic warning tape 12-inches below finished grade.
  2. Install conduit with minimum grade of 4-inches per 100 feet.
  3. Terminate conduit in end bell at manhole entries.

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4. Stagger conduit joints in concrete encasement 6-inches minimum.
5. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank. Use suitable separators and chairs installed not greater than four feet on centers to provide conduit spacing as indicated. Securely anchor conduit to prevent movement during concrete placement.
6. Construct duct banks with 3,000 psi concrete. Provide reinforcing bars as shown on the Drawings.
7. Where duct bank passes beneath footings or slabs resting on grade excavate to provide a minimum of 6-inch clearance between the conduits and the structure. Backfill to the base of the structure with concrete.

#### D. Box Installation

1. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation, except provide minimum 24-inch separation in acoustic-rated walls.
2. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
3. Support boxes independently of conduits openings.
4. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
5. In inaccessible ceiling areas, position outlets and junction boxes within 6-inches of recessed luminaires to be accessible through luminaire ceiling opening.
6. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
7. Align wall-mounted outlet boxes for switches, thermostats, and similar devices. Align adjacent devices at different elevations in one vertical line. Set floor boxes level and flush with finish flooring material.
8. Unless otherwise noted, use only cast outlet boxes. Sheet metal boxes may be used where concealed above ceilings or in dry walls, exposed in electrical closets, and for telephone wiring.
9. Field drill conduit holes in tap, junction and pull boxes so as to afford the maximum bending radius for the conductors.
10. Use PVC coated boxes wherever PVC coated conduit is indicated.
11. Label cover of junction boxes with circuit numbers of conductors in the box.

### 3.03 PROTECTION SCHEDULES

#### A. Conduit Schedule

1. Except as noted, use only rigid steel conduits.

## CONDUIT

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2. Use liquidtight flexible steel conduit for connections to motors, transformers and other vibrating equipment.
3. EMT may be used where concealed in spaces above hung ceilings and in hollow spaces of interior partitions.
4. Non-jacketed flexible steel conduit may be used for connections to lighting fixtures in suspended ceilings.
5. Use PVC coated conduits where conduits are in direct contact with earth.
6. Rigid nonmetallic conduit may be used for underground, concrete encased duct banks and in or below slab on grade. Exception: Use rigid steel conduit for analog signal circuits; 4 to 20 mA and AC or DC signals less than 25 volts.
7. Where PVC conduit is indicated, make a transition to rigid steel below grade or slab and continue above with rigid steel conduit. Exception: PVC may enter switchboards, motor control centers or other floor standing electrical equipment enclosures. Provide bell ends or socket end bell at enclosure entry.

END OF SECTION

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. AC variable frequency drives.

**1.02 RELATED SECTIONS**

- A. Except as noted equipment specified in this Section is provided under other Divisions. Include, under this Division, receiving, storage and handling; wall or floor mounting of drive control panels (including equipment pads); and wiring.

**1.03 SUBMITTALS**

- A. Submit shop drawings.
- B. Submit installation instructions.
- C. Submit schematic diagrams and layout.

**PART 2 PRODUCTS (VFD-100)**

**2.01 MANUFACTURERS**

- A. AC Drives: Allen-Bradley, Square "D" or approved equal.

**2.02 COMPONENTS**

- A. AC Drive Controllers:
  - 1. Type: Variable frequency consisting of an input full wave rectifier and output inverter capable of producing a constant volts per hertz output suitable for operating a standard squirrel cage induction motor.
  - 2. Drives are pulse width modulated (PWM) 6 pulse, 2-circuit with Insulated Gate Bipolar Transistors (IGBT) design with power components on one board and control components on another board.
  - 3. Ratings:
    - a. Speed Range: 6 to 60 Hertz with a variable torque load.
    - b. Efficiency: 95 percent minimum at 100 percent speed
    - c. Service Factor: 1.0 continuous; 1.5 for one minute.
    - d. Speed Regulation: 3 percent.

## VARIABLE SPEED DRIVES

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4. Equip drive with adjustments for minimum speed, maximum speed, acceleration-deceleration rate and current limit.
5. Protective Features:
  - a. Input molded case circuit breaker rated 42,000 AIC or fuses to disconnect the drive and control circuits.
  - b. Output contactor to disconnect the motor when the drive is off. Interlock contactor with drive to prevent starting unless the drive is at zero volts and hertz. Provide restart delay to allow equipment to coast to rest before restarting. Output contactor may be rated in accordance with NEMA standards. Where constant speed bypass is noted, provide bypass contactor rated in accordance with NEMA standards; IEC ratings are not acceptable.
  - c. Solid state protective circuits with diagnostic capabilities for over/under voltage, loss of voltage, inverse time and instantaneous overcurrent, phase loss, phase unbalance, and thermal overload. Activation of all protective functions shall be accomplished without damage to the drive and without need to replace any components. Over/under voltage and loss of voltage are to reset automatically when voltage returns to normal; all other conditions are to be manually reset.
  - d. Provide protective circuitry, if not inherent in the drive design, to shut down without damage to the drive if an out of synch condition occurs, i.e., running drive connected to a stopped motor, plug reversal or motor stall.
  - e. Where motor temperature switches are specified, provide circuitry to shut down the drive if the switch opens.
6. Input Voltage and Phase
  - a. Less than 1 HP: 208 volt, single phase, unless specified otherwise.
  - b. 1 HP and Above: 480 volt, three phase, unless specified otherwise.
7. Indoor Enclosures: Individual wall mounted, free standing or group assembly as noted. Enclosure shall meet NEMA 12 requirements. Outdoor Enclosures: NEMA 4X stainless steel. Oversize the drive and/or provide heat sinks on the drive and enclosure to allow operation in a 50 degree C ambient environment. Cooling fans are not acceptable. Provide thermostatically controlled space heater.
8. Harmonic Analysis Calculations:

VFDs will be supplied from different 480V bus as shown on the MCC single-line diagrams. The system reactance at 480V bus has to be determined before harmonic calculations are performed. The total harmonic distortion shall be calculated for each drive unit based on system impedances and configuration. Total harmonic distortion shall be determined in accordance with IEEE 519, 1992. With all VFDs operating full load, the supply voltage wave form shall not be distorted by more than 3 percent total harmonic distortion, at the 480-volt bus. The total current harmonic distortion shall also be limited to the values indicated in IEEE 519-Table 10.3, determined based on the actual ratio of short circuit current and full load current. The utility short circuit current shall be obtained by the Contractor. The

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Contractor shall field verify all existing equipment and associated loads and contribution to overall harmonic distortion. If harmonic filters are required to meet these requirements, the VFD manufacturer must provide the filter and is responsible for the design manufacturing, cost, and installation of the filter. Compliance shall be verified by the third party analysis of the on-site field measurements of the harmonic distortion at the point of common coupling with or without VFDs operating. The third party shall be hired by the contractor with the engineer's approval.

9. Line Input Filter and Reactor Network:

A line input filter network shall be provided on each VFD and a separate series reactor shall be provided on the input power source to the rectifies of each VFD in accordance with IEE 519, 1992 to reduce voltage and current harmonic distortion. Total harmonic distortion of the station bus wave form, including contribution of notching, and with all VFDs in operation shall not exceed 3 percent at the 480-volt main bus when calculated in accordance with IEEE 519, 1992. Voltage harmonic distortion higher than 3 percent is not acceptable. Shunt components of the input filter network shall be disconnected by a contractor when the drive is shut down. The input filter shall be located between items B and D. The current harmonic distortion shall also be limited to the values indicated in IEEE 519-Table 10.3.

10. Output Filters:

An output filter network shall be provided to eliminate high frequency camera waves. Motor heating must be limited to 1.05 times of standard motor heating.

### 2.03 SOURCE QUALITY CONTROL

A. Controls:

1. Provide the following door mounted operator control devices:
  - a. Local-OFF-Remote selector switch for remote START/STOP. Local-Remote selector remote speed control.
  - b. Manual START/STOP selector and speed adjustment knob.
  - c. Where constant speed bypass is noted, provide a Constant-Variable speed mode selector switch. Provide either START/STOP or Hand/Off/Automatic selector switch as indicated for on-off control in the constant speed mode.
  - d. Speed indicating meter.
  - e. Elapsed time meter: Elapsed time meter may be included in drive diagnostic module or may be a separate six digit, non reset, 3-1/2-inch square case meter equal to GE type 236.
  - f. Power ON indicating light.
2. Provide the following for remote control interface:
  - a. Remote (auto) speed command, isolated 4-20 mA DC.

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- b. Remote command, maintained dry contact, close to run. (Two contacts if constant speed bypass with H-0-A or L-0-R constant speed ON OFF control.
  - c. Isolated 4-20 mA DC output signal for remote speed indication.
  - d. 120 volt, 10 amp dry contact for remote run indication; closed when running.
  - e. 120 volt, 10 amp dry contact for remote alarm indication; closed on occurrence of any fault condition.
  - f. Two 120 volt powered contacts, one closed when motor operates and one open when motor operates, for accessories (motor space heater, pump seal water solenoid, etc.). Provide 750 VA spare capacity in the drive control power transformer for accessories.
- B. Service Conditions:
- 1. Operating Temperature: 0 to 50 degrees C.
  - 2. Altitude: Up to 3,300 feet above sea level.
  - 3. Relative Humidity: 0 to 90 percent.
  - 4. Voltage Variation: +5 percent to -10 percent.
- C. Line Reactor:  
Provide a 3% line reactor or better as indicated by the Harmonic Calculations.
- D. Drive Control Centers:
- 1. Description: Free standing group assembly with one or more drives in each section. Individual sections are motor control center construction as specified in Section 16446.
  - 2. Molded case circuit breaker or main lugs as indicated.
  - 3. Bus: Main horizontal bus as specified in Section 16446. Drives may be cable connected to the main bus. Vertical bus, if used, shall comply with Section 16446.
  - 4. Where a section includes more than one drive provide metal barriers between individual units.
  - 5. Short Circuit Rating: 42,000 AIC unless specified otherwise.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install in accordance with the manufacturer's instructions. Drive Manufacturers shall provide assistance of factory-trained engineers in accordance with the manufacturer's specification.

- B. Verify motor alignment prior to operation.
- C. Insure adequate space for air circulation around drive ventilation openings.
- D. VFD shall be provided with additional terminal blocks for termination of field equipment as shown on electrical control diagrams.

3.02 TRAINING

4 hours of training shall be provided for each VFD. The contractor shall make available experienced factory-trained representatives to provide the required operation and maintenance instructions.

END OF SECTION