

# Technical Specifications

for the

## **Big Flat Creek WRF Emergency Power Improvements**

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City of Loganville, Georgia

February 4, 2019

RFP# FY19-001

Project No. 560-1001-05

Prepared by

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**BID VERSION**

# TECHNICAL SPECIFICATIONS

FOR THE

## City of Loganville Big Flat Creek WRF 3.33 MGD Upgrade Emergency Power Improvements

PROJECT NO. 560-1001-05

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## SUMMARY OF WORK

### SECTION 01010

#### PART 1 GENERAL

##### 1.01 DESCRIPTION

- A. The scope of work shall include all material, labor and equipment to furnish and construct the project associated with the emergency power improvements of Big Flat Creek Water Reclamation Facility including demolition of certain electrical equipment and replacement with new equipment as well as construction of new generator pad and generator equipment; including all associated electrical and mechanical appurtenances, all site work and site utilities, electrical equipment including all electrical and controls, enclosures, to provide a complete and operable system.
- B. All Work described above shall be performed as shown on the Drawings and as specified and/or as directed by the Engineer.

##### 1.02 PROJECT REQUIREMENTS

- A. All materials and construction shall be in accordance with the Contract Documents and with Georgia Department of Transportation Standard Specifications for Road and Bridge Construction, Latest Edition, and their Standard Detail Drawings.
- B. The contractor is required to contact the **Utilities Protection Center, Inc.** in the State of Georgia call **1-800-282-7411** prior to any excavation or construction. Additional information is available at [www.gaupc.com](http://www.gaupc.com). The contractor shall first, Call Before You Dig. Second, Wait the Required Amount of Time. Third, Respect the Marks and Lastly, Dig With Care.

##### 1.03 PROJECT LOCATION

The equipment and materials to be furnished will be installed at the locations shown on the Drawings or as directed by the Engineer.

#### 1.04 QUANTITIES

The Owner reserves the right to alter the quantities of work to be performed or to extend or shorten the improvements at any time when and as found necessary, and the Contractor shall perform the work as altered, increased or decreased. Payment for such increased or decreased quantity will be made in accordance with the Instructions to Bidders. No allowance will be made for any change in anticipated profits nor shall such changes be considered as waiving or invalidating any conditions or provisions of the Contract and Bond.

**END OF SECTION**

## **DEFINITIONS AND INDUSTRY STANDARDS**

### **SECTION 01095**

#### **1.01 SUMMARY:**

- A. This Section specifies the following:
  - 1. Definitions of certain terms used in Contract Documents.
  - 2. Information about industry standards cited in Contract Documents.

#### **1.02 DEFINITIONS:**

- A. Regulations: The term "regulations" include laws, ordinances, statues, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within construction industry that control performance of Work.
- B. Installer:
  - 1. The term "installer" means Contractor or an entity engaged by Contractor, either as an employee, subcontractor or sub-subcontractor, for performance of a particular construction activity including installation, erection, application, and other similar operations.
  - 2. The term "experienced", when used with the term "installer," means having successfully completed not less than five previous projects equal in size and scope to this Project, being familiar with precautions needed for safe operations, and having knowledge of requirements of authorities having jurisdiction.
- C. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at Project site or elsewhere, and to report on and, if required, to interpret results of inspections or tests.

#### **1.03 INDUSTRY STANDARDS:**

- A. Applicability of Standards: Except where Contract Documents include more stringent requirements, applicable industry standards have same force and effect as if fully set forth in the Contract Documents. Such standards are made a part of Contract Documents by reference.

- B. Publication Dates: Where edition date of referenced industry standard is not specified, comply with edition in effect on date set forth on cover of Project Manual.
- C. Differing Requirements: If Contract Documents require compliance with two or more standards which establish different requirements, confer with Engineer prior to proceeding with affected operations.
- D. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such abbreviations are used, they mean recognized name of trade association, organization producing standard, authority having jurisdiction, or other similar entity.

End of Section

**APPLICATION FOR PAYMENT**

**SECTION 01290**

**PART 1 GENERAL**

**1.01 REQUIREMENTS INCLUDED**

- A. Schedule of values.
- B. Requirements for Application for Payment.
- C. Preparation of Application for Payment.
- D. Submittal Procedures.
- E. Substantiating data for progress payment.

**1.02 REQUIREMENT APPLICATION FOR PAYMENT**

- A. For each item, provide a column for listing each of the following:
  - 1. Item Number.
  - 2. Description of work
  - 3. Scheduled Values.
  - 4. Previous Applications.
  - 5. Work in Place and Stored Material under this Application.
  - 6. Authorized Change Orders.
  - 7. Total Completed and Stored to Date of Application.
  - 8. Percentage of Completion.
  - 9. Balance to Finish.
  - 10. Retainage.
  - 11. Construction Photographs.

**1.03 FORM AND CONTENT OF SCHEDULE OF VALUES**

- A. Submit 3 copies of a Schedule of Values to the ENGINEER within 20 calendar days after the Notice to Proceed.
- B. Identify the Schedule of Values with the following:

1. Title of Contract.
  2. Contract Number.
  3. Name and Address of CONTRACTOR.
  - 4.. Date of Submission.
- C. The CONTRACTOR shall submit a computer-generated report listing each activity, activity description, budget value, percent earned previously, amount earned previously, percent earned this period, amount earned this period, total percent earned to date, and total amount earned to date for each activity. Activities shall be sorted by bid item number (primary sort), by work area (secondary sort), and by responsibility code (tertiary sort). Provide a sub-total for each bid item. The total value for each bid item shall equal the bid item amount as indicated in the Proposal.
- D. Provide an overall summary sheet listing each of the bid items with the budget value, percent earned previously, amount earned previously, percent earned this period, amount earned this period, total percent earned to date, and total amount earned to date for each bid item.
- E. The sum of all values listed in the Schedule of values shall equal the contract Sum.

#### 1.04 PREPARATION OF APPLICATION FOR PAYMENT

- A. Present required information in typewritten form.
- B. Execute certification by signature of authorized officer on form approved by the Engineer.
- C. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored Products.
- D. Submit final payment in accordance with Section 01780.

#### 1.05 SUBMITTAL PROCEDURES

- A. Submit five (5) copies of each Application for Payment.
- B. Submit and updated construction schedule with each application for Payment.
- C. Payment Period: Submit on the 25<sup>th</sup> of each month.



- D. Submit with transmittal letter as specified for Submittals in Section 01300.
- E. Submit waivers showing that suppliers and sub-contractors have been paid the amount due from the previous invoice.
- F. The first application will be processed after owner agreement with the construction schedule.

#### 1.06 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

- A. When the ENGINEER or OWNER requires substantiating data, submit suitable information with a cover letter identifying:
  - 1. Project.
  - 2. Application for Payment number and date.
  - 3. Detailed list of enclosures.
  - 4. For stored products:
    - a. Item number and identification as shown on the Application for Payment.
    - b. Description of specific material
- B. Submit one copy of data and cover letter for each copy of the Application for Payment.
- C. Maintain an updated set of drawings to be used as record drawings in accordance with Section 01780. Exhibit the updated record drawings for review by the OWNER and ENGINEER.

#### 1.07 PREPARATION OF FINAL APPLICATION FOR PAYMENT

- A. Fill in Application for Payment form as specified for progress payments.
- B. Use continuation sheet for presenting the final statement of accounting as specified in Sections 01770 - Contract Closeout.
- C. Submit all Project Record Documents in accordance with Section 01780.

**END OF SECTION**

## **SUBMITTALS**

### **SECTION 01300**

#### **1.01 SUMMARY:**

- A. This Section specifies procedural requirements associated with Contractor submittals including the following:
  - 1. Contractor's construction schedule.
  - 2. Schedule of Values
  - 3. Schedule of Payment
  - 4. Submittal schedule.
  - 5. Shop Drawings.
  - 6. Product Data.
  - 7. Samples.
  
- B. Refer to Conditions of Contract and other Division 1 Sections for requirements associated with administrative submittals. Such submittals include, but are not limited to, the following:
  - 1. Performance and payment bonds.
  - 2. Insurance certificates.
  - 3. Applications for Payment.
  - 4. List of subcontractors.
  - 5. All mechanical, electrical and process equipment, pipe, architectural and building supplies, and materials, and all other miscellaneous items or materials used for the project.

#### **1.02 SUBMITTAL PROCEDURES:**

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with purchasing, fabrication, testing, delivery, other submittals, and related activities that requires sequential activity.
  - 2. Coordinate transmittal of different submittals involving related elements so processing will not be delayed by need to postpone review of submittals until related submittals are received.
  - 3. Engineer reserves right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
  - 4. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

- B. Processing: Allow Engineer sufficient review time so that installation will not be delayed as a result of time required to process submittals, including time for resubmittals.
1. Allow not less than 15 days for Engineer's review; allow additional time if processing must be delayed to permit coordination with subsequent submittals.
  2. If Engineer requires resubmittal of an item, process subsequent submittal in same manner as initial submittal.
  3. Allow 15 days for processing each resubmittal.
  4. Extension of Contract Time will not be authorized because of failure to transmit submittals to Engineer sufficiently in advance of Work to permit processing.
- C. Submittal Preparation: Place an identification label or title block on each submittal.
1. Provide an adequate space on label, or beside title block on Shop Drawings, to record Contractor's review and approval markings . Include the following information on label or title block: Project name. Name of Engineer. Date. Name of Contractor. Name of supplier. Name of manufacturer. Number of appropriate Project Manual document. Drawing number and detail references, as appropriate.
- D. Transmittal: Include a transmittal form or letter with each submittal. On transmittal, record relevant information and, if appropriate, requests for data. On form or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.
1. Submittals received from sources other than Contractor will be returned without action.
- E. Delivery:
1. Mail submittals to:  
  
The Engineering Group, Inc.  
P.O. Box 1224  
Watkinsville, GA 30677  
Attn: Michael Bledsoe
  2. If other methods of delivery are used, address submittals to:

The Engineering Group, Inc.  
4235 Heather Lane  
Bogart, Georgia 30622  
Attention: Michael Bledsoe  
Phone: (706) 769-5259

1.03 ENGINEER'S ACTION:

- A. Except for information-type submittals, Engineer will review and mark submittals to indicate actions taken and instructions to Contractor, and then return an appropriate number of copies to Contractor.
- B. Engineer will affix to submittals a self-explanatory stamp, marked to indicate one of the following:
  - 1. If marked "Approved," that portion of Work represented by submittal may proceed provided it complies with requirements of Contract Documents; final acceptance will depend on compliance.
  - 2. If marked "Approved as noted," that portion of Work represented by submittal may proceed provided it complies with noted corrections and requirements of Contract Documents; final acceptance will depend on compliance.
  - 3. If marked "Comments Attached," do not proceed with purchasing, fabrication, delivery, or other similar Work activities associated with submittal. Revise submittal in accordance with notations; resubmit without delay.
  - 4. If marked "Not Approved" do not proceed with purchasing, fabrication, delivery, or other similar Work activities associated with submittal. Prepare new submittal in accordance with notations; resubmit without delay.
- C. Engineer will review Contractor's construction schedule, submittal schedule, and other similar information-type submittals to determine if Engineer has objections to information contained therein. If it has no objections, Engineer will mark submittals "Action Not Required," and then return an appropriate number of copies to Contractor.

1.04 CONTRACTOR'S CONSTRUCTION SCHEDULE:

- A. Within 14 days of date of Commencement of Work, submit to Engineer five copies of horizontal bar chart-type construction schedule.
- B. Use a separate time-bar for each significant construction activity; mark each time-bar to describe its relationship to breakdown of units of Work identified in schedule of values.
- C. Provide a separate set of time-bars for each major portion of Work.

- D. Provide a series of continuous vertical lines to identify first working day of each week.
- E. Within each time-bar, identify planned completion percentage in 10 percent increments. As Work progresses, place a contrasting mark in each bar to identify actual percent completion.
- F. Prepare schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for entire construction period.
- G. Coordinate construction schedule with schedule of values, submittal construction schedule, schedule of payments, and Applications for Payment.
- H. Indicate completion of Work in advance of date established for Substantial Completion; allow time on schedule for Engineer's procedures necessary for certification of Substantial Completion.
- I. Unless Engineer objects to Contractor's initial construction schedule, one copy will be returned to Contractor marked "Action Not Required."
- J. Update and resubmit construction schedule as follows:
  - 1. Submit three copies to Engineer with each Application for Payment.
  - 2. If an event occurs which adversely affects bar chart data, submit four copies of revised schedule to Engineer within five days of event giving rise to change.
- K. When three updated copies are submitted to Engineer, none will be returned to Contractor. For those situations requiring submission of four updated copies, the Engineer, unless it objects to modifications contained in updated document, will return one copy to Contractor marked "Action Not Required."

#### 1.05 SCHEDULE OF VALUES

- A. Submit Schedule of Values with Construction Schedule for review and approval.

1.06 SUBMITTAL SCHEDULE:

- A. Not later than date of submission of Contractor's construction schedule, submit to Engineer three copies of Contractor's schedule of submittals.
- B. Prepare schedule in form of list that identifies each submittal as follows:
  - 1. Brief description of submittal.
  - 2. Number of appropriate Project Manual document.
  - 3. Planned date of submission.
- C. Unless Engineer objects to Contractor initial submittal schedule, one copy will be returned to Contractor marked "Action Not Required."
- D. If an event occurs which adversely affects submittal schedule, submit four copies of revised schedule to Engineer within five days of event giving rise to change. Unless the Engineer objects to such revised document, one copy will be returned marked "Action Not Required."

1.07 SHOP DRAWINGS:

- A. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar documents. As a minimum, indicate the following:
  - 1. Dimensions, including those established by field measurement.
  - 2. Identification of materials.
  - 3. Compliance with specified requirements.
  - 4. Coordination requirements.
  - 5. Product and manufacturer's name, if applicable.
- B. Submit newly prepared documents drawn to accurate scale. Do not reproduce Contract Documents or copy standard information as basis of Shop Drawings; standard information prepared without specific reference to Project will not be considered Shop Drawings.
- C. Collect Shop Drawings into a single submittal for each element of construction.
- D. Highlight, encircle, or otherwise indicate deviations from Contract Documents.
- E. Except for templates, patterns and similar full-size drawings, submit Shop Drawings on sheets 8 1/2 " x 11", but no larger than 24" x 36".

1.08 PRODUCT DATA:

- A. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, and standard color charts. As a minimum, include data which documents the following:
  - 1. Manufacturer's printed recommendations.
  - 2. Compliance with recognized industry and trade association standards.
  - 3. Compliance with recognized testing agency standards.
  - 4. Application of testing agency labels and seals.
  - 5. Notation of coordination requirements.
- B. Where special data must be prepared because standard printed data is not suitable for use, submit as "Shop Drawings".
- C. Collect Product Data into a single submittal for each element of construction.
- D. Highlight, encircle, or otherwise indicate deviations from Contract Documents.
- E. If Product Data includes information on materials or options which are not required, mark copies to indicate applicable information.
- F. Unless otherwise specified, submit to Engineer six copies of each submittal; two copies will be returned to Contractor.
- G. Include manufacturer supplied Operating instruction and Maintenance manuals for each piece of equipment.

1.09 SAMPLES:

- A. Submit Samples which are physically identical to products Contractor proposes to include in Work. Samples include, but not limited to, full- and reduced-size sections of manufactured or fabricated components, cuts or containers of materials, and range-sets showing color, pattern and texture.
- B. Mount, display, or package Samples to facilitate Engineer's review. Mark Samples to identify the following:
  - 1. Generic description of Sample.
  - 2. Sample source.
  - 3. Product and manufacturer's name.
  - 4. Compliance with specified requirements.

- C. Submit Samples for Engineer's review of shape, arrangement, type, color, pattern and texture, for comparison of these characteristics with other elements, and for subsequent comparison of these characteristics with products delivered and installed.
- D. Unless a greater number is specified elsewhere or needed to illustrate variations in color, pattern, texture or other characteristics inherent in material represented, submit to Engineer three sets of samples; either one set will be returned to Contractor or, at Engineer's option, Contractor will be notified of results of Engineer's review.
- E. Special field-erected samples may be specified elsewhere in Specifications. Such samples are full-size examples erected on Project site to illustrate products proposed for inclusion in Work and to establish standard by which Engineer will evaluate completed work.

End of Section



## **PROJECT CLOSEOUT**

### **SECTION 01770**

#### **1.01 GENERAL**

Comply with requirements stated in the General Conditions Article 14 for administrative procedures in serving notice of Substantial Completion, Retainage, Final Construction Review, Final Completion, Final Payment and Supplemental Conditions.

#### **1.02 SUBSTANTIAL COMPLETION**

- A. When contractor considers the work is substantially complete, he shall submit to Engineer:
  - 1. A written notice that the Work, or designated portion thereof, is substantially complete.
  - 2. A list of items to be completed or corrected.
- B. Within a reasonable time after receipt of such notice, the Engineer will make a construction review to determine the status of completion.
- C. If Engineer determines that the Work is not substantially complete:
  - 1. Engineer will promptly notify the contractor in writing giving the reasons therefore.
  - 2. Contractor shall remedy the deficiencies in the Work, and send a second written notice of substantial completion to the Engineer.
  - 3. Engineer will again review the Work for completion status.
- D. When the Engineer finds that the Work is substantially complete, he will:
  - 1. Prepare and deliver to Owner a tentative certificate of Substantial Completion with a tentative list of items to be completed or corrected before final payment.
  - 2. After consideration of any objections made by the Owner as provided in conditions of the contract, and when Engineer considers the Work substantially complete, he will execute and deliver to the Owner and the Contractor a definite Certificate of Substantial Completion with a revised tentative list of items to be completed or corrected

#### **1.03 RETAINAGE**

The retainage will be paid to the Contractor after the Project is SUBSTANTIALLY COMPLETE in accordance with these Contract Documents and all manuals,

Project Record Documents, Contractor certifications, Contractor affidavits, etc. have been submitted as required by these Contract Documents. However, the Owner may retain an amount equal to 200 percent of the value of any remaining incomplete minor item. Interest on all retained amounts shall accrue and this interest shall be paid to the Contractor by the Owner. The interest amount to be paid shall be at the current rate paid on a savings account at the local bank in which the Owner routinely transacts business. Interest on all retainage throughout the project period shall be paid to the Contractor in one lump sum amount following FINAL COMPLETION.

#### 1.04 FINAL CONSTRUCTION REVIEW

- A. When Contractor considers the Work is complete, he shall submit written certification that:
  - 1. Contract documents have been reviewed.
  - 2. Work has been reviewed for substantial compliance with contract documents.
  - 3. Work has been completed generally in accordance with contract documents.
  - 4. Equipment and systems have been tested in the presence of the Owner's representative and are operational.
  - 5. Work is completed and ready for final construction review,
- B. Engineer will perform a review to verify the status of completion with reasonable promptness after receipt of such certification.
- C. If Engineer considers the Work to be incomplete:
  - 1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.
  - 2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to Engineer that the work is complete.
  - 3. Engineer will again review the Work.
- D. When the Engineer finds that the work is acceptable under the contract documents, he will:

1. Prepare and deliver to Owner in writing that he has examined the work and that, in his opinion, it appears to conform to these Contract Documents and therefore recommends the work be accepted for FINAL COMPLETION. It is understood and agreed that such statement by the Engineer does not in any way relieve the Contractor or his Sureties from any duties, responsibilities, and obligations under these Contract Documents.
2. After work has been recommended by Engineer as acceptable for FINAL COMPLETION, the Engineer shall request that the Contractor submit closeout submittals.
3. After the Engineer recommends the work for FINAL COMPLETION, the Owner will, if he concurs in the Engineer's recommendation, promptly notify the Contractor in writing. If the Owner does not concur in the Engineer's recommendation, the Owner will promptly notify the Contractor in writing that he does not accept the work as complete and stating the deficiencies and/or conditions that shall be corrected or resolved before FINAL COMPLETION will be issued. After the deficiencies and/or conditions are corrected or resolved and the Owner is satisfied that the work is complete, the Owner will issue to the Contractor notice of FINAL COMPLETION.

#### 1.05 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

- A. Operating and maintenance data, instructions to Owner's personnel: to requirements of Section 01780.
- B. Spare Parts and Maintenance Materials: to requirements of Section 01780.
- C. Evidence of Payment and Release of Liens: to requirements of General and Supplementary Conditions.
- D. Certificate of Insurance for Products and Completed Operation.
- E. Record Drawings with annotations made by the contractor during construction of the work, and including As-Built coordinates and elevations on all structures, pipe inverts and key locations as required by Engineer.
- F. The Contractor shall furnish the Owner with certified copies of paid invoices (or other proof) indicating Georgia Sales Tax paid on items for which the Owner is eligible for tax refunds. Tax refunded will be to the Owner, with none credited to the Contractor.
- G. Consent of Surety Company to Final Payment.

- H. Retainage will not be paid until the above documents have been submitted and are satisfactory and acceptable to the Owner.

#### 1.06 FINAL PAYMENT

Upon Final Completion of the Work in accordance with the Contract Documents, the Contractor will be authorized to prepare a final estimate of the work and a Final Payment request. The Engineer will review the final payment request and will, if all items are satisfactory, recommend approval to the Owner. The Engineer will submit to the Owner the final estimate and the final payment request, together with a certification stating that the work is complete and in substantial conformance with these Contract Documents. The entire balance found to be due the Contractor including any retainages, except such sums as may be lawfully retained by the Owner, will be paid to the Contractor.

**END OF SECTION**

## **RECORD DOCUMENTS**

### **SECTION 01780**

#### **1.01 SECTION INCLUDES**

- A. Project Record Documents.
- B. Operation and Maintenance Data.

#### **1.02 RECORD DOCUMENTS**

- A. Project Record Documents: Record documents shall be submitted prior to Final Application for Payment.
- B. Maintain on site one set of the following record documents; record actual revisions to the Work:
  - 1. Drawings.
  - 2. Specifications.
  - 3. Addenda.
  - 4. Change Orders and other modifications to the Contract.
  - 5. Reviewed shop drawings, product data, and samples.
  - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- C. Ensure entries are complete and accurate, enabling future reference by.
- D. Store record documents separate from documents used for construction.
- E. Record information concurrent with construction progress.
- F. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
  - 1. Manufacturer's name and product model and number.
  - 2. Product substitutions or alternates utilized.
  - 3. Changes made by Addenda and modifications.
- G. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
  - 1. Generally anything shown on the plans as designed or modified

shall be recorded and more specifically stated below as applicable.

2. Measured depths of foundations in relation to finish first floor datum.
3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
4. Field changes of dimension and detail.
5. Details not on original Contract drawings

Sewer or Storm Sewer Projects:

1. Manhole top & invert elevations. (outside/inside drop, concrete encasement)
2. Manhole location with distance reference to permanent features (2 each per manhole).
3. Angles of sewer lines in/out of manholes
4. Ground elevation at manhole.
5. Distance between manholes.
6. Calculated slopes.
7. Pipe size, length, material and location (restraint information).
8. Location of any service laterals, as well as pipe size, length, material and location (If applicable).
9. Location of any force main connections and details of the connection (i.e. elevation, inside or outside drop, concrete encasement or joint restraint information) as well as forcemain size, length, material and location.
10. Location of force main fittings and valves with distance references to permanent features (2 each per appurtenance) and description of size and type of (check valves, plug valves & air release valves).
11. Pump station invert elevations, top elevations diameter and location.

12. Location of pump station accessories (Electrical service, control panel, security light, valve vault, hoist, water service, meter, fence, gate, cross drain, etc.).
13. Casing size, length, material and location.
14. Provided sketches with detailed information drawn in a larger size either on the plans (if there is space) or on a separate sheet attached to the record drawings is always very helpful. Good blow up details for complex tie-ins, crossings of multiple utilities, assemblies for multiple bends/fittings and for jack and bores and open-cut street crossings are important to help the owner locate their lines in the future for maintenance, repairs and extensions.

Water Projects: (also applies to force main installations or other pressure pipe projects)

1. Water main size, length and material with distance reference to edge of pavement or permanent features.
2. Water service line size, length, material and location (If applicable).
3. Service meter size and location (If applicable).
4. Locations with distance references to permanent features (2 each per appurtenance) and description of size and type for (valves, fire hydrants, blow-offs, meters, fittings & air release valves).
5. Casing size, length, material and location.
6. Booster pump station Chlorine building location.
7. Pump station accessories locations (Electrical service, panels, security light, chemical feed & sample lines, valves, manholes, fence, gate, cross drain, etc.).
8. Blow up details on plans or separate sheets for complex installations (multiple fittings), jack and bore or open cut installations at intersections and busy/congested areas and for utility crossings.

**END OF SECTION**

## GENERAL PROVISIONS

### SECTION 02000

#### PART 1 - GENERAL

##### 1.01 DEFINITIONS:

- A. Unsuitable Material: Unsuitable material is defined as earth materials unsatisfactory for its intended use and as classified by the soils technicians.
- B. Suitable Material: Where the term suitable material is used in Specification Sections pertaining to earthwork, it means earth or materials designated as being suitable for their intended use by the soils technicians or the Engineer. Also suitable material shall be designated as meeting the requirements of the Unified Soil Classification System types SW, GM, GC, SC, SM or as designated in these Specifications.
- C. Waste Material: Waste material is defined as trash, debris, broken concrete and other deleterious material resting on or below the surface of the ground.
- D. Rock: Rock is defined as the following:
  - 1. General Excavation: Any material which cannot be excavated with a single-tooth ripper drawn by a crawler tractor having a minimum draw bar pull rated at not less than 56,000 pounds (Caterpillar D 8K or equivalent) or by a Caterpillar 977 front-end loader or equivalent.
  - 2. Trench Excavation: Any material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 24,700 pounds (Caterpillar Model 225 or equivalent).

##### 1.02 JOB CONDITIONS:

- A. Soils Conditions: Site topography and topographic maps, soil reports and other topographic or soil data shown on the plans or included in the specifications are for the information of the Contractor, and neither the Owner nor the Engineer is responsible for their accuracy, completeness or usefulness and meaning. The Contractor shall make such additional investigations as required to acquaint himself adequately with the site topography, and the subsurface soil condition for the successful execution of the Work.



- B. Existing Conditions: The Contractor shall investigate the site to determine the necessary data to perform the Work required under the contract or in the Specification Sections of Division 2. Such investigation may include, but not be limited to, site visits, soil borings, chemical and physical tests and research of public and private records.
- C. Protection of Monuments, Landscape Features, Work and Structures:
1. Monuments: The Contractor shall prevent the destruction of any survey monuments, bench marks, property corners or any other survey points. Where the removal of such points is necessary for the accomplishment of the Work, the Contractor shall inform the Engineer in writing, prior to the disturbance of any point, and shall not disturb the point until written permission to do so has been issued by the Engineer. Points whose removal is allowed shall be permanently referenced prior to their disturbance. Clear notes and sketches of all reference points shall be furnished to the Engineer, all affected property Owners, government bodies or utility companies.
  2. Landscapes: Trees, shrubs, grass or other growth designated to remain in place, or outside of the limits of Work, shall be protected during the accomplishment of the Work, and shall not be damaged in any manner. Such growth damaged by the Contractor shall be repaired as directed at no cost to the Owner. Lawn surfaces, embankments, cut slopes, ditches, or other surfaces disturbed by the Contractor shall be regraded to the original shape, and the grass or lawn surface replaced in kind, at no additional cost to the Owner.
  3. Structures: Structures outside of the limits of Work or designated to remain in place shall be protected by the Contractor during the progress of the Work. Any structure damaged in any manner shall be repaired or restored to its original condition as directed by the Owner and at no cost to the Owner. Sidewalks, curbs, concrete or asphaltic pavement shall be replaced in kind, in accordance with the applicable section of specifications or as directed by the Owner.
  4. Protection of Work: The Contractor shall be solely responsible for the Work of other Contractors in the area and the protection of his Work. Such grading as is necessary to prevent damage to Work by water will be solely the responsibility of the Contractor and will be at no additional cost to the Owner. The Engineer may direct the Contractor to perform necessary grading and drainage to prevent surface run off from damaging the Work.

- D. Scheduling: The Contractor is responsible for the scheduling of his Work. The Contractor shall submit a detailed schedule of his work showing specific target dates and final completion dates.
- E. Work Within Easements:
  - 1. All Work on private or public property not owned by the Owner shall be within the limits of permanent or construction easements obtained by the Owner. The Contractor shall coordinate with the Owner as required to determine which easements have been acquired and shall insure that all Work, materials and equipment do not encroach beyond the limits of the easements.
  - 2. The Contractor shall remove from the easements (or dispose of as directed on the easement) all construction debris, including, but not limited to, felled trees and brush, rock, trash and other objectionable material.

#### 1.03 QUALITY ASSURANCE:

- A. Requirements of Regulatory Agencies: The Contractor is responsible for obtaining any permits required by Local, State or Federal Government or their agents, or by all owners of utilities, public or private, where such permits are required for the completion of Work. It is the responsibility of the Contractor to notify all utility owners or governmental agencies as to the scope of this Work with respect to the utility or service involved, and take what steps that are necessary, and submit the information required to obtain permits that are required.

Permits required include, but are not limited to, the following: building permits, blasting permits, railroad or highway crossing permits, burning permits, excavation or digging permits. Copies of all permits are to be forwarded to the Owner. Exceptions are the permits which the Owner has obtained.

- B. Erosion Control Measures: Erosion control measures shall be installed as required by the drawings and permit to prevent sedimentation from damaging adjacent property. The Contractor is responsible for maintaining the erosion control measures until the Project is accepted as complete by the Engineer and Owner. Upon completion of the Project the Contractor shall remove all temporary erosion and sedimentation control measures.

The Contractor shall conduct earthwork operations in a manner to minimize erosion on the Project site and to prevent sedimentation from

leaving the work area.

The Contractor shall be completely responsible for all damage to property resulting from his earthwork operations.

- C. Dust Control: The necessary equipment and materials to provide dust control for the duration of the earthwork operations shall be provided.

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT:

- A. The choice of equipment to perform the required operations in conformity with these specifications will be the responsibility of the Contractor. However, any equipment that results in waste or damage of material, or inaccurate Work or is otherwise objectionable is to be promptly replaced as directed by the Engineer.

When the Contractor performs any type of operation after daylight hours with the permission of the Engineer, he shall maintain at his expense sufficient artificial lighting to permit proper construction, observation and inspection. If in the opinion of the Engineer, the lighting is insufficient for inspection, or observation, the Contractor shall provide lighting as directed by the Engineer.

## PART 3 - EXECUTION

### 3.01 FIELD ENGINEERING:

- A. The Contractor shall be solely responsible for all field engineering required for construction, furnishing all lines, grades points necessary for construction, starting from control points and elevations furnished by the Engineer, or shown on the plans.
- B. Any excavations made requiring extra payment shall be cross-sectioned prior to excavation and after excavation for payment purposes.

### 3.02 SPECIAL SAFETY REQUIREMENTS:

- A. The Contractor shall comply with all Federal, State and Local Safety Codes and Regulations at all times and is responsible for educating his supervisors and employees of the safety requirements and practices to be followed during the course of his Work.

1. **Barricades:** The Contractor shall barricade any open excavations and install adequate warning lights. Temporary bridges shall be installed and maintained by the Contractor to maintain traffic and accessibility of facilities in the area of Work during excavation operations. The Contractor shall provide a flagman, as required for safety or as directed by the Engineer to maintain traffic controls and safety.
2. **Access:** The Contractor shall provide safe access of trenches or excavations, including, as appropriate ramps, steps or other access, where the depth of trench or excavation is greater than three feet, and where access to the trench or excavation is required for the Work.
3. **Side Slopes:** Sides of excavations and trenches shall be sloped, benched, sheeted and shored to maintain the wall or sides. Materials obtained from the excavation shall be piled a minimum of four feet from the edge of roads, streets, sidewalks, railroad tracks and shall be kept clear of excavation material at all times. It is the Contractor's responsibility to insure stability of trench and excavation walls for the safety of personnel and the Work. Excavation to be performed in accordance with OCGA, chapter 9, Title 25.
4. **Blasting:** During blasting operations the Contractor is to exercise the up-most care in the transportation, storage, use, handling and control of any and all explosives, including blasting caps, and will employ competent, knowledgeable persons for such work. The Contractor is required to notify all utility owners where applicable, governing agencies required by law, and the Engineer prior to the transport, storage, or use of any explosives. No blasting is allowed where such operations might endanger the life and property of others. The Contractor is responsible for any permits, license, etc., required for the use of explosives and will be responsible for any damage or injury caused from the explosives. Blasting to be performed in accordance with OCGA, chapter 9, Title 25.
5. **Working Conditions:** Nothing contained herein is to be construed to relieve the Contractor of his responsibility to provide and maintain safe and clean working conditions for his employees and others in the area of his Work.

### 3.03 FIELD DRAWINGS:

- A. If changes to the design drawings are required due to field conditions and are approved, records of the changes shall be kept and turned into the

Engineer before submitting the final invoice. Field drawings must show the change to size, location, and elevations and must be approved by the Engineer before approval of final payment.

3.04 COMPLETED WORK:

- A. Clean-Up: The Contractor shall keep the area in which he is working free of debris, trash, garbage and other offensive waste material and keep all construction materials such as, but not limited to, sheeting, shoring, formwork, pipes and reinforcing steel, stockpiled in a neat, orderly manner at points designated by the Engineer, until ready for use on the job site. During construction walkways, passages, traveled ways, railroad tracks adjacent to the area of Work are to be kept clean and open to vehicular and pedestrian traffic. Upon completion of any stage of Work in any area, all debris, trash, litter, construction materials, etc., shall be removed to the satisfaction of the Engineer, and the area left in suitable condition for the next stage of construction or for the use of the Owner. The Engineer may withhold payment of any fund due the Contractor under the following specifications, if in the opinion of the Engineer; the Contractor has not maintained the Work area covered by his contract. Such funds, less any retainage or other sums due the Owner or others, shall be paid the Contractor when required clean-up has been completed to the satisfaction of the Engineer.

End of Section

## **DEMOLITION AND ALTERATIONS**

### **SECTION 02050**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION:**

- A. Demolition and alterations of existing facilities as indicated on drawings, as specified and directed by Engineer.
- B. Removal, salvage, or other disposition of minor site improvements as specified in SITE PREPARATION.

##### **1.02 RELATED WORK:**

- A. Section 02102: Clearing and Grubbing
- B. Section 02220: Foundation and Trench Excavation, Bedding, and Backfill

##### **1.03 QUALITY ASSURANCE:**

- A. Accomplish demolition and removal of existing construction, utilities, equipment, and appurtenances without damaging integrity of existing structures, equipment, and appurtenances that are to remain.
- B. Store equipment to be salvaged for relocation where directed by Engineer, and if necessary, protect from damage during work.
- C. Repair or remove items that are damaged. Repair and installation of damaged items at no additional compensation and to condition at least equal to that which existed prior to start of Work.
- D. Exercise all necessary precautions for fire prevention. Acceptable fire extinguisher made available at all times in areas where demolition work by burning torches is being done.
- E. Provide protection of persons and property throughout progress of work. Proceed in such manner as to minimize spread of dust and flying particles and to provide safe working conditions for personnel.
- F. Maintain circulation of traffic within area at all times during demolition operations.

- G. Obtain permission from Engineer before abandoning or removing any existing structures, materials, equipment and appurtenances.
- H. Arrange with and perform work required by utility companies and municipal departments for discontinuance or interruption of utility services due to demolition work.

1.04 SUBMITTALS: Submit demolition plan to Engineer for review, describing proposed sequence, methods, and equipment for demolition and disposal of each structure.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 REFERENCES:

- A. Provide two reference points for each survey marker and monument removed, establish by a licensed civil engineer or land surveyor and record locations and designations of survey markers and monuments prior to removal.
- B. Store removed markers and monuments during demolition work, and replace upon completion of work. Reestablish survey markers and monuments in conformance with recorded reference points. Forward letter to Engineer verifying reestablishment of survey markers and monuments, signed by licensed civil engineer or land surveyor.

3.02 DEMOLITION:

- A. Confine apparatus, storage of material, demolition work, new construction, and operations of workmen to areas that will not interfere with continued use and operation of entire facility. Provide and maintain lights, barriers, and temporary passageways for free and safe access.
- B. Demolish foundation walls to a depth of not less than two feet below existing ground level. Remove materials entirely where foundations or slabs conflict with new Work to be performed under this Contract. Break floors into pieces having area not more than four square feet with well-defined cracks through full depth of floor.
- C. Cap or plug with brick and mortar, as indicated, pipes and other conduits abandoned due to demolition.

3.03 SALVAGE:

- A. Materials, equipment, and appurtenances removed, that are not designated by the Owner for relocation, became property of Contractor and hauled from site and disposed of at no additional compensation.

End Of Section



## CLEARING AND GRUBBING

### SECTION 02102

#### PART 1 - GENERAL

##### 1.01 DEFINITIONS:

- A. Clearing: Clearing is defined as the removal of all trees and structures not noted to remain, stumps, bushes, grass, rubbish, refuse and other deleterious materials from the area of Work. Only such excavation as required for the removal of stumps and structures shall be performed.
- B. Grubbing: Grubbing is defined as the excavation and removal of all trees 2 inches and larger not noted to remain, roots, stumps, rubbish, and other deleterious materials to a depth of not less than two feet below ground surface, and raking to remove matted organic material such as large root masses.

#### PART 2 - PRODUCTS

##### 2.01 EQUIPMENT:

- A. Equipment used to accomplish the Work shall comply with requirements of Section 02000.

#### PART 3 EXECUTION

##### 3.01 FIELD ENGINEERING:

- A. The Contractor is responsible for performing this Work in accordance with Section 02000.

##### 3.02 SPECIAL SAFETY REQUIREMENTS:

- A. The Contractor shall comply with requirements of Section 02000.

##### 3.03 CLEARING:

- A. The Contractor shall completely clear, remove and satisfactorily dispose of all unsuitable materials resting on or protruding above the surface of existing ground that would prohibit normal construction activities. Stockpile and storage areas designated shall be cleared.

3.04 GRUBBING:

- A. The Contractor shall completely grub the entire designated area free of all roots, stumps, logs, rubbish and other deleterious materials to a depth of at least two feet below existing ground. If no further excavation will occur, all excavations made for the removal of stumps, trees and rocks shall be filled and compacted with suitable material and graded to conform to surrounding surface.

In fill areas, added soils shall be compacted to the same density required for the embankment.

3.05 DISPOSAL:

- A. Combustible Material: The Contractor may burn combustible material on-site, in accordance with Local, State, and Federal Laws.
- B. The Contractor shall remove all non-combustible waste materials to permitted offsite disposal areas.

End of Section

## EARTHWORK

### SECTION 02200

#### PART 1 - GENERAL

##### 1.01 QUALITY ASSURANCE:

A. Applicable Standards: Conform to the following Standards:

ASTM D698: Moisture-Density Relations of Soils, Using 5.5-lb. Hammer and 12-in. Drop. (Standard Proctor)

ASTM D1556: Density Soil in Place by the Sand-cone Method.

ASTM D2922: Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depths).

ASTM D3017: Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depths).

Other methods will be considered upon written request to the Engineer. The request must demonstrate a correlation with the above standards. The final approval is the responsibility of the Engineer.

When density is determined by nuclear method, the equipment shall be calibrated on soils from the site. Take all safety precautions and obey all regulations governing the use of radioactive materials.

B. Tests:

1. Qualified soils technicians working under direct supervision of Geotechnical Engineer will be employed by the Contractor for the purpose of identifying soils, checking densities and classifying soils materials during construction. Charges for this service will be paid for by the Contractor.

2. Density tests shall be made in accordance with the following minimum schedule or as required by the soils technician or as may be directed by the Engineer.

(a) Two every layer of fill,

(b) One every 100 cubic yards of fill,

(c) Areas where degree of compaction is in question.

3. Such tests and submittals shall not relieve the Contractor from any of his

contractual obligations and he shall be responsible for ensuring that his work is maintained to the required quality.

1.02 SUBMITTALS:

- A. The soils technicians shall submit formal reports of all compaction tests and retests. The reports shall be furnished to the Engineer and Owner as soon as possible upon completion of the required tests.

This report information shall include but not be limited to the following:

1. Date of the test and date submitted.
  2. Location of test by approximate station, coordinate and elevation.
  3. Wet weight, moisture content and dry weight of field sample.
  4. Description of soil.
  5. Maximum dry density and moisture content of the lab sample which best matches the field sample in color, texture, grain size and maximum dry density.
  6. Ratio of field dry density to maximum lab dry density expressed as a percent.
  7. Comments concerning the field density passing or failing the specified compaction.
  8. Comments about recompaction if required.
- B. The soils technician shall notify the Engineer immediately upon receipt of any tests indicating failure to comply with the specification requirements. The Contractor shall bear the cost of all tests indicating failure to meet the specification requirements.

1.03 DEFINITIONS:

- A. Reference Section 02000, Article 1.01

## PART 2 - PRODUCTS

### 2.01 MATERIALS:

- A. Materials: Where the terms approved, suitable, unsuitable and similar designations are used in specification sections pertaining to earthwork, it means earth or materials designated as being approved, suitable or unsuitable for their intended use by the soils technicians or the Soils Engineer. Also suitable material shall be designated as meeting the requirements of the Unified Soil Classification System types SW, GM, GC, SC, SM, or as designated in these specifications.
- B. Off-site Borrow Material: Suitable material obtained from locations off the Owner's property. Off-site borrow material shall have a plasticity index of less than 15 and contain no more than 5% by weight fibrous organic material. Sources of off-site borrow shall be tested and approved for use by the Soils Engineer prior to material being delivered to the site.

## PART 3 - EXECUTION

### 3.01 FIELD ENGINEERING:

- A. Field engineering is the responsibility of the Contractor in accordance with requirements of Section 02000.

### 3.02 EROSION AND SEDIMENTATION CONTROL:

- A. The Contractor shall perform earthwork operations in a manner to completely control erosion and sedimentation runoff. Provisions of the erosion and sedimentation control shall not be violated. Erosion and sedimentation control shall comply approved plan.

### 3.03 EXCAVATION:

- A. Preparatory Work:
  - 1. Clearing operations shall be performed in all areas to be graded and shall consist of the removal to the ground surface of all trash and vegetation (including, but not limited to heavy weed growth, trees, stumps, and logs).
  - 2. Removal of subsurface organics shall be performed in the embankment areas. Removal of subsurface organic debris and root systems larger than one inch in diameter shall be accomplished to a depth of 18 inches below existing grades.

3. Clearing and grubbing operations shall be observed by the Owner's Representative. Non-combustible organic and inorganic materials resulting from the clearing and grubbing operations shall be hauled off the site. Burning of combustible materials on-site shall be permitted in accordance with Local, State, and Federal Laws.
4. Side ditches, as indicated on the Drawings, shall be constructed prior to excavation, wherever possible and in any case as soon as possible after excavation is complete. Proof-rolling of excavated areas shall not be performed until side ditches are in place.
5. The Contractor shall proof-roll the subgrade in all cut areas beneath pavement or structures and all areas to receive fill or embankment. The areas to be proof-rolled shall be tested with a minimum of four coverages of a 25 to 35 ton four-wheeled rubber tired proof-roller, unless failure occurs during the first coverage. The last two passes of the proof-roller shall be perpendicular to the first two. An area will be considered covered when the out to out dimension of the wheels of the roller has passed over it four times. An additional coverage may be required by the Soils Technician to insure that a suspicious area is stable. The roller shall be operated in a systematic manner so that the number of coverages over all areas designated can be readily determined. The equipment shall be operated at a speed not to exceed five miles an hour or be less than 2-1/2 miles per hour. Proof-rolling shall be done only in the presence of the Soils Technician. Proof-rolling shall not be done where water is ponded on the surface or when rainfall has occurred within the previous 24 hours. After areas found to be unstable have been improved by excavation and backfilling, they shall be proof-rolled again to insure the effectiveness of the corrective measures.
6. The Contractor shall excavate those areas where, in the opinion of the Soils Technician, proof-rolling indicates unstable subgrade or excessive rutting. The elevation or depth of excavation shall be that necessary to correct the unstable condition or as directed by the Soils Engineer.
7. Backfill excavated areas with approved suitable material unless otherwise directed by the Engineer. Suitable material shall have a plasticity index less than 15 and shall contain no more than 5% by weight of fibrous organic material. Backfill shall be placed as soon as possible after excavation but in no case shall the excavation be left open overnight. Backfill shall be placed on areas by approved methods. Backfill material shall be placed and compacted in accordance with the requirements for fills or embankments as

specified in this Section.

- B. Excavating: The Contractor shall excavate the areas designated on the drawings to the elevations or depths indicated on the Drawings. The excavated material to the extent practical shall be segregated into suitable and unsuitable materials and stockpiled for future use or disposal.
- C. Stockpiling: The Contractor shall stockpile the excavated materials in suitable and unsuitable stockpiles. All roots, stumps, rocks larger than 4 inches, refuse, and other deleterious materials will be segregated from the excavated material and disposed of offsite. The stockpiled materials are to be no greater than four feet in height and shall not obstruct proper drainage of the area. Stockpiles shall be protected by prompt and proper use of erosion and sediment control measures.
- D. Use of Excavated Materials: All suitable materials removed from the excavation, including ditches, shall be used to form the fill or embankment indicated on the Drawings. Excess suitable material shall be stored on site at a location as directed by the Engineer. Unsuitable material shall be removed from the site.
- E. Dewatering: An adequate dewatering system capable of removing any water that accumulates in the excavation and maintaining the excavated area in a dry condition while construction is in progress shall be provided.

#### 3.04 EXCAVATION OF UNSUITABLE MATERIAL:

- A. Excavation of Unsuitable Material: The Contractor shall excavate those areas where, in the opinion of the Geotechnical Engineer, unstable subgrade exists. The elevation or depth of excavation shall be that necessary to correct the unstable condition or as directed by the Geotechnical Engineer. Unsuitable materials removed shall be disposed of by the Contractor off-site.
- B. Backfilling of Excavated Areas: Backfill excavated areas with approved suitable borrow material unless otherwise directed by the Engineer. Backfill shall be placed as soon as possible after excavation but in no case shall the excavation be left open overnight without written permission of the Engineer. Backfill shall not be placed on areas covered by water. Water shall be removed from all excavated areas by approved methods. Backfill material shall be placed and compacted in accordance with the requirements for fills or embankments as specified in this Section.

#### 3.05 FILLS OR EMBANKMENTS:

- A. Preparatory-Work:

1. Prior to fill construction, clearing and grubbing, topsoil removal and proof-rolling shall be completed as specified.
2. All stump holes, cavities and other irregularities resulting from the clearing and grubbing operation within the fill construction shall be enlarged, to permit use of proper compaction equipment, and backfilled with suitable material and compacted to the specified density for the fill.
3. All areas that are to receive compacted fill shall be observed by the Geotechnical Engineer prior to the placement of fill. Exposed soils shall be proof-rolled with approved compaction equipment.
4. Areas to be occupied by fill shall be plowed and harrowed unless, in the opinion of the Engineer, scarifying by disc harrow or other approved means is sufficient. Just prior to placing the fill, the fill foundation area shall be densified to a depth of six inches to the density specified for the fill. The density and moisture content of the soil underlying the six inch compacted layer shall be altered as necessary to obtain the specified density of the fill foundation.

B. Placement of Fill Material:

1. Fill or embankment shall be constructed using only approved suitable material.
2. In fill construction, the material shall be deposited and spread in successive uniform approximately horizontal layers of not more than 8 inch depth loose measurement for the full width of the required cross section. It shall be placed so that during construction the center of the fill shall be kept higher than the edges. Sandy or rocky material encountered shall be spread in full width layers to form drainage planes from the center through the edge of embankments, except that rocky material larger than four inches in size shall not be used in embankment. Care shall be taken to avoid pockets of open graded material surrounded by tight or more impervious material. Each layer of embankment shall be rolled and compacted to the specified density. Successive trips of compaction equipment shall progress from edges toward center. Fills and slopes shall be finished true and straight, in conformity with lines and grades as shown with true and even surfaces. Fill shall be constructed of approved materials. Moisture content of soils shall be maintained within the percentage of optimum moisture content specified in this section. During periods of dry weather, the Contractor shall water material to provide sufficient



moisture for compaction. Water required to provide sufficient moisture will not be measured for direct payment. Materials containing excessive moisture will not be measured for direct payment. Materials containing excessive moisture shall be permitted to dry out to the proper moisture content before compaction is attempted. Borrow areas shall be drained and otherwise properly operated to assist in achieving this objective.

3. Fill sections failing to meet requirements shall be removed and replaced, or reworked until satisfactory to the Engineer and at no additional cost to the Owner.
4. Side ditches or gutters emptying from cuts to embankments shall be constructed so as to avoid damage to embankments by erosion.

### 3.06 FINISH GRADING:

- A. All exposed earth surfaces and pavement sub-grades shall be finish graded to within  $\pm 0.10$  foot of theoretical grade. Finish grading for slopes shall be that degree ordinarily obtainable for either blade-grader or scraper operations, or that obtainable by hand shovel operations. When directed or noted, the accuracy of finish grades obtained by using templates and stringline or hand raking methods is required in case of shoulders, gutters, and similar areas. All ditches and other graded areas shall be finished so they drain readily. All areas not under proposed structures or pavements shall be left in a suitable condition for grassing as indicated on the Drawings. In areas adjacent to pavement where bulking of soil caused by the growth of grass will prevent drainage of runoff from pavement, the finished grade shall be left one inch lower than the top of pavement elevation.

### 3.07 SOIL COMPACTION CONTROL:

- A. Compaction Requirements: The percent compaction of maximum dry density as specified herein, and required for fill areas within the scope of the project, unless otherwise defined in other sections, are as follows:
  1. General Fill Area not located under roads, buildings, or other structures, 95% compaction, with reference to ASTM D698 Standard Proctor.
  2. Fill sections required for the construction of roads and paved areas, 96% compaction, ASTM D698 except for the top 18" which shall be compacted to 100% Standard Proctor, ASTM D698. Fill for building foundations and slabs on grade shall be compacted to 96% Proctor, ASTM D698 and the top 24" shall be compacted to

3. 100% of ASTM D698.  
Existing-Material to a point 6 inches below the top of subgrade in paved areas, 100% compaction, with reference to ASTM D698 Standard Proctor.
  4. Structures in Fill or Backfill areas shall be compacted to 98% Proctor, ASTM D698, and the top 36" shall be compacted to 100% of ASTM D698.
  5. Moisture Content: All fill material shall be placed within +2% and -2% of optimum moisture content.
  6. Lift Thickness: All fill shall be placed in 8-inch lifts maximum, loose measure.
- B. Field Density Testing: Field density shall be determined by methods outlined in ASTM D1556 and D2922.
- C. Compaction Results:
1. The soils technician shall advise the Contractor immediately of any compaction tests failing to meet the specified minimum requirements. The Engineer will inform the soils technician of any retesting required. Formal reports of all test results will be submitted. No additional lift shall be placed on a lift with any portion failing.

### 3.08 DISPOSAL OF EARTHWORK DEBRIS:

- A. Disposal of Debris or Waste:
1. Burning of combustible material on site shall be permitted. All burning shall be conducted in accordance with Local, state, and Federal Laws. Disposal of materials off site by the Contractor shall be at no additional cost to the Owner.
  2. Remove non-combustible materials, including, but not limited to, rock, muck, broken concrete, metals, from the site and dispose of by the Contractor at no additional cost to the Owner.

3.09 PROTECTION:

- A. Completed Work: The Contractor shall be responsible until final acceptance for maintaining the stability of all fills and subgrade constructed under the contract and shall bear the expense of replacing any portions which, in the opinion of the Engineer, have become damaged due to carelessness or negligence on the part of the Contractor, including failure to properly route or contain surface water run-off. No runoff or other water shall be allowed to pond on or against completed work. If such ponding occurs for any reason the areas affected shall be reworked to the satisfaction of the Engineer. Specifically excluded from extra payment is replacement of slope material washed away by natural rainfall or run-off, which shall be at the expense of the Contractor. The final grade shall be maintained to +1/10 ft. of theoretical grade.

End of Section

**FOUNDATION AND TRENCH EXCAVATION, BEDDING, AND BACKFILL**

**SECTION 02220**

**PART 1 - GENERAL**

**1.01 QUALITY ASSURANCE:**

**A. Applicable Standards:**

1. General: Current editions or revisions of the following specifications and standards shall apply unless specifically noted otherwise on the Drawings or specified herein. Modifications to standard specifications shall be noted within the Specification and will be noted as revisions to the standard specifications, but will not nullify unaffected portions of the specifications.
2. American Society for Testing and Materials: Comparable standard specifications for the American Society for Testing and Materials, herein referred to as ASTM and the American Association of State Highway and Transportation Officials, herein referred to as AASHTO, are listed below. Where only one specification number is shown, the standard specification for that society shall apply.

<u>ASTM</u>	<u>AASHTO</u>	<u>TITLE</u>
D 698		Moisture-Density Relations of Soils Using 5.5 lb. Hammer and 12 Inch Drop (Standard Proctor).
D 1556	T-191	Density of Soil in Place by the Sand Cone Method.

Other methods will be considered upon written request to the Engineer. The request must demonstrate a correlation with the above standards. The final approval is the responsibility of the Engineer.

**B. Tests:**

1. Qualified soils technicians working under the direct supervision of a Geotechnical Engineer shall be employed by the Contractor for the purpose of identifying soils, checking densities, and classifying soils materials during construction. Charges for this service will be paid for by the Contractor.
2. Density Tests shall be made as directed by the Engineer.

3. Contractor to deliver test results to the Engineer and Owner as soon as possible upon completion of the required test.

C. Materials: Reference Section 02000, Part 1, paragraph 1.01.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 FIELD ENGINEERING:

A. All field engineering is the responsibility of the Contractor.

3.02 SPECIAL SAFETY REQUIREMENTS:

A. Any trench that is not backfilled at the end of day's work shall be barricaded and marked with warning lights. Temporary bridges and crossings shall be provided and maintained by the Contractor, where in the opinion of the Engineer, they are required to maintain traffic. Materials obtained from excavation shall not be piled closer than four feet to the edge of the excavation. Along streets and roads excavated material shall be kept clear of any traveled way. The Contractor is required to locate all underground structures and utilities, shown on the Drawings or made known to him during construction, by hand digging and exposing the structure or utility for the full width of the new trench. The Contractor shall coordinate with the local utility companies as required to determine the location of utilities within the limits of the Work in adequate time to allow for relocation or adjustment of utility lines prior to conflict with the Work, and to show the location of the utilities ahead of the Work. Each utility exposed shall be fully protected and supported during construction. Nothing contained herein relieves the Contractor of his responsibility to provide safe working conditions for the workmen in the area of construction.

3.03 EXCAVATION:

A. Foundation Excavation: Foundation excavation shall be of sufficient dimension to accommodate all forms required to be erected.

1. Remove all loose material from excavation bottoms and level or grade excavation bottoms to receive foundation materials. All excavations to receive structures or foundations shall be inspected by the Geotechnical Engineer. Any unsuitable or unstable material shall be removed and replaced with suitable material and compacted as directed.

2. Excavation shall be of sufficient dimensions to accommodate all forms and/or structures required. Walls of excavations shall be sloped to remain stable until backfill is placed.
  3. Retain suitable material from excavation and use for backfill. Material will be classified as suitable or unsuitable by the Soil Technician.
  4. Unsuitable excavated material becomes the responsibility of the Contractor. Remove and dispose of such material away from site. All unsuitable excavated material must be properly disposed of in a manner acceptable to the City/County Public Works Department and in a manner that will not adversely impact the environment.
  5. Perform excavation in a manner and sequence to provide drainage at all times. Temporary drains, ditches, pumps, drainage lines or other equipment to intercept, divert, or remove surface and sub-surface water from the excavation are required.
- B. Trench Excavation: Excavation for trenches as stated below to receive gravity or pressure pipe or other utility lines shall be for the proper installation of the utility and shall be at the lines and grades shown on the Drawings. Trench walls shall be maintained as nearly vertical as possible to an elevation one foot above the top of the utility, not to exceed a vertical height of four feet above the bottom of the trench. Any trench exceeding a height of four feet is to be sloped, benched, or sheeted and shored to maintain the stability of the trench wall. If suitable bearing for the pipe or conduit is not encountered at the depth indicated for trench bottom due to wet or unstable material, such material shall be excavated to depth required and refilled and compacted to proper grade with coarse sand, fine gravel, or other suitable approved material. Where rock is encountered at proper grade for trench bottom, excavation shall extend six (6) inches below proper grade and such excavation shall be refilled and compacted to proper grade with coarse sand, fine gravel, or other suitable approved material. Special requirements relating to specific utilities are as follows:
1. All Pipe Lines and Conduits: Excavation shall be open cut and the proper width of the trench one foot above the top of the pipe or conduit shall be such that the clear space between the barrel of the pipe or conduit and trench wall shall not exceed 8 inches on either side of the pipe or conduit. The width of the trench above that level shall be as wide as necessary for sheeting and bracing and the proper performance of the Work.
  2. Pressure Lines: Unless otherwise indicated, trenches shall be

graded to avoid high points with the necessity of placing vacuum and relief valves in the pressure lines. Trenches shall be of a depth to provide a minimum cover over the top of the pipe of 3'-6" in unpaved areas and 4 feet in paved areas, or as shown on the drawings, and to avoid interference with other utilities.

- C. Rock Excavation: Rock shall be excavated to a depth six inches below the bottom of the pipe.
- D. Bedding:
  - 1. General: The bottoms of trenches shall be shaped in undisturbed soil or in the bedding required on the Drawings. Minimum acceptable bedding, unless shown otherwise on the plans or specified elsewhere herein, shall consist of uniform contact with undisturbed soil or compacted bedding material by the pipe barrel, for an arc of a central angle of 90 degrees. The entire bottom of the excavation is to be firm, stable, and at a uniform density, and unless for removal of rock or muck, left undisturbed. Joint holes shall be excavated by hand to the minimum size required for proper installation of the joint so the joint does not carry the weight of the pipe.
  - 2. Muck Areas: After muck or unsuitable material has been removed, the bed of the trench shall be brought back to the line and grade shown on the drawings using a suitable backfill material placed in eight inch lifts and compacted to 98 percent of the maximum dry density as determined by ASTM D 698.
  - 3. Rock Areas: A six inch layer of compacted concrete sand, fine gravel or crushed stone, not larger than 1/4 inch in size, shall be placed above the rock and shaped as required herein to receive the utility.

#### 3.04 BACKFILL:

- A. General: Backfilling operations shall not proceed until all necessary tests, inspections or observations have been performed as required by the applicable utility specification, or unless directed by the Engineer. All debris, rocks, broken concrete, formwork, etc., shall be removed from the trench and backfill material prior to the start of backfilling operations.
- B. Backfill adjacent to structures shall be placed in eight inch layers (loose measure) and each layer compacted to 96% maximum dry density as determined by ASTM D698, Standard Proctor, except the top twenty four inches shall be compacted to 100% maximum dry density for areas to

support structures or pavements.

- C. Trench backfill shall be placed in uniform six inch layers, loose measure, and compacted the full width of the trench to the percent of maximum dry density as determined by ASTM D 698. This procedure shall be carried out for the full height of the utility plus one foot above the utility. All backfill material shall be free of muck, rock, organic material, broken concrete or other debris.
1. **Placing Backfill Material:** Backfill material shall be placed in the trench in such a manner so as not to disturb the alignment of the utility. Under no circumstances shall a bulldozer or other equipment be allowed to push fill material into the trench. The material shall not be dropped on the pipe, but placed in a manner as to allow the pipe to remain in place and to allow for the uniform spreading and compaction of the material. Material shall be placed on both sides of the utility so that the backfill will have the same elevation on each side during compaction operations.
  2. **Backfill Above the Utility:** After the backfill has reached an elevation one foot above the top of the pipe, operations shall proceed as follows:
    - a. Under existing or proposed roads, floor slabs, parking areas, etc., backfill material shall be placed in uniform six inch layers, loose measure and compacted to 96% of the maximum dry density as determined by ASTM D 698, to within two feet of the top of the trench. The top 24 inches shall be compacted to 100% density of the same specification.
    - b. In areas where no construction is to take place over the utility, backfill material shall be placed in uniform 8 inch layers, loose measure and compacted to 96% of the maximum dry density as determined by ASTM D 698 for the full depth of the trench.
- D. **Moisture Content:** Moisture content of backfill material shall be within +or- 2.0% of optimum.

End of Section



## **GRASSING**

### Section 02821

#### PART 1 GENERAL

##### 1.01 SCOPE

This section pertains to seeding work, including preparing the seedbed, furnishing and placing of topsoil, seed and other required materials for a complete installation to the limits of construction and specified herein. Seeding operations shall be performed on all newly graded earth areas not otherwise specified covered by structures, pavements and/or surfaces, riprap, sod, sprigging, walkways, and other items of a similar nature; on all cleared and/or grubbed areas which are to remain as finish grade surfaces and not to be excavated or embankments constructed thereon; on all existing off site and on site turfed earth surfaces which are disturbed by construction operations and which are to remain as finish grade surfaces; and at all other locations which may be designated on the drawings or specified herein. The contractor shall follow the GA DOT Standard Specifications Construction of Roads and Bridges Section 700, 882, 890 and 891 latest edition and/or pages 6-35 thru 6-60 of the Manual for Erosion and Sediment Control in Georgia (1975 and as amended in the latest edition).

#### PART 2 PRODUCTS

##### 2.01 TOPSOIL

Topsoil for planting shall be a rich friable loam containing a large amount of humus and shall be original surface sandy loam, topsoil of good rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2-inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips, or other undesirable material harmful or unnecessary to plant growth. Topsoil shall be reasonably free from perennial weeds and perennial weed seeds, and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life. Bermuda grass roots in topsoil will not be accepted, unless otherwise approved by the Engineer.

Topsoil shall be natural topsoil without admixture of subsoil material, and shall be classifiable as loam, silt loam, clay loam, or a combination thereof.

## 2.02 GRASS SEED

All seeds shall be labeled in accordance with U.S.D.A. Rules and Regulations. Seeds shall be packaged in suitable containers in accordance with the Georgia Seed Laws, Rules and Regulations currently in effect. No seed shall be used which has become molded, wet or otherwise damaged. Seed shall be tested by the Georgia Department of Agriculture for the purity and germination within six months prior to the date of sowing.

1. Grass seed on level or slightly sloping ground shall consist of the following for the planting dates specified:
  - (a) March 1 to June 30

Common Bermuda (hulled)	10 lbs./acre
Tall Fescue	50 lbs./acre
  - (b) August 1 to November 1

Tall Fescue	50 lbs./acre
Common Bermuda (unhulled)	10 lbs./acre
  - (c) November 1 to March 1

Common Bermuda (unhulled)	10 lbs./acre
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2. Grass seed on slopes 3:1 or steeper and infrequently mowed areas shall consist of the following for the planting dates specified:
  - (a) March 1 to June 15

Weeping Lovegrass	5 lbs./acre
Sericea Lespedeza (scarified)	60 lbs./acre
  - (b) August 1 to November 1

Tall Fescue	50 lbs./acre
Sericea Lespedeza (unscarified)	75 lbs./acre
  - (c) November 1 to March 1

Common Bermuda (unhulled)	10 lbs./acre
Sericea Lespedeza (unscarified)	75 lbs./acre

When as directed by the Engineer, an approved quick growing species of grass seed such as rye, Italian rye, millet or other cereal grass, shall be applied at a rate of 30 lbs./acre in conjunction with and in addition to the seed mixture specified above.

### 2.03 SPRIGS

Bermuda, common, healthy living stolons native to locality of project. Plant on day of removal from growing location. Plant sprigs from March 15 to July 15.

### 2.04 MULCH

- A. Dry Mulch: Dry mulch shall be straw or hay, consisting of oat, rye or wheat straw, or of pangola, peanut, coastal Bermuda or Bahia grass hay. Only undeteriorated mulch which can be readily cut into the soil shall be used. Application rate shall be 2 ½ tons per acre.
- B. Mulch for hydroseeding: This material shall consist of wood cellulose fiber applied at 500 lbs./acre with dye color equal to Weyerhaeuser Company, or Conway Corporation material used for "hydroseeding" and suitable for this purpose.

### 2.05 FERTILIZER

Fertilizer shall be of an accepted and approved commercial brand. Fertilizer shall be a ready mixed material containing the soil nutrients as specified and in a suitable form compatible with the equipment used to achieve uniform distribution of the fertilizer. The fertilizer mixture shall contain the following nutrients expressed in per cent of the total weight: 6% nitrogen, 12% available phosphoric acid, and 12% water soluble potash (6-12-12) analysis. Container tags shall have the name and address of the manufacturer, the brand name, net weight, and chemical composition of analysis. Fertilizer shall be applied at 1500 lbs./acre.

### 2.06 LIME

Agricultural lime shall be within the specifications of the Georgia Department of Agriculture. Ground limestone is calcitic or dolomitic limestone ground so that 90 percent of the material shall pass a 10-mesh sieve, not less than 50 percent will pass through a 50-mesh sieve and at least 25% shall pass a 100-mesh sieve. Lime shall be applied as indicated by soil test, or the rate of 1 to 2 tons per acre.

### 2.07 WATER

The water used in the grassing operations may be obtained from any approved spring, pond, lake, stream or municipal water system. The water shall be free of excess and harmful chemicals, acids, alkalies, or any substance which might be harmful to plant growth or obnoxious to traffic.

2.08 SOD

Shall be healthy living, disease and weed free grass that has been freshly cut.

PART 3 EXECUTION

3.01 HYDROSEEDING

- A. The materials for grassing shall consist of a thoroughly mixed slurry of grass seed, fertilizer, lime and mulch as specified. The application rate for wood fiber mulch shall be approximately 500 lbs./acre. All materials shall be discharged within one hour after being combined in the hydroseeder.
- B. Each kind of leguminous seed shall be inoculated separately with the appropriate commercial culture according to instructions of the manufacturer of the material. All inoculated seed shall be protected from the sun and shall be planted the same day it is inoculated.
- C. Equipment for mixing and applying the slurry shall be especially designed for this purpose. It shall be capable of applying a uniform mixture over the entire area to be seeded. The slurry mixture shall be agitated during application to keep the ingredients thoroughly mixed. A suitable metering device to determine the rate of application and assist in obtaining uniform coverage of the grassed areas shall be incorporated as part of the equipment.
- D. Ground preparation for hydroseeding shall be the same as for conventional seeding.
- E. Hydroseeding shall not be performed when windy weather prevents even distribution; when the prepared surface is crusted; or when the ground is frozen, wet or otherwise in a non-tillable condition.

3.02 CONVENTIONAL SEEDING

A. Grading and Shaping

Grade and shape to finish contours and to allow practical use of equipment.

B. Seedbed Preparation

- 1. Broadcast plantings:

- a. Tillage as a minimum shall: adequately loosen the soil to a depth of 4 to 6 inches; alleviate compaction; incorporate lime and fertilizer; smooth and firm the soil; allow for the proper placement of seed, sprigs, or plants; and allow for the anchoring of straw or hay mulch if a disk is to be used.
  - b. Tillage may be done with any suitable equipment.
  - c. Tillage may be done on the contour where feasible.
  - d. On slopes too steep for the safe operation of tillage equipment, the soil surface will be pitted or trenched across the slope with appropriate hand tools to provide a place 6 to 8 inches apart in which seed may lodge and germinate.
2. Individual plants:
- a. Where individual plants are to be set, the soil will be well prepared by excavating holes, opening furrows, or dibble planting.
  - b. For nursery stock plants, holes shall be large enough to accommodate roots without crowding.

### 3.03 SPRIGS

Separate or shred and broadcast over area prepared for planting at 40 cu. ft. per acre. Harrow into ground with disc turned straight.

### 3.04 LIME/FERTILIZER APPLICATION

Lime and fertilizer will be applied uniformly during land preparation so that it will be mixed with the soil during seedbed preparation. On steep surfaces, scarify slope prior to broadcasting lime and fertilizer.

### 3.05 PLANTING

- A. Seeding will be done on a freshly prepared and firmed seedbed. For broadcast planting, use a cultipacker-seeder, drill, rotary seeder, other mechanical seeder, or hand seeding to distribute the seed uniformly over the area to be treated. Cover the seed lightly with a cultipacker or other suitable equipment.
- B. No-till seeding is permissible into annual cover crops when planting is done following maturity of the cover crop or if the temporary cover stand is sparse enough to allow adequate growth of the permanent species.

- C. No-till seeding must be done with appropriate no-till seeding equipment. The seed must be uniformly distributed and planted at the proper depth.

### 3.06 MULCHING

All seeded areas shall be mulched. Soil retention blankets, erosion control netting, and other manufactured materials may be required in addition to mulch on unstable soils and concentrated flow areas. Mulch shall be spread uniformly within 24 hours after seeding.

### 3.07 WATER, MAINTENANCE AND RESEEDING

- A. Contractor shall be responsible for maintaining the proper moisture content of the soil to insure adequate plant growth until a satisfactory stand of grass is obtained. Watering shall be performed to maintain an adequate water content in the soil.
- B. **The Contractor shall mow and maintain all seeded areas without additional payment until final acceptance of the work by the Owner, and any regrading, refertilizing, reliming, reseeding or remulching shall be done at his own expense.** Seeding work shall be repeated on defective areas until a satisfactory uniform stand of grass is accomplished. A satisfactory stand of grass is defined as grass that covers at least 98% of the total area with no bare spots larger than one square foot and bare spots shall be scattered such that bare areas do not comprise more than 1/100 of any given area. **Damage resulting from erosion, gulleys, washouts, or other causes shall be repaired by filling with topsoil, compacting, and repeating the seeding work at the Contractor's expense.**

### 3.08 SODDING

Smooth grade the specified area to be planted. Apply amendments and fertilizer requirements as determined in soil test. Planting area shall be free of stumps, roots, large stone over 4" diameter, and any other debris. Apply fertilizer and rake into the soil surface. Lightly wet soil surface if dry. Lay the sod at right angles to any major water flow. Sod shall be pinned and secured on slopes greater than 6:1. Sod joints shall be staggered between rows. Sod shall be watered after installation each day.

End of Section

**AGGREGATE FILL UNDER SLABS**  
**SECTION 03000**

**PART 1 - GENERAL**

**1.01 QUALITY ASSURANCE:**

- A. Applicable Standards: Conform to the following Standards:
  - ASTM D448: Standard Sizes of Coarse Aggregate for Highway Construction.
  - ASTM D698: Moisture - Density Relations of Soils Using 5.5 lb. Hammer and 12 in. Drop (Standard Proctor).

**1.02 PRODUCT STORAGE:**

- A. Product Storage: Stockpile aggregate fill material in a manner to prevent contamination with other sizes of aggregates which may be stored at the site.

**PART 2 - PRODUCTS**

**2.01 MATERIALS:**

- A. Aggregate Type: Clean crushed stone, crushed gravel or uncrushed gravel.
- B. Aggregate Size: Size No. 57, 6, 67, or 7 as set forth in Table 1 of ASTM D448.

**PART 3-EXECUTION**

**3.01 PLACEMENT:**

- A. General: Place aggregate fill on subgrade meeting density and elevation requirements as indicated on the drawings. Place as indicated beneath the Digester, Dewatering building slab as indicated.
- B. Compaction:
  - 1. Requirement: Compact fill to 100 percent of aggregate's Standard Proctor as determined by Method D of ASTM D698.
  - 2. Procedure: Compact aggregate fill in layers not exceeding six inches in compacted thickness. Compact each layer with a minimum of two passes of a vibratory compactor.

End of Section

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

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.
- B. Cast-in-place concrete includes the following:
  - 1. Foundations and footings.
  - 2. Slabs-on-grade.
  - 3. Fill for load-bearing masonry walls.
  - 4. Clear sealer applied to all slabs.

**1.3 SUBMITTALS**

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Engineer.
- C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.
- D. Samples of materials as requested by Engineer, including names, sources, and descriptions, as follows:
  - 1. Color finishes.
  - 2. Normal weight aggregates.
  - 3. Vapor retarder/barrier.
- E. Laboratory test reports for concrete materials and mix design test.



- F. Material certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

#### 1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:
  - 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
  - 2. ACI 318, "Building Code Requirements for Reinforced Concrete."
  - 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- B. Concrete Testing Service: Engage a testing agency acceptable to Engineer to perform material evaluation tests and to design concrete mixes.
- C. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.
- D. Mockup: Cast mockup of size indicated or as required to demonstrate typical joints, form tie spacing, and proposed surface finish, texture, and color. Maintain sample panel exposed to view for duration of Project, after Engineer's acceptance of visual qualities.
  - 1. Demolish mockup and remove from site when directed by Engineer.

### PART 2 - PRODUCTS

#### 2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
  - 1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

- C. Forms for Cylindrical Columns and Supports: Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to support weight of placed concrete without deformation.
- E. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 mg/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- F. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to the plane of the exposed concrete surface.

## 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.
  - 1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
  - 2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
  - 1. Use one brand of cement throughout Project unless otherwise acceptable to Engineer.
- B. Fly Ash: ASTM C 618, Type F.
- C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.
  - 1. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Engineer.

- D. Lightweight Aggregates: ASTM C 330.
- E. Water: Potable.
- F. Reinforcement: Provide 6x6x10/10 w.w.m.
- G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Air-Tite, Cormix Construction Chemicals.
    - b. Air-Mix or Perma-Air, Euclid Chemical Co.
    - c. Darex AEA or Daravair, W.R. Grace & Co.
    - d. MB-VR or Micro-Air, Master Builders, Inc.
    - e. Sealtight AEA, W.R. Meadows, Inc.
    - f. Sika AER, Sika Corp.
- H. Water-Reducing Admixture: ASTM C 494, Type A.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Chemtard, ChemMasters Corp.
    - b. PSI N, Cormix Construction Chemicals.
    - c. Eucon WR-75, Euclid Chemical Co.
    - d. WRDA, W.R. Grace & Co.
    - e. Pozzolith Normal or Polyheed, Master Builders, Inc.
    - f. Metco W.R., Metalcrete Industries.
    - g. Prokrete-N, Prokrete Industries.
    - h. Plastocrete 161, Sika Corp.
- I. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Super P, Anti-Hydro Co., Inc.
    - b. Cormix 200, Cormix Construction Chemicals.
    - c. Eucon 37, Euclid Chemical Co.
    - d. WRDA 19 or Daracem, W.R. Grace & Co.
    - e. Rheobuild or Polyheed, Master Builders, Inc.
    - f. Superslump, Metalcrete Industries.
    - g. PSPL, Prokrete Industries.
    - h. Sikament 300, Sika Corp.

- J. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Q-Set, Conspec Marketing & Manufacturing Co.
    - b. Lubricon NCA, Cormix Construction Chemicals.
    - c. Accelguard 80, Euclid Chemical Co.
    - d. Daraset, W.R. Grace & Co.
    - e. Pozzutec 20, Master Builders, Inc.
    - f. Accel-Set, Metalcrete Industries.
- K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. PSI-R Plus, Cormix Construction Chemicals.
    - b. Eucon Retarder 75, Euclid Chemical Co.
    - c. Daratard-17, W.R. Grace & Co.
    - d. Pozzolith R, Master Builders, Inc.
    - e. Protard, Prokrete Industries.
    - f. Plastiment, Sika Corporation.

## 2.4 RELATED MATERIALS

- A. Vapor Retarder: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:
1. Water-resistant barrier consisting of heavy kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.
    - a. Product: Subject to compliance with requirements, provide Moistop by Fortifiber Corporation.
- B. Colored Wear-Resistant Finish: Packaged dry combination of materials consisting of portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground nonfading mineral oxides interground with cement. Color as selected by Engineer from manufacturers' standards, unless otherwise indicated.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Conshake 600 Colortone, Conspec Marketing & Mfg. Co.

- b. Floorcron, Cormix Construction Chemicals.
  - c. Quartz Tuff, Dayton-Superior.
  - d. Surfex, Euclid Chemical Co.
  - e. Colorundum, A.C. Horn, Inc.
  - f. Quartz Plate, L&M Construction Chemicals, Inc.
  - g. Colorcron, Master Builders, Inc.
  - h. Floor Quartz, Metalcrete Industries
  - i. Lithochrome Color Hardener, L.M. Scofield Co.
  - j. Harcol Redi-Mix, Sonneborn-Chemrex.
  - k. Hard Top, Symons Corp.
- C. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- D. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
- 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. Polyethylene-coated burlap.
- E. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
- 1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 mg per liter.
  - 2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Highseal, Conspec Marketing and Mfg. Co.
    - b. Sealco - VOC, Cormix Construction Chemicals.
    - c. Safe Cure and Seal, Dayton Superior Corp.
    - d. Aqua-Cure, Euclid Chemical Co.
    - e. Dress & Seal WB, L&M Construction Chemicals, Inc.
    - f. Masterkure 100W, Master Builders, Inc.
    - g. Vocomp-20, W.R. Meadows, Inc.
    - h. Metcure, Metalcrete Industries.
    - i. Stontop CS1, Stonhard, Inc.
- F. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
- 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Aquafilm, Conspec Marketing and Mfg. Co.
    - b. Eucobar, Euclid Chemical Co.

- c. E-Con, L&M Construction Chemicals, Inc.
  - d. Confilm, Master Builders, Inc.
  - e. Waterhold, Metalcrete Industries.
- G. Bonding Agent: Polyvinyl acetate or acrylic base.
- 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Polyvinyl Acetate (Interior Only):
      - 1) Superior Concrete Bonder, Dayton Superior Corp.
      - 2) Euco Weld, Euclid Chemical Co.
      - 3) Weld-Crete, Larsen Products Corp.
      - 4) Everweld, L&M Construction Chemicals, Inc.
      - 5) Herculox, Metalcrete Industries.
      - 6) Ready Bond, Symons Corp.
    - b. Acrylic or Styrene Butadiene:
      - 1) Acrylic Bondcrete, The Burke Co.
      - 2) Strongbond, Conspec Marketing and Mfg. Co.
      - 3) Day-Chem Ad Bond, Dayton Superior Corp.
      - 4) SBR Latex, Euclid Chemical Co.
      - 5) Daraweld C, W.R. Grace & Co.
      - 6) Hornweld, A.C. Horn, Inc.
      - 7) Everbond, L&M Construction Chemicals, Inc.
      - 8) Acryl-Set, Master Builders Inc.
      - 9) Intralok, W.R. Meadows, Inc.
      - 10) Acrylpave, Metalcrete Industries.
      - 11) Sonocrete, Sonneborn-Chemrex.
      - 12) Stonlock LB2, Stonhard, Inc.
      - 13) Strong Bond, Symons Corp.
- H. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.
- 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
    - a. Burke Epoxy M.V., The Burke Co.
    - b. Spec-Bond 100, Conspec Marketing and Mfg. Co.
    - c. Resi-Bond (J-58), Dayton Superior.
    - d. Euco Epoxy System #452 or #620, Euclid Chemical Co.
    - e. EpoxTite Binder 2390, A.C. Horn, Inc.
    - f. Epabond, L&M Construction Chemicals, Inc.

- g. Concrete Standard Liquid, Master Builders, Inc.
- h. Rezi-Weld 1000, W.R. Meadows, Inc.
- i. Metco Hi-Mod Epoxy, Metalcrete Industries.
- j. Sikadur 32 Hi-Mod, Sika Corp.
- k. Stonset LV5, Stonhard, Inc.
- l. R-600 Series, Symons Corp.

## 2.5 PROPORTIONING AND DESIGNING MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.
  - 1. Do not use the same testing agency for field quality control testing.
  - 2. Limit use of fly ash to not exceed 10 percent of cement content by weight.
- B. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Engineer.
- C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:
  - 1. 4000-psi, 28-day compressive strength; water-cement ratio, 0.44 maximum (non-air-entrained), 0.35 maximum (air-entrained).
  - 2. 3000-psi, 28-day compressive strength; water-cement ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained).
- D. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:
  - 1. Subjected to freezing and thawing: W/C 0.45.
- E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
  - 1. Ramps, slabs, and sloping surfaces: Not more than 4 inches.
  - 2. Reinforced foundation systems: Not less than 2 inches and not more than 4 inches.
  - 3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-3-inch slump concrete.
  - 4. Other concrete: Not more than 4 inches.
- F. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Engineer. Laboratory

test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in Work.

- G. Fiber Reinforcement: Add at manufacturer's recommended rate but not less than 1.5 lb per cu. yd.

## 2.6 ADMIXTURES

- A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
- B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
- C. Use high-range water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, Engineerural concrete, parking structure slabs, concrete required to be watertight, and concrete with water-cement ratios below 0.50.
- D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
  - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
    - a. 4.5 percent (moderate exposure); 5.5 percent (severe exposure) for 1-1/2-inch maximum aggregate.
    - b. 4.5 percent (moderate exposure); 6.0 percent (severe exposure) for 1-inch maximum aggregate.
    - c. 5.0 percent (moderate exposure); 6.0 percent (severe exposure) for 3/4-inch maximum aggregate.
    - d. 5.5 percent (moderate exposure); 7.0 percent (severe exposure) for 1/2-inch maximum aggregate.
  - 2. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.
- E. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

## 2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.
  - 1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.



## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

### 3.2 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:
  - 1. Provide Class A tolerances for concrete surfaces exposed to view.
  - 2. Provide Class C tolerances for other concrete surfaces.
- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.
- D. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- E. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- F. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing

concrete, as required, to prevent mortar leaks and maintain proper alignment.

### 3.3 VAPOR RETARDER INSTALLATION

- A. General: Place vapor retarder sheeting in position with longest dimension parallel with direction of pour.
- B. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape.

### 3.4 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
  - 1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Engineer.
- D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### 3.5 JOINTS

- A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Engineer.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
- C. Place construction joints in lieu of control joints in floor slab as shown on drawings. Do not continue reinforcement through sides of strip placements.

- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."
- F. Control Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.
  - 1. Form control joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
  - 2. Control joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
  - 3. If joint pattern is not shown, provide joints not exceeding 16 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
  - 4. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

### 3.6 INSTALLING EMBEDDED ITEMS

- A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- B. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

### 3.7 PREPARING FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.
- B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

### 3.8 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
  - 1.d Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
  2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
- E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
  1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.
  2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
  3. Maintain reinforcing in proper position on chairs during concrete placement.

- F. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- G. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- H. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.
  - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2.d Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
  - 3.d Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
  - 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Engineer.
- I. Concrete slabs shall be finished with the following tolerance: True plane within 1/8" in ten feet as determined by a ten foot straightedge placed anywhere on the slab in any direction.

### 3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

- B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.10 MONOLITHIC SLAB FINISHES

- A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.
  - 1.d After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured according to ASTM E 1155. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.
- B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.
  - 1.d After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.

1.d After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F(F) 20 (floor flatness) and F(L) 17 (floor levelness) measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.

D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

E. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

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

F. Colored Wear-Resistant Finish: Apply a colored wear-resistant finish to monolithic slab surface indicated.

1.d Apply dry shake materials for the colored wear-resistant finish at a rate of 100 lb per 100 sq. ft., unless a greater amount is recommended by material manufacturer.

2.d Cast a trial slab approximately 10 feet square to determine actual application rate, color, and finish, as acceptable to Engineer.

3.d Immediately following the first floating operation, uniformly distribute with mechanical spreader approximately two-thirds of the required weight of the dry shake material over the concrete surface, and embed by power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material with overlapping applications to ensure uniform color, and embed by power floating.

4. After broadcasting and floating, apply a trowel finish as specified. Cure slab surface with a curing compound recommended by the dry shake material manufacturer. Apply the curing compound immediately after the final finishing.

### 3.11 MISCELLANEOUS CONCRETE ITEMS

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

### 3.12 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect

concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified and approved by Engineer.
- D. Provide moisture curing by the following methods:
  - 1.d Keep concrete surface continuously wet by covering with water.
  - 2.d Use continuous water-fog spray.
  - 3.d Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4-inch lap over adjacent absorptive covers.
- E. Provide moisture-retaining cover curing as follows:
  - 1.d Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- F. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:
  - 1.d Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
  - 2.d Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- G. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- H. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.



- 1.d Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

### 3.13 SHORES AND SUPPORTS

- A. General: Comply with ACI 347 for shoring and reshoring in multistory construction, and as specified.
- B. Extend shoring from ground to roof for structures four stories or less, unless otherwise permitted.
- C. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to support work without excessive stress or deflection.
- D. Keep reshores in place a minimum of 15 days after placing upper tier, or longer, if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

### 3.14 REMOVING FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

### 3.15 REUSING FORMS

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

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

### 3.16 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Engineer.
- B. Mix dry-pack mortar, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
  - 1.d Cut out honeycombs, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
  - 2.d For surfaces exposed to view, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.
  - 1.d Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
  - 1.d Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or

- completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.
- 2.d Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
  - 3.d Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Engineer.
  - 4.d Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- E. Perform structural repairs with prior approval of Engineer for method and procedure, using specified epoxy adhesive and mortar.
  - F. Repair methods not specified above may be used, subject to acceptance of Engineer.

### 3.17 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Contractor will employ a testing agency to perform tests and to submit test reports.
- B. Sampling and testing for quality control during concrete placement may include the following, as directed by Engineer.
  - 1.d Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
    - e. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
    - f. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
    - g. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
    - h. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise

- directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
- i. Compressive-Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
  3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
  4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- C. Test results will be reported in writing to Engineer, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.
- 3.18 SEALER  
Apply a clear sealer to all concrete slabs that do not receive a floor finish.

**END OF SECTION**

## **PRECAST CONCRETE**

### **SECTION 03411**

#### **PART 1 - GENERAL**

##### **1.01 DESCRIPTION:**

- A. The work required under this section consists of all materials, accessories, equipment, tools, and labor required to construct precast concrete standard and drop manholes, precast wetwells and underground utility structures, where shown on the drawings.
  
- B. Manholes and precast underground utility structures shall be constructed of specified materials to the sizes, shapes and dimensions, and at the locations shown on the plans or as otherwise directed by the Engineer. The height or depth of the structures will vary with the location, and shall be as directed by the Engineer. Generally, the height shall be such that the top of the manhole frame will be at the finished grade of the pavement or ground surface for manholes located in pavement, in road or street right-of-ways or in maintained grounds. In these locations the manholes are shown to be near the grade in profile on the drawings. Generally, for manholes located along streams or in open fields, the height above ground shall be no less than three feet. In these locations the manholes are shown to be at this height in profile on the drawings. The invert will be at the designed elevations.

##### **1.02 SUBMITTALS:**

- A. The Contractor shall submit detailed drawings conforming to the requirements of Section 01300 of these Specifications and shall receive approval of same before any material may be delivered or erected at the jobsite.

#### **PART 2 - PRODUCTS**

##### **2.01 MATERIALS:**

- A. Concrete, cement, sand and water used in manhole construction shall conform to the applicable requirements of Division 3 of these Specifications. All concrete shall be Class B unless otherwise indicated. Steel reinforcement shall conform to the applicable requirements of Section 03300.
  
- B. Manhole rims, toe pockets and covers shall be cast iron conforming to the minimum requirements of the latest ASTM Standard Specifications,

Serial Designations A 48, for Class 30 Gray Iron Castings. All castings shall be made accurately to the required dimensions, fully interchangeable, sound, smooth, clean and free from blisters and/or other defects. Defective castings which have been plugged or otherwise treated shall not be used. All castings shall be thoroughly cleaned and painted or coated with a bituminous paint. Each casting shall have its actual weight in pounds stenciled or painted on it in white paint.

- C. Manhole frames shall have a minimum diameter of 20 inches at the top opening and a minimum diameter of 22-3/4 inches at the opening at the base of the frame. The cover shall be a solid lid with a minimum diameter of 22 inches. The height of the frame shall not be less than 6 inches. The frame and cover shall be heavy duty and shall not weigh less than 320 pounds.
- D. Watertight, bolted manhole covers shall be Griffin Foundry Co., Type R, Locking, weighing 315 pounds; Neenah Foundry Co., R-1916-C; or approved equal.
- E. The contact surfaces of all manhole frame and covers shall be machined to provide full perimeter contact.
- F. All sanitary sewer manhole covers shall have the words "Sanitary Sewer" cast on the top in letters two (2) inches high.

### PART 3 - EXECUTION

#### 3.01 CONSTRUCTION OF PRECAST CONCRETE MANHOLES:

- A. Precast concrete manholes shall consist of precast reinforced concrete sections, a conical, eccentric, or flat slab top section, and a base section conforming with the typical manhole details as shown on the contract drawings.
- B. Precast manhole sections shall be manufactured, tested, and marked in accordance with the latest provisions of ASTM Standard Specifications, Serial Designation C 478.
- C. Joints of the manhole sections shall be of the tongue-and-groove type. Sections shall be joined using O-ring rubber gaskets, flexible plastic gaskets conforming to the applicable provisions of ASTM Standard Specification, Serial Designation C 443, latest revision, or an approved bituminous mastic joint material. In addition, the inside joint shall be sealed with cement mortar using one part portland cement to two parts clean sand, meeting ASTM Standard Specifications, Serial Designation C 144, latest revision.

- D. Each section of the precast manhole shall have not more than two holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with rubber stoppers or mortar after installation.
- E. Manhole steps conforming to the applicable provisions of ASTM Specification C 478, latest edition, such as aluminum 14967 as manufactured by Alcoa or plastic step manufactured by M.A. Industries, Inc., or equal, shall be factory built into the precast sections.
- F. All standard manholes shall be constructed on concrete bases of the size and minimum thickness, as indicated on the drawings. Bases may be precast or cast-in-place. If cast-in-place, concrete shall be Class A conforming to the requirements of Division 3. If precast, base shall be placed on a six inch crushed stone mat. Holes in precast bases to receive sewer pipe shall be precast at the factory at the required locations and heights. Knocking out of holes in the field will not be permitted.
- G. Manhole base and inverts shall be constructed of Class B concrete in accordance with details on contract drawings and inverts shall have the same cross-section as the invert of the sewers which they connect. The manhole base and invert shall be carefully formed to the required size and grade by gradual and even changes in sections. Changes in direction of flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit.
- H. Brickwork required to complete the precast concrete manhole shall be constructed using 1 part portland cement to 2 parts clean sand, meeting ASTM Specifications, Serial Designation C 144, thoroughly mixed to a workable plastic mixture. Brickwork shall be constructed in a neat and workmanlike manner.
- I. The cast iron frame for the manhole cover shall be set at the required elevation and properly anchored to the masonry. where manholes are constructed in paved areas, the top surface of the frame and cover shall be tilted to conform to the exact slope, crown and grade of the existing adjacent pavement.
- J. Masonry work shall be allowed to set for a period of not less than 24 hours. Outside forms, if any, then shall be removed and the manhole backfilled and compacted in the manner provided in Section 02220 of these Specifications. All loose or waste material shall be removed from the interior of the manhole. The manhole cover then shall be placed and the surface in the vicinity of the work cleaned off and left in a neat and orderly condition.
- K. After backfilling has been completed, the excavated area, if located in a

street, alley or sidewalk, shall be provided with a temporary surface as provided for under these Specifications.

### 3.02 DROP MANHOLES:

- A. Where indicated on the plans a drop manhole shall be constructed as detailed on the plans. They shall be similar in construction to the standard manhole except that a drop connection of pipe and fittings of the proper size and materials shall be constructed outside the manhole and supported by Class B concrete.
- B. Drop manholes must be provided for a sewer entering a manhole at an elevation of 2 feet above the manhole invert.

### 3.03 UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES:

- A. Precast utility structures shall be manufactured, tested and marked in accordance with the latest provisions of ASTM Standard Specifications, Serial Designation C478 and sub-paragraph 7.2 of ASTM-C478. Further, rectangular precast concrete products shall comply specifically with the requirements set in ASTM- C858 "Standard Specifications for Underground Precast Concrete Utility Structures", and ASTM-C857 "Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures".
- B. Precast utility structures shall be designed conforming to Standard Specifications A.A.S.H.O. H-20 and/or H-20-S-16 for loads imposed upon the structure.

### 3.04 FIELD INSPECTION:

- A. After completion all manholes will be inspected. The Contractor shall make, at his own expense, all necessary changes, modifications, and/or adjustments required to assure satisfactory operation.
- B. Installation and test method of Manholes, Wetwells, and Utility Structures shall be in accordance with Section 2550.3.04.D.

### 3.05 MEASUREMENT AND PAYMENTS:

- A. The quantities of manholes as shown on the drawings for which payment will be allowed shall be the number of manholes, by category depth, as specified in the Bid Schedule or shown on the drawings for each type and size of manhole installed by the Contractor and accepted by the Engineer.
- B. The depth of standard manholes will be measured from the top of the



manhole frame and cover to the bottom of the base. The depth of special manholes constructed on top of concrete junction chambers or pipe manhole base sections will be measured from the top of the manhole frame and cover to the top of the concrete of the junction chamber or pipe manhole base section.

- C. All drop manholes shall be measured and paid for as specified for the 4' diameter standard manholes and, in addition, extra payment for unit price contracts will be allowed at applicable contract unit price for each drop connection complete including excavation, pipe, pipe specials, and concrete encasement. Drop manholes must be provided for a sewer entering a manhole at an elevation of 2 feet above the manhole invert.
- D. Payment for cast iron frame and covers shall be the type and actual number installed by the Contractor and approved by the Engineer.
- E. Extra payment will be allowed for each vented connection constructed to a manhole.
- F. All other items such as rock excavation, pavement replacement, plugged stubs, etc., shall be paid for under their respective items in the Bid Schedule as elsewhere provided herein.
- G. Payment for all manholes as constructed under these specifications shall be made for the quantities determined in the manner specified above as listed under the applicable pay item in the Bid Schedule, or the lump sum price, as applicable. The amounts, so paid, shall constitute full compensation to the Contractor under this item and shall cover the cost of furnishing all labor, materials, tools, equipment, services and other expenses in connection with the construction of manholes complete in place including all types of excavation, backfill, masonry, all castings, except frame and cover, concrete, reinforcing steel, inspection and tests, all as herein specified.

End of Section

**GENERAL CARPENTRY**

**SECTION 06000**

**PART 1 - GENERAL**

- A. Furnish and install all carpentry, and millwork complete, including rough hardware and installation of finish hardware.
- B. Furnishing of finish hardware is not included herein, unless specifically scheduled for millwork.
- C. Deliver material in dry condition and protect from injury and dampness. Do not deliver, store, or install materials, including millwork, until concrete or masonry is dry.
- D. Furnish and install nails, screws, bolts, anchors and other rough hardware required for installation of items.
- E. Coordinate work herein with other trades to insure placement of anchors, inserts, receptacles and other attachments.
- F. Shop Drawings of millwork shall be submitted to the Engineer for approval.
- G. Lumber for rough carpentry shall be air dried and well seasoned. All lumber for finish carpentry and millwork shall be kiln-dried and shall contain not more than 12% moisture.
- H. Lumber and millwork shall be protected at all times. Millwork shall be stored and protected to prevent warpage and damage.

End of Section

## MISCELLANEOUS ROUGH CARPENTRY

### SECTION 06001

#### PART 1 - GENERAL

##### 1.01 QUALITY ASSURANCE:

A. Applicable Standards: Conform to the following Standards:

- APA: Plywood Construction Guide.
- AWPA C1: All Timber Products - Preservative Treatment by Pressure Processes.
- AWPA C2: Lumber, Timbers, Bridge Ties and Mine Ties Preservative Treatment by Pressure Processes.
- AWPA C9: Plywood - Preservative Treatment by Pressure Processes.
- AWPA M4: Standard for the Care of Preservative Treated Wood Products.
- AWPA PS: Standard for Water-Borne Preservatives.
- SPIB: Grading Rules.
- USPS PS 1: Construction & Industrial Plywood.
- USPS PS 20: American Softwood Lumber Standard.
- WCLIB: Standard Grading Rules for Western Lumber.

##### 1.02 SUBMITTALS:

- A. Certificates: Submit a Certificate of Inspection issued by an independent inspection agency approved by the American Lumber Standards Committee stating grade of lumber, paintability, drying time, treatment quality and moisture content upon shipment from the treatment plant.

##### 1.03 PRODUCT HANDLING, DELIVERY AND STORAGE:

- A. Conform to AWPA Standard M4.

#### PART 2 - PRODUCTS

## 2.01 MATERIALS:

- A. Lumber:
  - 1. General: Except where otherwise indicated, lumber sizes indicated are nominal. Actual sizes shall conform to USPS PS 20.
  - 2. Moisture Content: Provide lumber with the following moisture content at time of delivery to the job site:
    - a. Lumber two inches and less in thickness: 19% maximum.
    - b. Lumber over two inches thick: 25% maximum.
  - 3. Species: S4S, Southern Pine graded in accordance with SPIB's "Grading Rules" or Douglas Fir graded in accordance with WCLIB's "Standard Grading Rules for Western Lumber".
    - a. Up Through Four Inches Wide: Light Framing Classification, Construction Grade.
    - b. Over Four Inches Wide: Structural Joists and Planks Classification, No. 1 Grade.
  - 4. No finger jointed lumber will be allowed.
- B. Plywood: Softwood plywood, Appearance Grade, Exterior Type, B/C Veneer Grade, Group 1, identified with APA grade-trademark and conforming to USPS PS 1.
- C. Water-Borne Preservative: Chromated copper arsenate, Type A, Type B or Type C conforming to AWWA PS.
- D. Hardware: Nails, spikes, screws, bolts, anchor bolts, washers, steel plates, straps and other carpenter's iron of type, size and finish best suited for the intended use. Provide zinc coated hardware where exposed to the weather or embedded in or in contact with exterior masonry or concrete.

## 2.02 MATERIAL TREATMENT:

- A. Water-Borne Preservatives:
  - 1. Lumber: Treat in accordance with AWWA Standards C1 and C2.
  - 2. Plywood: Treat in accordance with AWWA Standards C1 and C9.

## PART 3 - EXECUTION

### 3.01 ERECTION:

- A. General: Erect all nailers, blocking, bracing, scaffolding and any other rough carpentry detailed or required to complete the Project. Install all work plumb, level, in true alignment, closely fitted and rigidly fastened

into place. Exercise care in spiking and nailing using spikes and nails of proper size so as not to split the members. Drill members accurately for bolting. Provide suitable washers under heads and/or nuts and draw nut and bolt up tight.

- B. Nailers and Blocking: Anchor nailers or blocking embedded in or adjacent to concrete, masonry or covered with metal with bolts, straps, nails or as detailed.
- C. Plywood: Anchor plywood with nails of type, size and spacing recommended by the APA's "Plywood Construction Guide".

### 3.02 TEMPORARY WORK:

- A. Temporary Access: Maintain convenient and safe access from lowest to highest portion of the building by means of temporary stairs or ladders of strong construction.
- B. Temporary Closures: Enclose all portions of building as may be necessary to properly protect same with dust tight wood bulkheads and wood doors.

End of Section

## **REQUIREMENTS FOR ELECTRICAL WORK**

### **SECTION 16000**

#### **PART 1 — GENERAL**

##### **1.01 DESCRIPTION**

This section specifies electrical work including electrical material, equipment, installation and testing requirements. The electrical drawings included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations.

##### **1.02 QUALITY ASSURANCE**

###### **REFERENCES:**

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI A58.1-82	Minimum Design Loads for Buildings and Other Structures
IEEE 81-83	Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C57.12.01-89	General Requirements for Dry-Type Distribution and Power Transformers
NEMA 250-85	Enclosures for Electrical Equipment (1000 volt Maximum)
NEMA ICS 1-88	General Standards for Industrial Controls and Systems
NEMA ICS 2-88	Industrial Control Devices, Controllers, and Assemblies

<u>Reference</u>	<u>Title</u>
NEMA ICS 6-88	Enclosures for Industrial Controls and Systems
NEMA ST20-86	Dry-Type Transformers for General Application
NEMA WD 1-83	General Requirements for Wiring Devices
NEC 1996	National Electric Code (NEC)
SBC 1991	Standard Building Code
UL 67-88	Panelboards
UL 489-86	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
UL 506-79	Specialty Transformers

#### IDENTIFICATION OF LISTED PRODUCTS

Electrical equipment and materials shall be listed by an independent testing laboratory for the purpose for which they are to be used. Three such organizations are Underwriters Laboratories, Inc. (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). The independent testing laboratory shall be acceptable to the inspection authority having jurisdiction.

#### 1.03 SUBMITTALS

The following information shall be provided for all electrical equipment and materials:

Verification of fault withstand and interrupting ratings of all applicable power equipment and devices.

Interconnection diagrams—The Contractor shall prepare interconnection diagrams depicting all cable requirements together with their actual terminations as specified below. Interconnection diagrams shall be drawn similar to the typical interconnection diagram specified on the drawings. The interconnection diagram shall indicate wiring between

panels, terminal boxes, remotely mounted devices, and motor starters. The diagrams shall interface with the manufacturer's internal connection diagrams for panels. The diagrams shall indicate the terminations to terminal blocks of field devices at each end of the cable, the number of conductors in the cable, the size of wire, and the number of spare conductors. For each termination, the diagrams shall indicate the terminal number, wire color, and wire number as it appears on the wire marker. All terminal blocks, including spares, shall be indicated on the diagrams. Interconnection diagrams shall be provided prior to installation of equipment.

Catalog-cuts including technical specifications, application information, ratings, and other information required to verify the equipment and/or material meets the requirements of this specification.

A copy of this specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

Completed test Form 16000-A.

#### 1.04 PROJECT/SITE CONDITIONS

##### GENERAL

Unless otherwise specified, equipment and material shall be sized and rated for an ambient temperature of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated ratings.

#### PART 2 - PRODUCTS

##### 2.01 GENERAL

Equipment and materials shall be new and free from defects. All equipment of the same or similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

##### 2.02 RACEWAY, FITTINGS, AND SUPPORT

###### GENERAL:

Conduits shall be provided for power, control, instrumentation, grounding, lighting, receptacles, and signaling systems.

###### RACEWAY:



Exposed conduit shall be threaded, aluminum conduit. Minimum size shall be  $\frac{3}{4}$  inch. Bushings shall be galvanized, malleable iron with a feed through compression lug. Unions shall be galvanized, ferrous alloy type. Threadless fittings are not acceptable. Running threads shall not be used in lieu of conduit nipples. Thread hubs shall be used to terminate conduits entering boxes.

Liquidtight, flexible steel conduit shall be formed from spirally wound, galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover. Minimum size shall be  $\frac{3}{4}$  inch. Fittings for liquidtight conduit shall have cadmium-plated, malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty five and 90 degree fittings shall be used where applicable.

Embedded or encased conduit shall be schedule 40, high impact, polyvinyl chloride (PVC). Minimum size shall be 1 inch.

Fittings for PVC conduit shall be solvent welded type.

#### BOXES:

Boxes for the use outdoors and in process areas shall be hot-dip, galvanized cast ferrous alloy type FD with integrally cast threaded hubs for conduit entry unless shown otherwise on the Electrical Drawings. Boxes larger than FD boxes shall be welded steel and hot-dip galvanized after fabrication.

Boxes installed in areas where electrical metallic tubing is specified shall be standard UL approved electro-galvanized sheet steel, 4 inch square or octagon minimum trade size.

Conduit bodies shall be ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.

#### RACEWAY SUPPORT:

Hot-dip galvanized framing channel shall be used to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps with galvanized iron clamp backs and nesting backs where required. Ceiling hangers shall be adjustable, galvanized carbon steel rod hangers. Straps or plumbers tape is not acceptable. Hanger rods shall be  $\frac{1}{2}$  inch all thread rod.

## 2.03 CONDUCTORS, WIRE, AND CABLE

### GENERAL:

Conductors, wires, and cables shall be provided for power, control, lighting, receptacles, instrumentation, grounding and signal circuits. The quantity and size of conductors shall be as specified.

### POWER AND CONTROL CONDUCTORS:

Power and control conductors shall be single conductor stranded, annealed copper with 600 Volt THWN-2/THHN polyvinyl chloride (PVC) insulation, Okonite, Okoseal-N, CABLEC; or equal.

### LIGHTING AND RECEPTACLE CIRCUIT CONDUCTORS:

Conductors for lighting and receptacle circuits shall be single conductor, annealed copper with 600 Volt THWN-2 PVC insulation. Conductor sizes No. 10 AWG and larger shall be stranded. Minimum conductor size shall be No. 12 AWG. Conductors shall be Okonite, Okoseal-N; CABLEC; or equal.

### GROUNDING CONDUCTORS:

Grounding conductors shall be as specified in this section.

### INSTRUMENTATION AND SIGNAL CABLE:

Cable for instrumentation and signal circuit shall be twisted shielded pair of triad as specified, No. 16 AWG 7-strand copper with 600 Volt PVC insulation, 100 percent aluminum-Mylar tape shield, No.18 AWG tinned copper drain wire and overall PVC jacket, Okonite, Okoseal-N type P-OS, or equal.

### SPLICING AND TERMINATING MATERIALS:

#### CONNECTORS:

Connectors for stranded conductors shall be tool applied, tin-plated copper, compression type of the correct size and UL approved for the application.

Connectors for wire sizes No.10 AWG and smaller shall be nylon self-insulated, ring tongue or locking-space terminals. Connectors for wire sizes No. 8 AWG and larger shall be one-hole lugs up to size no.3/0 AWG and two-hole or four hole for size 4/0 AWG and larger. Mechanical clamp, dimple, or screw type connectors are not

acceptable.

480 Volt motor terminations shall be made using bolt connected lugged connectors and factory engineered kits consisting of heat shrinkable, polymeric insulating material with high dielectric strength mastic sealant.

Termination of solenoid valves, 120 Volt motors and other devices furnished with pigtail leads shall be made using self-insulating, tubular compression connectors.

#### TERMINAL BLOCKS:

Terminal blocks shall be provided for external control and power wires size No.10 AWG and smaller. Terminal blocks shall be 600 Volts, heavy-duty, rated 20 amperes for control and 30 amperes for power.

#### WIRE MARKERS:

Wire markers shall be yellow or white shrink tubing, Thermofit Marker System (TMS) by Raychem Co. , or equal for conductors No. 10 AWG and smaller and locking tab cable markers, W.H. Brady Co., or equal, for conductors No.8 and larger. Letters and numbers identifying each conductor shall be machine printed in permanent black ink.

### 2.04 WIRING DEVICES

#### GENERAL:

Receptacles, plugs, switches, and appurtenances shall be provided as specified on the drawings. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Receptacles and switches shall be premium, specification grade.

#### RECEPTACLES:

Receptacles shall be grounding type. Receptacles for use outdoors and in process areas shall be corrosion resistant, marine duty with polycarbonate weatherproof lift covers, Hubbell 53CM62/53CM21, General Electric, or equal.

### 2.05 INDIVIDUAL MOTOR STARTERS:

#### GENERAL:

Unless otherwise specified, individual motor starters shall be

combination type with molded case motor circuit protector, 3-pole, 600 Volt AC contactor, and three overload relays, NEMA size 1 minimum. Each motor starter shall be individually enclosed.

ENCLOSURES:

The door of the motor starter enclosure shall be interlocked with an externally operated disconnect handle, lockable in the open position. Enclosures shall be NEMA 12 for dry indoor areas and NEMA 4X for outdoor and process areas.

MOTOR BRANCH PROTECTION:

Molded case motor circuit protectors shall be magnetic only with trip settings adjustable over a range of 700 to 1300 percent of the full load current of the motor served. The motor circuit protector, in conjunction with the starter, shall be rated to interrupt 22,000 amperes (symmetrical) unless otherwise specified.

OVERLOAD RELAY:

Overload relays shall be bimetallic type with separate heaters for each of the three poles. Reset shall be accomplished with a reset pushbutton located on the unit door exterior. Trip setting shall be adjustable from 85 to 115 percent of the motor full load rating.

CONTROL CIRCUITS:

Control power transformers, fuses, and control devices shall be provided as specified. Two control transformer primary fuses rated to interrupt 200,000 amperes at 600 Volts, shall be provided on all motor starters. Each motor starter shall be provided with one control circuit secondary fuse rated to interrupt 10,000 amperes at 250 Volts and sized at 125 percent of the control circuit full load current. Control circuit shall be 120 V with grounded leg.

WIRING:

Conductors shall be switchboard type and rated 90 degrees C above ambient temperature. Conductor shall be identified with tag numbers as specified.

MANUAL STARTERS:

Manual starters shall be provided as indicated on the drawings. Manual starters shall consist of a horsepower rated quick-make,

quick-break toggle mechanism together with one or two overloads as specified.

## 2.06 MOTOR CONTROL CENTER:

N/A

## 2.07 ELECTRICAL CONTROL DEVICES

### CONTROL DEVICES

#### PUSH BUTTONS:

Pushbuttons shall be flush head, heavy-duty, 600 Volts, 10 amperes, continuous with NEMA rating to match enclosure types. Pushbuttons operators shall be red for stop functions and black for all other functions. Escutcheon plates shall be as specified on the drawings.

#### SELECTOR SWITCHES:

Selector switches shall be heavy-duty, with NEMA rating to match enclosure type, rated 600 Volt, 10-ampere, continuous. Switches shall be provided with contact blocks and number of positions as required to perform the specified operations. The escutcheon legend shall be as specified on the drawings.

#### INDICATING LIGHTS:

Indicating lights shall be heavy-duty, push-to-test, transformer type with 6.3-Volt lamps. Indicating lights shall be NEMA rated to match enclosure type.

#### CONTROL STATIONS:

Unless otherwise specified, control stations shall be NEMA 12 for dry, indoor locations and NEMA 4X for process areas and outdoor locations, Allen Bradley Bulletin 800H, Crouse-Hinds NCS series, or equal.

### CONTROL RELAYS

#### LOAD-SWITCHING CONTROL RELAYS:

Control relays used for switching loads (solenoids, actuators, contactors, motor starter coils, etc.) shall be heavy-duty, machine tool type. Relays that have contacts used for remote interlocking or for which the switching load is not shown shall also be heavy-duty machine tool type.

Contacts shall, as a minimum, be 4-pole and be field

interchangeable to either normally open or normally closed. Relay shall be capable of accepting a 4-pole adder.

AC relays shall have NEMA A600 contact rating and electrical clearances for up to 600 Volts. DC relays shall have NEMA P300 contact ratings and electrical clearances of up to 250 Volts.

Relays shall be Allen Bradley Bulletin-700, Square D Class 8501, or equal.

#### LOGIC LEVEL SWITCHING CONTROL RELAYS:

Control relays used for switching solid-state logic and signal circuits shall be Potter Blumfield series KUP, Schrack Series RA, or equal. Relays shall have a minimum of three SPDT, gold-flashed, fine silver contacts rated 3 amps resistive at 120 Volts AC or 28 Volts DC. Relay shall be plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener. AC models shall have neon lamp indicator wired in parallel with coil.

#### TIMING RELAYS:

Solid state timing relays shall be pulse-count type using a high frequency RC oscillator and integrated circuit counter for timing. Electrolytic capacitors shall not be used in the timing circuits. Time delays from 0.1 seconds to 48 hours shall be available with each timer model adjustable over a 20:1 range. On-delay, off-delay, and single-shot timing models shall be available. Timer shall reset in 0.3 seconds or less. Timer accuracy shall be plus or minus 2.0 percent under normal conditions. The timing relay shall have two NEMA Form-C timed contacts. Solid state timing relays shall be Agastat, STA series or equal.

## 2.08 GROUNDING MATERIAL:

### CABLE:

Grounding cable shall be concentric stranded, annealed bare copper. Cable size shall be as specified.

### GROUND RODS:

Ground rods shall be copper-covered steel,  $\frac{3}{4}$  inch diameter, and 10 feet long. Rods shall have threaded type, removable caps so that extension rods of the same diameter and length may be added where necessary.

COMPRESSION CONNECTORS:

Compression connectors shall be cast copper as manufacturer by Thomas and Betts, or equal.

D. BOLTED CONNECTORS:

Bolted connectors shall be Burndy, O.Z. Gedney, or equal.

2.09 LIGHTING FIXURES

N/A

2.10 DISTRIBUTION EQUIPMENT

CIRCUIT BREAKERS

Circuit breakers shall be molded-case type provided for the current ratings and pole configurations specified on the panelboard schedule. Circuit breaker rated 120/208 Volts and 120/240 Volts AC shall have a minimum interrupting current rating as indicated on the drawings.

Circuit breakers shall be bolt-on type.

Circuit breakers shall be listed in accordance with UL-489 for the service specified.

Load terminals of circuit breakers shall be solderless connectors.

Circuit breakers and panelboards shall be products of the same manufacturer.

DRY-TYPE TRANSFORMERS:

N/A

2.11 NAMEPLATES

Nameplates shall be made from laminated phenolic plastic. The nominal size of the nameplates shall be  $\frac{3}{4}$  inch high by 2 inches long. Nameplates shall have black backgrounds with  $\frac{3}{16}$  inch white letters. If abbreviations are required because of space limitations, abbreviations shall be submitted to the Construction Manager prior to manufacture. Nameplates shall be fastened using self-tapping stainless steel screws.

The use of adhesives will not be permitted on the outside of enclosures.

## 2.12 PRODUCT DATA

The following information shall be provided:

Applicable operating and maintenance instructions.

Lighting fixture information as follows:

Polar plots on 8 ½ x 11 inch paper providing candlepower versus angle and foot-lamberts (brightness) versus angle for longitudinal and transverse axis.

Table of utilization factors for calculation of illumination levels by the zonal cavity method.

Catalog information describing fixture make, materials, and dimensions.

## PART 3 - EXECUTION

### 3.01 GENERAL

Unless otherwise detailed or dimensioned, electrical layout drawings are diagrammatic. The Contractor shall coordinate the location of electrical material and equipment with the work.

Electrical equipment shall be protected from dust, water, and damage.

### 3.02 RACEWAY, FITTINGS, AND SUPPORTS

#### GENERAL:

The Contractor shall limit the number of directional changes of conduit to a total of not more than 270 degrees in any run between pull boxes. Conduit runs shall be limited to 400 feet, less 100 feet for each 90 degree change in direction.

Signal conduit shall be separated from AC power and control conduits. The minimum separation shall be 12 inches for rigid steel and 24 inches for PVC conduits.

#### EXPOSED CONDUITS:

Metallic conduit shall be assembled to provide a continuous ground path. Joints shall be made with standard couplings or threaded unions. Bends and offsets shall be made with a hicky or conduit bending machine or shall be factory pre-formed bends.



Exposed conduit shall be run on supports spaced not more than 10 feet apart and shall be constructed with runs parallel and perpendicular to walls, structural members, or intersections of vertical planes and ceiling. No conduit shall approach closer than 6 inches to any object operating above 30 degrees C.

Conduit supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors, die cast, rustproof alloy expansion shields, or cast-flush anchors. Wooden plugs, plastic inserts, or gunpowder driven inserts are not acceptable as a base for securing conduit supports.

Liquidtight, flexible steel conduit shall be used for the final connection to equipment, devices, and instruments where flexibility is required.

The length of liquidtight flexible steel conduit shall not exceed the lesser of 15 times the trade diameter of the conduit or 36 inches.

#### EMBEDDED OR ENCASED CONDUIT:

Conduits constructed in concrete which is in contact with earth shall be separated from earth by at least 3 inches of concrete. Clearances equal to the nominal conduit diameter but not less than 2 inches, shall be maintained between encased or embedded conduits except where conduits cross or terminate.

#### ELECTRICAL METALLIC TUBING

Electrical metallic tubing shall be used only within stud walls and above suspended ceilings.

### 3.03 CONDUCTORS, WIRE AND CABLE

#### GENERAL:

Raceway construction shall be complete, cleaned, and protected from the weather prior to wire and cable being installed. Pulling wire and cable into conduit shall be completed without damaging or putting undue stress on the cable insulation. Soapstone, talc, or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Nylon pull rope shall be pulled through the conduit immediately after concrete pour.

Each power, control, signal, and instrumentation conductor shall be identified at each terminal to which it is connected utilizing the wire

markers specified in paragraph 16000-2.3 G.

#### 600 VOLT CONDUCTOR AND CABLE

Slack shall be provided in junction and pull boxes. Slack shall be sufficient to allow cable or conductors to be routed along the walls of the box.

Conductors crossing hinges shall be bundled in groups not exceeding 12 and shall be so arranged that they will be protected from chaffing when the hinged member is moved.

Raceway fill limitations shall be as defined by NEC and the following: Lighting and receptacle circuits may be together in the same conduit in accordance with derating requirements of the NEC. However, lighting and receptacle circuits shall not be in conduit with other circuits.

Solid wire shall not be lugged nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.

#### SIGNAL AND INSTRUMENTATION CABLES:

Signal and instrumentation circuits shall be run as individual shield twisted pairs or triads. Triads shall be used where ever three wire circuits are required. Terminal blocks shall be provided at cable junction for running signal leads and shield drain wires. Each conductor shall be identified at such junctions.

Shields shall not be used as a ground path.

#### 3.04 WIRING DEVICES

Switches and receptacles for use outdoors and in process areas shall be mounted in "FD" type boxes. Unless otherwise specified, switches shall be mounted 48 inches above the floor. Receptacles shall be mounted 18 inches above the floor in finished areas and 48 inches above the floor in process areas and outdoors unless otherwise specified.

#### 3.05 INDIVIDUAL MOTOR STARTERS:

Individual motor starters shall be mounted with the operating mechanism 48 inches above the finished floor unless otherwise specified. The Contractor shall size the overload heater elements to the

nameplate full load amperes of the motor served. Motor circuit protectors shall be adjusted to the lowest setting not causing false tripping.

### 3.06 MOTOR CONTROL CENTER:

Not included in specification.

### 3.07 MISCELLANEOUS CONTROL DEVICES:

Control stations shall be mounted 48 inches above the floor unless otherwise specified.

### 3.08 GROUNDING

Electrical equipment and enclosures, metal surfaces of equipment, and metal structural members shall be grounded. Grounding system shall be provided in compliance with the NEC and as specified on the drawings.

Embedded and buried cable connections shall be made by cast copper compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire size 2/0 AWG and larger. Embedded ground cables and fittings shall be securely attached to concrete reinforcing steel with tie wires.

Grounding conductors which extend beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by conduit or terminated in a flush grounding plate.

Exposed ground connections shall be made by bolted connectors. Exposed grounding conductors shall be supported by non-corrosive metallic hardware at 4-foot intervals or less.

Grounding conductors entering enclosures shall be bonded together to the enclosure if it is metallic and to metallic raceway within terminating at the enclosure. Metal surfaces shall be cleaned prior to making grounding connections and bonds.

### 3.09 LIGHTING FIXTURES:

N/A

### 3.10 PANELBOARDS:

N/A

### 3.11 TESTING:

#### GENERAL:

Prior to energizing the electrical circuits, the tests shall be performed as specified. Unless otherwise specified, a 1000-Volt megohmmeter shall be used for resistance measurements.

The measurements of the tests shall be recorded on the specified forms and provided in accordance with paragraph 16000-1.03.

#### INSULATION RESISTANCE MEASUREMENTS:

##### GENERAL:

General 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.

##### 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.

Insulation resistance shall be recorded in a format similar to Form 16000-A, contained in Section 01999. Insulation with resistance of less than 10 megohms is not acceptable.

##### MOTOR TESTS:

N/A

#### FUNCTIONAL CHECKOUT:

Prior to energization of equipment, the Contractor shall perform a functional checkout of the control circuit. Prior to functional testing, all protective devices shall be adjusted and made operative. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each

interlock in turn to verify that the specified action occurs. Contractor shall submit a description of his proposed functional test procedures prior to the performance of functional checkout.

The Contractor shall verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

#### GROUNDING SYSTEM TESTS:

The Contractor shall test each grounding connection to determine the ground resistance. The grounding test shall be IEEE Standard 81. A plot of ground resistance readings for each isolated ground rod or ground mat shall be provided to the Construction Manager on 8 1/2 X 11 inch size graph paper. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

A grounding system that shows greater than 2 ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded. The Contractor shall add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2 ohm requirement. Ground rods required over that specified will be paid for as extra work. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

#### 3.12 RECORD DRAWINGS:

Record drawings refer to those documents maintained and annotated by the Contractor during construction include record drawings, and the following additional schedules, lists, and drawings:

Interconnection Diagrams (16000, part 1)  
Original Submittal Drawings (16000, part 1)

END OF SECTION

**FORM 16000-A**  
**WIRE AND CABLE RESISTANCE TEST DATA FORM**

Wire or Cable No.: \_\_\_\_\_

Temperature, F \_\_\_\_\_

Location of Test

Insulation Resistance  
Megohms

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

Certified \_\_\_\_\_  
Contractor's Rep

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

Witnessed \_\_\_\_\_  
Owner's Rep

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

## **GENERATOR AND ATS**

### **SECTION 16231**

#### **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 with related component accessories and Automatic Transfer Switch 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 MANUFACTURERS**

- A. There shall be one source responsibility for warranty, parts and service through a local representative with factory trained service personnel.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Generator Set

- a. Cummins-Onan
  - b. Caterpillar
    - c. Generac
  - d. Kohler.
2. Automatic Transfer Switch
    - a. ASCO
    - b. Hubbell
    - c. Cummins-Onan.

#### 1.05 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.
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.
14. Letter of guarantee that the proposed generator will be capable of starting and running the loads specified on the drawings.

#### 1.06 WARRANTY

- A. The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of substantial completion 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.

#### 1.07 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 4 hours of notification, 24 hours per day.

### PART 2 - PRODUCTS

#### 2.01 GENERAL REQUIREMENTS

- A. The generator set shall be Standby and have a kW rating as shown

on the one line diagram. The additional ratings shall be 1800 RPM, 0.8 power factor, 480Y/277 VAC, 3 phase, 4 wire, 60 hertz, including radiator fan and all parasitic loads. See Electrical Drawings for additional Generator and ATS requirements.

- B. All materials and parts comprising the unit shall be new and unused.
- C. The selected generator shall have a voltage dip not exceeding 25% and frequency dip not exceeding 10%.

## 2.02 DIESEL ENGINE

- A. 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 be equipped with fuel, lube oil, and intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, service meter, gear-driven water pump.
- B. The complete engine block shall be machined from one casting. Designs incorporating multiple blocks bolted together are not acceptable.
- C. The engine shall utilize a gear-type, positive displacement, full pressure lubricating oil pump and water-cooled lube oil cooler. Pistons shall be spray-cooled. Provide oil filters, oil pressure gauge, dipstick and oil drain.
- D. Fuel filter and serviceable fuel system components shall be located to prevent fuel from spilling onto generator set batteries.
- E. The engine shall be equipped with an isochronous electronic governor to maintain 0% droop from no load to full load and +/- 0.25% steady state frequency variation. The governor shall be equipped with speed adjustment.

## 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. Temperature rise of the rotor and stator shall not exceed NEMA class F (130° C rise by resistance over 40° C ambient). 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, three phase sensing, over-excitation protection, loss of sensing protection, temperature compensation, 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. Breaker shall be sized as shown on the drawings. Breaker shall be thermal magnetic trip unit. The breaker shall be UL listed with shunt trip device connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box mounted on the side of the generator. Mechanical type lugs, sized for the circuit breaker feeders shown on drawing, shall be supplied on the load side of breaker. Breaker shall include long term, short term instantaneous, and ground fault protection.

#### 2.05 CONTROLS

- A. Generator Mounted Control Panel:
  - 1. Provide a generator mounted control panel for complete control and monitoring of the engine and generator set functions. Panel shall include automatic start/stop operation, adjustable cycle cranking, digital LCD AC metering (0.5% true rms accuracy) with phase selector switch, digital engine monitoring, shutdown sensors and alarms with horn and reset, adjustable cooldown timer and emergency stop push-button. Panel shall incorporate self-diagnostics capabilities and fault logging. 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 lid.
  - 2. Provide the following digital readouts on the Generator

Mounted Control Panel:

- a. Engine oil pressure
  - b. Coolant temperature
  - c. Engine RPM
  - d. System DC Volts
  - e. Engine running hours
  - f. Generator AC volts
  - g. Generator AC amps
  - h. Generator frequency
3. Control Panel Annunciation - Provide the following indications for protection and diagnostics according to NFPA 110 level 1:
- a. Low oil pressure
  - b. High water temperature
  - c. Low coolant level
  - d. Overspeed
  - e. Overcrank
  - f. Emergency stop depressed
  - g. Approaching high coolant temperature
  - h. Approaching low oil pressure
  - i. Low coolant temperature
  - j. Low voltage in battery
  - k. Control switch not in auto. position
  - l. Low fuel main tank
  - m. Battery charger ac failure
  - n. High battery voltage

- o. Generator supplying load
  - p. Spare.
4. Generator control panel shall be equipped with the following 120VAC, 5 Amp rated dry contacts for interface with the SCADA system: “Generator Running Status”, “Generator Common Fault” and “Diesel Tank Low Level” or generator control panel shall be equipped with ModBus communication port for interface with the plant SCADA system as shown on the drawings. Generator vendor shall supply SCADA system integrator with ModBus Register Map and support during the start-up. As a minimum, the following parameters shall be available via ModBus communication link:
- Generator Status
  - Generator Fault
  - Diesel Tank Low Level
  - Diesel Fuel Leakage
  - Available kW
  - Running kW
  - Spare kW
  - Voltage
  - Amperage
  - Power Factor.

B. COOLING SYSTEM

1. 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 ambient air entering the room or enclosure (If an enclosure is specified) without derating the unit and 50/50 anti-freeze mixture. The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

C. FUEL SYSTEM

1. 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.

2. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted.
3. Flexible fuel lines shall be rated for 300 degrees F and 100 PSI.
4. Fuel Tank shall be double wall with Leak Detection.

#### D. EXHAUST SYSTEM

1. A critical type silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed according to the manufacturer's recommendation.
2. Mounting shall be provided by the contractor as shown on the drawings. The silencer shall be mounted so that its weight is not supported by the engine.
3. Exhaust pipe size shall be sufficient to ensure that exhaust back pressure does not exceed the maximum limitations specified by the engine manufacturer.

#### E. STARTING SYSTEM

1. A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.
2. Jacket Water Heater: A unit mounted thermal circulation type water heater. The heater watt rating shall be sized by the manufacturer to maintain jacket water temperature at 90 degrees F, and shall be a **120 volt, single phase, 60 hertz**.
3. 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 140 ampere hours and 1000 CCA. Necessary cables and clamps shall be provided.
4. 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.

5. **Battery Charger:** A current limiting battery charger shall be furnish to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. 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**. Charger shall have LED annunciation for low DC volts, rectifier failure, loss of AC power, high DC volts. Amperage output shall be as required. Charger shall be wall mounting type in NEMA 1 enclosure, installed in the generator set enclosure.

F. **GENERATOR SET ENCLOSURE - SOUND ATTENUATED AND WEATHER PROTECTIVE**

1. The complete diesel engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, weather protective enclosure mounted on the fuel tank base.
2. The enclosure shall be constructed of corrosion resistant steel with electrostatically applied powder coated baked polyester paint. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.
3. A dual wall fuel tank base of 24 hour capacity at 100% load 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.
4. The enclosure shall reduce the ambient noise level at full load to a maximum of 75 dB at 23 feet.
5. 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.
6. 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.

7. 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.
8. 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.
9. Lifting points shall be provided on base frame suitable for lifting combined weight of base tank, generator set and enclosure.

#### G. AUTOMATIC TRANSFER SWITCH

##### 1. GENERAL

- a. The transfer switch shall have an enclosure type, voltage and ampacity rating as shown on the Drawings and shall have 600 volt insulation on all parts in accordance with NEMA standards.
- b. 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.
- c. 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.
- d. 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.
- e. 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.



- f. 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.
- g. Transfer switches shall comply with the applicable standards of UL, CSA, ANSI, NFPA, IEEE, NEMA and IEC.
- h. The transfer switches shall be supplied with a solid state control panel as detailed further in these specifications.

## 2. SEQUENCE OF OPERATION

- a. The ATS shall incorporate adjustable three phase under-voltage sensing of the normal source.
- b. 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.
- c. The ATS shall incorporate adjustable single phase under-voltage sensing of the emergency source.
- d. 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.
- e. 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.
- f. 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.
- g. 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.

- h. The control panel shall include indicators for timing functions, and ATS test switch.
- i. 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.
- j. 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:
  - i. An LED display for continuous monitoring of the ATS functions.
  - ii. Test switch to simulate a normal source failure.
  - iii. 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.
  - iv. 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.
  - v. Time delay on transfer to emergency, continuously adjustable 0-15 seconds, factory set at 1 second.
  - vi. An in-phase monitor or time delayed neutral shall be provided to prevent excessive transient currents from switching motor loads.

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

### 3. CONSTRUCTION AND PERFORMANCE

- a. 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.
- b. 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.
- c. 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.
- d. 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.
- e. 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

i. 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

ii. 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.

- f. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation between a 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.
- g. 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.
- h. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

- i. 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.
- j. The switch shall be mounted in a NEMA 4X stainless steel enclosure unless otherwise indicated on the plans.
- k. Switches composed of molded case breakers, contactors or components thereof not specifically designed as an automatic transfer switch will not be acceptable.
- l. 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.

## 2.06 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.
- B. Start-Up and Testing
  - 1. Coordinate all start-up and testing activities with the Engineer and Owner.
  - 2. After installation is complete and normal power is available, the manufacturer's local dealer shall perform the following:
  - 3. Verify that the equipment is installed properly.
  - 4. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), generator space heater, remote annunciator, etc.
  - 5. Test all alarms and safety shutdown devices for proper operation and annunciation.
  - 6. Check all fluid levels.

7. Start engine and check for exhaust, oil, fuel leaks, vibrations, etc.
8. Verify proper voltage and phase rotation at the transfer switch before connecting to the load.
9. Connect the generator to building load and verify that the generator will start and run all designated loads in the plant.
10. Perform a 4 hour load bank test at full nameplate load using a load bank and cables supplied by the local generator dealer. Observe and record the following data at 15 minute intervals:
  - a. Service meter hours
  - b. Volts AC - All phases
  - c. Amps AC - All phases
  - d. Frequency
  - e. Power factor or Vars
  - f. Jacket water temperature
  - g. Oil Pressure
  - h. Fuel pressure
  - i. Ambient temperature
11. Operation and Maintenance Manuals
  - a. Provide three (3) sets of operation and maintenance manuals covering the generator, switchgear, and auxiliary components. Include parts manuals, final as-built wiring interconnect diagrams and recommended preventative maintenance schedules.

### 3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."
  1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
  2. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data".

3. Schedule training with Owner, with at least seven days' advance notice.
4. Minimum Instruction Period: Six hours. In addition, the generator supplier shall provide support to the SCADA system integrator for the generator interface with the SCADA system.

END OF SECTION

## **LOW VOLTAGE SWITCHBOARDS**

### **SECTION 16429**

#### **PART 1- GENERAL**

##### **1.01 SCOPE**

The Contractor shall furnish and install, where indicated, a free-standing, dead-front type low voltage distribution switchboard, utilizing group mounted circuit protective devices as specified herein, and as shown on the contract drawings.

##### **1.02 RELATED SECTIONS**

##### **1.03 REFERENCES**

The low voltage distribution switchboards and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:

1. NEMA PB-2
2. UL Standard 891

##### **1.04 SUBMITTALS – FOR REVIEW/APPROVAL**

A. The following information shall be submitted to the Engineer:

1. Master drawing index
2. Front view elevation
3. Floor plan
4. Top view
5. Single line
6. Schematic diagram
7. Nameplate schedule
8. Component list
9. Conduit entry/exit locations
10. Assembly ratings including:
  - a. Short-circuit rating
  - b. Voltage
  - c. Continuous current
11. Major component ratings including:
  - a. Voltage
  - b. Continuous current



- c. Interrupting ratings
    - 12. Cable terminal sizes
    - 13. Product data sheets
  - B. Where applicable, the following additional information shall be submitted to the Engineer:
    - 1. Busway connection
    - 2. Connection details between close-coupled assemblies
    - 3. Composite floor plan of close-coupled assemblies
    - 4. Key interlock scheme drawing and sequence of operations
- 1.05 SUBMITTALS – FOR CONSTRUCTION
- A. The following information shall be submitted for record purposes:
    - 1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
    - 2. Wiring diagrams
    - 3. Certified production test reports
    - 4. Installation information
    - 5. Seismic certification and equipment anchorage details as specified
- 1.06 QUALIFICATIONS
- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
  - B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
  - C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- 1.07 REGULATORY REQUIREMENTS
- A. The low-voltage switchboard shall be UL labeled.
- 1.08 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

#### 1.09 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Schneider Electric
- B. Eaton
- C. ABB / General Electric
- D. Or Engineer pre-approved equal.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

#### 2.02 RATINGS

- A. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current as shown on the drawings.
- B. Voltage rating to be as indicated on the drawings.

#### 2.03 CONSTRUCTION

- A. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

- B. All sections of the switchboard shall be front and rear aligned with depth as shown on the drawings. All feeder devices protective devices 1200A and below shall be group mounted plug-on type. Devices shall be front removable and load connections front and rear accessible enabling switchboard to be mounted against a wall.
- C. The assembly shall be provided with adequate lifting means.
- D. The switchboard shall be suitable for use as service entrance equipment where shown on the drawings and be labeled in accordance with UL requirements.

#### 2.04 BUS

- A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
- B. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.
- C. A copper ground bus (minimum 1/4 x 2 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
- D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

#### 2.05 WIRING/TERMINATIONS

- A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
- B. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.
- C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
- D. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all

control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

- 2.06 MAIN AND FEEDER PROTECTIVE DEVICES, 2500A AND GREATER
- A. Protective devices shall be fixed switchboard class insulated case low-voltage power circuit breakers. Frame ratings shall be 800, 1600, 2000, 3200, 4000, 5000, or 6000 amperes, as shown on the drawings. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.
  - B. Main circuit breaker (Normal Side) shall be Service Entrance Rated and shall have long-time, short-time and ground fault protection. Main circuit breaker for Emergency side shall have long-time and short-time protection only.
  - C. Provide Automatic Transfer system equipment preinstalled and prewired within the Switchboard structure to automatically switch main power service between Normal Utility power and Emergency Generator power upon loss of an active source. Include all necessary components for starting the emergency generator and for Open Transition transfer with selectable time delay.
  - D. All insulated case circuit breakers shall have a minimum symmetrical interrupting capacity of 100,000 amperes unless listed otherwise on Electrical Drawings. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to 18 times their frame ratings. Insulated case circuit breakers without an instantaneous trip element adjustment shall be equipped with a fixed internal instantaneous override set at that level.
  - E. All insulated case circuit breakers shall be constructed and tested in accordance with UL 1066. The circuit breakers shall carry a UL label.
  - F. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is attempted to be tripped or

opened.

G. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.

H. Trip units for insulated case breakers shall have the following characteristics:

1. Each insulated case circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker.
2. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.
3. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.
4. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.
5. Trip unit shall have selectable thermal memory for enhanced circuit protection.
6. Protective device coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
  - a. All circuit breakers shall have adjustments for long delay pickup and time
  - b. All circuit breakers shall have individual adjustments for short delay pickup and time, and include  $I^2t$  settings

- c. All circuit breakers shall have an adjustable instantaneous pickup
  - d. All circuit breakers shall have individually adjustable ground fault current pickup and time, and include I<sup>2</sup>t settings or ground alarm only
7. The trip unit shall have provisions for a single test kit to test each of the trip functions.
  8. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.
  9. Trip units for breakers 1,200A frame and above shall be equipped with the Arcflash Reduction Maintenance System. The Arcflash Reduction Maintenance System shall allow the operator to enable a maintenance mode which enables a preset accelerated instantaneous trip to reduce arc flash energy. A blue LED or indicator flag on the trip unit shall indicate the trip unit is in the maintenance mode.
  10. See Electrical Drawing One Line Diagram for additional spacing and other details.

## 2.07 MAIN AND FEEDER PROTECTIVE DEVICES, 2000A AND BELOW

- A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- D. Circuit breakers 400-ampere frame and below shall have thermal-magnetic trip units and inverse time-current characteristics.
- E. Circuit breakers 600-ampere and above shall have microprocessor-based rms sensing trip units with the following characteristics:
  1. Microprocessor-based tripping system shall consist of three

(3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.

2. An adjustable trip setting dial mounted on the front of the trip unit shall establish the continuous trip ratings of each circuit breaker.
3. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
  - a. Adjustable long-time setting (set by adjusting the trip setting dial)
  - b. Adjustable short-time setting and delay with selective curve shaping
  - c. Adjustable instantaneous setting
  - d. Adjustable ground fault setting and delay, where indicated on the drawings
4. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

## 2.08 ACCESSORIES

- A. Provide shunt trips, bell alarms and auxiliary switches/contacts as shown on the contract drawings.

## 2.09 MISCELLANEOUS DEVICES

- A. Key interlocks shall be provided as indicated on the drawings.
- B. Control power transformers with primary and secondary protection shall be provided, as indicated on the drawings, or as required for proper operation of the equipment.

## 2.10 METERING

- A. Metering section shall include a Microprocessor-Based power meter capable of measuring as a minimum Volts, Amps, kW and Power Factor. All meter parameters shall be available for transferring to the Plant SCADA system through an integral EtherNet port via EtherNet TCP/IP protocol. Any deviations in the proposed protocol shall be coordinated with SCADA

system integrator.

## 2.11 ENCLOSURES

- A. NEMA 3R Enclosure unless listed otherwise on Electrical Drawings.

## 2.12 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.
- B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

## 2.13 FINISH

- A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

## 2.14 SURGE PROTECTIVE DEVICE

- A. Provide integral surge protective devices with short circuit rating as shown on Electrical Drawings.

## PART 3 - EXECUTION

### 3.01 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
  - 1. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to ensure the accuracy of the



wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground.

- B. The manufacturer shall provide three (3) certified copies of factory test reports.

### 3.02 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code.
- B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills provided the floor is level to 1/8 inch per 3-foot distance in any direction. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
- C. Install Switchboard on a 4-inch housekeeping pad and secure to sills imbedded in the concrete with 1/2-inch threaded bolts and nuts.
- D. Touch up paint scratches and vacuum to remove construction debris and dirt. Install all doors, wireway covers etc., and plug any unused device holes.
- E. Properly set and level channel sills.
- F. Furnish complete, clear, and concise instructions for installation, operation, and maintenance of the equipment.

### 3.03 FIELD ADJUSTMENTS

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.
- B. Necessary field settings of devices, adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.04 TESTS

- A. Set all breakers parameters based on the Power Study recommendations.
- B. Megger each bus, phase-to-phase and phase-to-ground.

END SECTION