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#### SECTION 01300 ADMINISTRATIVE REQUIREMENTS

# PART 1 GENERAL

- 1.1 SECTION INCLUDES
  - A. Coordination and project conditions.
  - B. Field engineering.

#### 1.2 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals, and Work of various sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.
- C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. In finished areas, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.
- E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.
- F. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

#### 1.3 FIELD ENGINEERING

- A. The Contractor shall employ a Land Surveyor registered in State of Alabama for construction stakeout services. The Engineer can be employed by the Contractor to provide control points if requested.
- B. Locate and protect survey control and reference points. Promptly notify ESG of discrepancies discovered.
- C. Control datum for survey is that shown on Drawings.
- D. Verify setbacks and easements; confirm drawing dimensions and elevations.
- E. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.
- F. Submit copy of site drawing signed by Land Surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.

- G. Maintain complete and accurate log of control and survey work as Work progresses.
- H. On completion of foundation walls and major site improvements, prepare certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.
- I. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- J. Promptly report to ESG loss or destruction of reference point or relocation required because of changes in grades or other reasons.
- K. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to ESG.

## **PART 2 PRODUCTS**

Not Used.

# **PART 3 EXECUTION**

Not Used.

END OF SECTION

## SECTION 01330 SUBMITTAL PROCEDURES

## PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Submittal procedures.
- B. Product data.
- C. Shop drawings.
- D. Samples.
- E. Design data.
- F. Test reports.
- G. Certificates.
- H. Manufacturer's instructions.
- I. Manufacturer's field reports.
- J. Erection drawings.

#### 1.2 SUBMITTAL PROCEDURES

- A. Transmit each submittal with ESG accepted form.
- B. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
- C. Submittals will be routed through ESG's Procore project. All submittal documents will be electronically submitted in a media format in commonly compatible viewing platforms. File extensions anticipated are PDF, DWG, MS Office Documents.
- D. For each submittal for review, allow 15 days excluding delivery time to and from Contractor.
- E. Identify variations from Contract Documents and product or system limitations, which may be detrimental to successful performance of completed Work.
- F. When revised for resubmission, identify changes made since previous submission.
- G. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- H. Submittals not requested will not be recognized or processed.

## 1.3 PRODUCT DATA

- A. Product Data: Submit to ESG for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- C. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- D. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01700.

## 1.4 SHOP DRAWINGS

- A. Shop Drawings: Submit to ESG for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01700.

#### 1.5 SAMPLES

- A. Samples: Submit to ESG for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Samples For Selection as Specified in Product Sections:
  - 1. Submit to ESG for aesthetic, color, or finish selection.
  - 2. Submit samples of finishes from full range of manufacturers' standard colors, textures, and patterns for ESG selection.
- C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- D. Include identification on each sample, with full Project information.
- E. Reviewed samples which may be used in the Work are indicated in individual specification sections.
- F. Samples will not be used for testing purposes unless specifically stated in specification section.

#### 1.6 DESIGN DATA

- A. Submit for ESG's knowledge as contract administrator.
- B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

# 1.7 TEST REPORTS

- A. Submit for ESG's knowledge as contract administrator.
- B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

# 1.8 CERTIFICATES

- A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to ESG, in quantities specified for Product Data.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product, but must be acceptable to ESG.

#### 1.9 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to ESG in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

# 1.10 MANUFACTURER'S FIELD REPORTS

- A. Submit reports for ESG's benefit as contract administrator.
- B. Submit report within 30 days of observation to ESG for information.
- C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

#### 1.11 ERECTION DRAWINGS

- A. Submit drawings for ESG's benefit as contract administrator.
- B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

- C. Data indicating inappropriate or unacceptable Work may be subject to action by ESG.
- D. All files shall be submitted via ESG's Project Management portal in Procore.

# **PART 2 PRODUCTS**

Not Used.

# **PART 3 EXECUTION**

Not Used.

END OF SECTION

# SECTION 01600 PRODUCT REQUIREMENTS

# PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.
- D. Product options.
- E. Product substitution procedures.

#### 1.2 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
- C. Furnish interchangeable components from same manufacturer for components being replaced.

#### 1.3 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

#### 1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide off-site storage and protection when site does not permit on-site storage or protection.

- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

## 1.5 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

## 1.6 PRODUCT SUBSTITUTION PROCEDURES

- A. ESG will consider requests for Substitutions.
- B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.
- C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- D. A request constitutes a representation that Contractor:
  - 1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
  - 2. Will provide same warranty for Substitution as for specified product.
  - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to ESG.
  - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
  - 5. Will reimburse ESG and Engineer for review or redesign services associated with re-approval by authorities having jurisdiction.
- E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

- F. Substitution Submittal Procedure:
  - 1. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
  - 2. ESG will notify Contractor in writing of decision to accept or reject request.

## **PART 2 PRODUCTS**

Not Used

# **PART 3 EXECUTION**

Not Used.

END OF SECTION

#### SECTION 01700 EXECUTION REQUIREMENTS

## PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Closeout procedures.
- B. Final cleaning.
- C. Starting of systems.
- D. Demonstration and instructions.
- E. Testing, adjusting and balancing.
- F. Protecting installed construction.
- G. Operation and maintenance data.
- H. Manual for materials and finishes.
- I. Manual for equipment and systems.
- J. Spare parts and maintenance products.
- K. Product warranties and product bonds.
- L. Maintenance service.

## 1.2 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for ESG's review.
- B. Provide submittals to ESG required by authorities having jurisdiction.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. AA-2 Submit Subcontractor Lien Release, and BB-2 Waiver for Progress Payment and Subcontractor Final Release.

#### **1.3** FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.

- D. Replace filters of operating equipment.
- E. Clean debris from roofs, gutters, downspouts, and drainage systems.
- F. Clean site; sweep paved areas, rake clean landscaped surfaces.
- G. Remove waste and surplus materials, rubbish, and construction facilities from site.

## 1.4 STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify ESG seven days prior to start-up of each item.
- C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report in accordance with Section 01330 that equipment or system has been properly installed and is functioning correctly.

# 1.5 DEMONSTRATION AND INSTRUCTIONS

- A. Contractor shall develop a training plan for the Operator on all equipment and systems for the Project. Training plan shall be submitted to Owner for approval within 30 days prior to commencement of the Functional Test.
- B. Demonstrate Project equipment and instructed by qualified manufacturer's representative who is knowledgeable about the Project.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.

- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. Required instruction time for each item of equipment and system is specified in individual sections.

#### 1.6 TESTING, ADJUSTING AND BALANCING

- A. ESG will appoint and employ services of independent firm to perform testing, adjusting, and balancing.
- B. Reports will be submitted by independent firm to ESG indicating observations and results of tests and indicating compliance or non-compliance with requirements of Contract Documents.

# 1.7 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

# 1.8 OPERATION AND MAINTENANCE DATA

- A. Submit electronically in pdf format.
- B. Prepare cover with title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter.
- C. Subdivide contents, logically organized as described below; with bookmarked by section.
- D. Drawings: Provide electronically in both pdf and dwg format.
- E. Contents: Prepare Table of Contents for each volume, with each product or system description identified, in three parts as follows:
  - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
  - 2. Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
    - a. Significant design criteria.

- b. List of equipment.
- c. Parts list for each component.
- d. Operating instructions.
- e. Maintenance instructions for equipment and systems.
- f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
- 3. Part 3: Project documents and certificates, including the following:
  - a. Shop drawings and product data.
  - b. Air and water balance reports.
  - c. Certificates.
  - d. Originals of warranties.

## 1.9 MANUAL FOR MATERIALS AND FINISHES

- A. Submit preliminary draft. ESG will review draft and return with comments.
- B. For equipment, or component parts of equipment put into service during construction, submit documents within ten days after acceptance.
- C. Submit completed volumes 15 days prior to final inspection. Draft copy be reviewed and returned after final inspection, with ESG comments. Revise content of document sets as required prior to final submission.
- D. Submit final volumes in final form within 10 days after final inspection.
- E. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for re-ordering custom manufactured products.
- F. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- G. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
- H. Additional Requirements: As specified in individual product specification sections.
- I. Include listing in Table of Contents for design data.

#### 1.10 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit preliminary draft. ESG will review draft and return with comments.
- B. For equipment, or component parts of equipment put into service during construction, submit documents within ten days after acceptance.
- C. Submit completed volumes 15 days prior to final inspection. Draft copy be reviewed and returned after final inspection, with ESG comments. Revise content of document sets as required prior to final submission.
- D. Submit revised final volumes in final form within 10 days after final inspection.

- E. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; by label machine.
- G. Include color coded wiring diagrams as installed.
- H. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and special operating instructions.
- I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- J. Include servicing and lubrication schedule, and list of lubricants required.
- K. Include manufacturer's printed operation and maintenance instructions.
- L. Include sequence of operation by controls manufacturer.
- M. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- N. Include control diagrams by controls manufacturer as installed.
- O. Include Contractor's coordination drawings, with color coded piping diagrams as installed.
- P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- Q. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- R. Additional Requirements: As specified in individual product specification sections.
- S. Include listing in Table of Contents for design data.

# 1.11 SPARE PARTS, CONSUMABLE PARTS AND MAINTENANCE PRODUCTS

- A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to Project site and place in location as directed by ESG; obtain receipt prior to final payment.

# 1.12 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed by responsible subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
- B. Execute and assemble transferable warranty documents and bonds from

subcontractors, suppliers, and manufacturers.

- C. Verify documents are in proper form, contain full information, and are notarized when required.
- D. Co-execute submittals when required.
- E. Submit prior to final Application for Payment.
- F. Time Of Submittals:
  - 1. For equipment or component parts of equipment put into service during construction with ESG's permission, submit documents within ten days after acceptance.
  - 2. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
  - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

# **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

Not Used.

END OF SECTION

## SECTION 02060 AGGREGATE

#### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Coarse aggregate materials.
  - 2. Fine aggregate materials.

## B. Related Sections:

1. Plans and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO M147 Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
  - 2. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

## B. ASTM International:

- 1. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- 2. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
- 3. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
- 4. ASTM D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- 5. ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

#### 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Materials Source: Submit name of imported materials suppliers.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

## 1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

## **PART 2 PRODUCTS**

## 2.1 COARSE AGGREGATE MATERIALS

- A. Coarse aggregate shall consist of crushed gravel or stone having hard, strong, durable pieces, free from adherent coatings.
- B. Coarse Aggregate Type A1 (ALDOT Aggregate size No. 4) shall be graded in accordance with the following limits:

Percent Passing
100
90 to 100
20 to 55
0 to 15
0 to 5

C. Coarse Aggregate Type A2 (ALDOT Aggregate size No. 57) shall be graded in accordance with the following limits:

Percent Passing
100
95 to 100
25 to 60
0 to 10
0 to 5

D. Coarse Aggregate Type A3 (ALDOT Aggregate size No. 78) shall be graded in accordance with the following limits:

Sieve Size	Percent Passing
2 inches	
1-1/2 inch	
1 inch	
3/4 inch	100
1/2 inch	90 to 100
3/8 inch	40 to 75
No. 4	5 to 25

No. 8	0 to 10
No. 16	0 to 5

## 2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate Type A4 (Concrete Sand): Washed sand; free of loam, friable or soluble materials, and organic matter; non-plastic; graded in accordance with ASTM C136; within the following limits:

Sieve Size	Percent Passing
3/8 inch	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 90
No. 50	5 to 30
No. 100	0 to 10

B. Fine Aggregate Type A5 (Natural Sand): Natural sand; free of loam, friable or soluble materials, and organic matter; non-plastic; graded in accordance with ASTM C136; within the following limits:

Sieve Size	Percent Passing
3/8 inch	100
No. 4	95 to 100
No. 8	
No. 16	50 to 80
No. 50	20 to 50
No. 100	10 to 25
No. 200	5 to 12

#### 2.3 SOURCE QUALITY CONTROL

- A. Coarse Aggregate Material Testing and Analysis: Perform in accordance with ASTM D698, ASTM D1557, ASTM D4318, or ASTM C136.
- B. Fine Aggregate Material Testing and Analysis: Perform in accordance with ASTM D698, ASTM D1557, ASTM D4318, or ASTM C136.
- C. When tests indicate materials do not meet specified requirements, change material and retest.

#### **PART 3 EXECUTION**

- 3.1 EXCAVATION
  - A. Excavate aggregate materials from on-site locations as specified in Section 02300.
  - B. Stockpile excavated material meeting requirements for coarse aggregate materials and fine aggregate materials.
  - C. Remove excess excavated materials not intended for reuse, from site.

D. Remove excavated materials not meeting requirements for coarse aggregate materials and fine aggregate materials from site.

# 3.2 STOCKPILING

- A. Stockpile materials on site.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.
- D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.

# 3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

## END OF SECTION

# **SECTION 02230 SITE CLEARING**

# PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Removing surface debris.
  - 2. Removing designated paving, curbs, and culverts.
  - 3. Removing designated trees, shrubs, and other plant life.
  - 4. Removing abandoned utilities.
  - 5. Excavating topsoil.
- B. Related Sections:
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

#### 1.2 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

## 1.3 QUALITY ASSURANCE

A. Conform to applicable codes for environmental requirements, disposal of debris, burning debris on site, use of herbicides, and disposal of sludge.

#### PART 2 PRODUCTS

Not Used.

#### **PART 3 EXECUTION**

#### 3.1 EXAMINATION

- A. Section 01300 Administrative Requirements.
- B. Verify existing plant life designated to remain is tagged or identified.

#### 3.2 PREPARATION

- A. Call Alabama One Call service at 1-800-292-8525 or 811 not less than three working days before performing Work.
  - 1. Request underground utilities to be located and marked within and surrounding construction areas.

## 3.3 **PROTECTION**

- A. Locate, identify, and protect utilities indicated to remain, from damage.
- B. Protect trees, plant growth, and features designated to remain.
- C. Protect bench marks, survey control points, and existing structures from damage or displacement.

## 3.4 CLEARING

- A. Clear areas required for access to site and execution of Work to minimum depth of 12 inches.
- B. Remove trees and shrubs within indicated areas. Remove stumps, surface rock, and fences.
- C. Clear undergrowth and deadwood, without disturbing subsoil.
- D. Apply herbicide to remaining stumps to inhibit growth.

## 3.5 REMOVAL

- A. Remove debris, rock, and extracted plant life from site.
- B. Partially remove paving, curbs, and gutters. Neatly saw cut edges at right angle to surface.
- C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.
- D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
- E. Do not burn or bury materials on site. Leave site in clean condition.

# 3.6 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, relandscaped, or regraded, without mixing with foreign materials for use in finish grading.
- B. Do not excavate wet topsoil.
- C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion. Stockpile material on impervious material until disposal.
- D. Remove excess topsoil not intended for reuse, from site.

## 3.7 SITE RESTORATION

A. Restore all areas disturbed by the construction activities to pre-construction conditions or better.

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- B. Restore areas to satisfaction of ESG and Land Owner if work has occurred on private property.
- C. If preconstruction documentation of existing conditions has not been performed, restore areas to complete satisfaction of ESG and Land Owner at no additional cost to ESG.
- D. Restore paved or unpaved streets, roads, sidewalks, curbs, etc. disturbed by the construction activities to preconstruction conditions or better using materials and workmanship conforming to requirements of ESG, City or Alabama Department of Transportation, whichever applies.

E. Maintain seeded areas and re-seed as needed until a stand of grass satisfactory to ESG is established.

## END OF SECTION

## SECTION 02300 EARTHWORK

## PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Preparing of subgrade and grading for buildings, slabs, walks, embankments, slopes and pavements.
  - 2. Excavating and backfilling of utility trenches.
- B. Related Documents
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO R 18 Establishing and Implementing a Quality System for Construction Materials Testing Laboratories.
- B. ASTM International:
  - 1. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
  - 2. ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in place by the Sand-Cone Method
  - 3. ASTM D 1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
  - 4. ASTM D 2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - 5. ASTM D 2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depth).
  - 6. ASTM D 2937 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
  - 7. ASTYM D 3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (shallow depth).
  - 8. ASTM D 4318 Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
  - 9. ASTM D 4959 Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating.
  - 10. ASTM D 6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
  - 11. ASTM D 7830 Standard Test Method for In-Place Density and Water Content of Soil Using an Electromagnetic Soil Density Gauge

# 1.3 DEFINITIONS

- A. Excavation: Removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.
- B. Unauthorized excavation: Removal of materials beyond indicated subgrade elevations or dimensions without specific direction of ESG. Unauthorized excavation, as well as remedial work directed by ESG, shall be at the Contractor's expense.
  - 1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation

CDG, Inc. Earthwork by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to ESG.

- 2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by ESG.
- C. Additional Excavation: When excavation has reached required subgrade elevations, notify ESG, who will evaluate conditions. If ESG determines that bearing materials at required subgrade are unstable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by ESG. The Contract Sum may be adjusted by an appropriate Contract Modification.
  - 1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- D. Subgrade: The undisturbed soil or rock, or the compacted fill layer immediately below structures, granular base, drainage fill, or topsoil materials.
- E. Structures: Buildings, foundations, slabs, tanks, pavements, gravel drives or road, walks, curbs, cut slopes, fill embankments, utilities, or other man-made stationary features occurring above or below ground surface.
- F. Structural Areas: Those plan locations containing a structure plus a minimum of 5 feet beyond the outside edge of the structure including appurtenances or as defined elsewhere in the project documents.
- G. Structural Fill: Materials placed as fill in Structural Areas.

# 1.4 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Materials Source: Submit name of imported materials source.
- C. Test Reports: All test reports must be completed under the supervision of a registered engineer, licensed in the state in which the project is located. Contractor will notify testing agency a minimum of 24 hours prior to performing work that requires testing. Submit the following test reports directly to ESG, with copy to Contractor:
  - 1. Test reports on borrow material. (ASTM D-2487, 4318, 6913)
  - 2. Verification of each foundation bearing surface in accordance with specified requirements.
  - 3. Field reports of in-place density tests.
  - 4. One optimum moisture-maximum density curve for each type of soil encountered. (ASTM D-698 or ASTM D-1557)
  - 5. Subgrade evaluation report for all structural areas prior to fill placement and after establishing final subgrade, but prior to pavement or building slab construction.

# 1.5 QUALITY ASSURANCE

- A. Furnish each soil material from single source throughout the Work.
- B. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

- C. Testing and Inspection Service: Contractor will employ and pay for a qualified independent geotechnical testing and inspection laboratory in accordance with Section 01200 to perform soil testing and inspection service during earthwork operations. Laboratory shall be selected by ESG.
- D. Testing Laboratory Qualifications: To qualify for acceptance, the geotechnical testing laboratory must demonstrate to ESG's satisfaction, based on evaluation of laboratory submitted criteria conforming to AASHTO R18, that it has the experience and capability to conduct the required field and laboratory geotechnical testing.

## 1.6 PROJECT CONDITIONS

- A. Site Information: Data in subsurface investigation reports (if performed) was used for the basis of the design and are available to the Contractor for information only. Conditions noted in the report(s) are not intended as representations or warranties of accuracy or continuity between soil borings. ESG will not be responsible for interpretations or conclusions drawn from this data by Contractor.
  - 1. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
- B. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
  - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with ESG and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner at no expense to ESG.
  - 2. Do not interrupt existing utilities serving facilities occupied by land owner or others during occupied hours, except when permitted in writing by ESG and then only after acceptable temporary utility services have been provided.
    - a. Provide minimum of 48-hour notice to ESG and receive written notice to proceed before interrupting any utility.
  - 3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active. Resultant excavations must be backfilled in lifts and tested in accordance with the project requirements.
- C. Use of Explosives: Use of explosives is not permitted.
- D. Jobsite safety and conformance to applicable codes and guidelines to protect persons and property is solely the responsibility of the contractor.
  - 1. Excavate in accordance with OSHA guidelines. Barricade open excavations.
  - 2. Operate safety barriers, markings and warning lights as required to maintain a safe work environment and as recommended by authorities having jurisdiction.
  - 3. Protect structures, utilities, sidewalks, pavements, and other facilities to remain

from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

4. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

## PART 2 PRODUCTS

- A. Base Material: Naturally or artificially graded mixture of crushed gravel or stone, sand or select granular materials conforming to the Department of Transportation requirements for the state in which the project is located.
- B. Aggregate: Graded fine or coarse aggregates as specified in Section 02060.
- C. Structural Fill: On or off-site soil free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material shall have a liquid limit of 50 or less, a plasticity index of 25 or less, less than 20% rock fragments retained on a <sup>3</sup>/<sub>4</sub>" sieve, and a maximum dry density of at least 100 pcf. May also consist of Aggregate Type A2, Type A3 or Crushed Aggregate Base Course.
- B. General Fill: On or off-site soil and/or rock which is stable and can be compacted to the specified density. Rock fragments shall be less than 4 inches in largest dimension and blended with sufficient fines to create a dense fill mass free of visible voids.

## PART 3 EXECUTION

#### 3.1 EXCAVATION

- A. Excavate topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas as directed by ESG.
- B. Stockpile excavated material meeting requirements for satisfactory soil materials and topsoil materials.
- C. Remove excess excavated material not intended for reuse from site.
- D. Excavate to subgrade elevations or cut line as indicated, regardless of character of materials and obstructions encountered, including rock, existing structures, and utilities. Subsurface materials are unclassified.

#### 3.2 STABILITY OF EXCAVATIONS

- A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction. Design of retaining structures must be performed, signed and sealed by a registered engineer licensed in the state in which the project is located.
- B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling,

uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

1. Provide permanent steel sheet piling or reinforced concrete drilled shaft walls wherever subsequent removal of retaining structure might permit lateral movement of soil under adjacent structures. Cut off tops a minimum of 2'-6" below final grade and leave permanently in place.

# 3.3 DEWATERING

- A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
  - 1. Do not allow water to accumulate in excavations or in foundation excavations prior to or following footing construction. Remove water to prevent softening of foundation boring soils, undercutting footings, and soil changes detrimental to stability of the subgrade and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
  - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.
  - 3. Dewater excavations only as necessary for suitable construction. Do not continue dewatering overnight or for an extended period of time except as required.

# 3.4 STORAGE OF EXCAVATED MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage. Stabilize in accordance with ADEM and NPDES regulations.
  - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
  - 2. Dispose of excess excavated soil material and materials not acceptable for reuse as backfill or fill.

# 3.5 EXCAVATION FOR STRUCTURES

- A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
  - 1. Excavations for footings and foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim sides and bottom to required lines and grades. Compact with hand or remote operated equipment to leave solid base to receive other work.
  - 2. For pile foundations, stop excavations from 6 inches to 12 inches above bottom of cap before piles are placed. After piles have been placed, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
  - 3. Excavations for soil supported foundations must be neat, clean and dry. Remove

loose, disturbed and soft soil. Dewater only as necessary for proper construction.

# 3.6 EXCAVATION FOR PAVEMENTS

A. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated.

# 3.7 TRENCH EXCAVATION FOR PIPES AND CONDUIT

- A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 36 inches total width.
- B. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on structural fill or undisturbed soil and bedding material. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
  - 1. Where rock is encountered, refer to Section 02316 Rock Removal. No direct payment will be made for rock removal, unless specified in other sections.
  - 2. For pipes or conduit in all other soil conditions, refer to Section 02324 Utility Trenching.

# 3.8 COLD WEATHER PROTECTION

- A. Protect excavation bottoms against freezing when atmospheric temperature isless than 35 degrees F.
- B. Do not place frozen soil fill.
- 3.9 BACKFILL AND FILL
  - A. General: Place soil material in uniform, horizontal lifts as required to final subgrade elevations. Compact individual lifts uniformly to specified density prior to placing the subsequent lift. For each area classification listed below, use materials specified in Part 2 of the Section.
    - 1. In non-structural areas, use general fill. The final lift shall be the required thickness of topsoil.
    - 2. In structural areas, use structural fill or aggregate. The final lift shall be as indicated on the plans.
    - 3. Under utilities, use aggregate as indicated on the plans in areas determined by ESG to be unsuitable for pipe bedding. Shape excavation bottom to fit bottom 90 degrees of cylinder.
    - 4. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings or that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
      - a. Concrete is specified in Section 03300.
      - b. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by ESG. Use care in backfilling to avoid damage or displacement of pipe systems.
    - 5. Provide 4-inch-thick concrete base slab support for piping or conduit less than 24" below surface of roadways. After installation and testing of piping or conduit, provide minimum 4-inch-thick encasement (sides and top) of concrete prior to

backfilling or placement of roadway base.

- B. Backfill excavations as promptly as work permits, but not until completion of the following:
  - 1. Acceptance of construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
  - 2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
  - 3. Removal of concrete formwork.
  - 4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
  - 5. Removal of trash and debris from excavation.
  - 6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

# 3.10 PLACEMENT AND COMPACTION

- A. Ground Surface Preparation: Remove vegetation, debris, topsoil, obstructions, underground structures (foundations, slabs, walls and utilities), and deleterious materials from area prior to placement of fills. Backfill disturbed areas with compacted and tested fill. Contractor shall notify ESG to evaluate the natural ground prior to fill placement. Where access permits, Contractor shall provide pneumatic-tired equipment capable of producing the pressure equal to that produced by a fully-loaded, tri-axle dump truck for use in evaluation.
  - 1. When existing ground exhibits instability, scarify ground surface, moisturecondition to within 2% of the optimum moisture content, and compact to the project requirements. Alternatively, remove and replace unstable soils with suitable, compacted soils or stabilize at the direction of ESG.
  - 2. Bench sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface. Benches shall consist of alternating horizontal and vertical soil surfaces in the original ground with horizontal benches no more than 5 feet apart vertically.
  - 3. Overbuild slopes and cut back to the desired configuration to ensure the soils at the slope face are properly compacted and tested.
- B. In structural areas, place structural fill or aggregate in layers not more than 8 inches in loose thickness for material compacted by heavy compaction equipment, and not more than 4 inches in loose thickness for material compacted by hand-operated tampers. In non-structural areas, place general fill in maximum 24" thick lifts.
- C. In structural areas, before compaction, moisten or aerate each layer of fill as necessary to provide moisture content within the fill at  $\pm 2\%$  of the optimum moisture content. Compact each layer to required percentage of maximum dry density for each area classification. Do not place structural fill on surfaces that are muddy, frozen, or contain frost or ice.
- D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

- E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by ESG if soil density tests indicate inadequate compaction.
  - 1. Percentage of Maximum Standard Proctor Density Requirements:
    - a. Structural Areas: Compact each individual lift of structural fill and fine aggregate to not less than 98% of the maximum standard Proctor density in accordance with ASTM D-698. Compact each individual lift of coarse aggregate using multiple passes of a vibratory compactor or as directed by ESG.
    - b. Non-Structural Areas: Compact each individual lift using multiple passes of a compactor designed for the type of soils used as fill or backfill.
  - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
    - a. Remove and replace, or scarify and air dry soil material that is too wet to permit compaction to specified density.
    - b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

# 3.11 GRADING

- A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition area. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.
- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:
  - 1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
  - 2. Walks: Shape surface of areas under walks to line, grade, and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
  - 3. Pavements: Shape surface of areas under pavement to line, grade, and crosssection, with finish surface not more than  $\frac{1}{2}$  inch above or below required subgrade elevation.
- C. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of <sup>1</sup>/<sub>2</sub> inch.
- D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

# 3.12 PAVEMENT BASE COURSE

- A. General: Base course consists of placing base material in layers of specified thickness, over subgrade surface to support a pavement base course.
  - 1. Refer to other Division 2 sections for paving specifications.

- B. Grade Control: During construction, maintain lines and grades including crown and crossslope of base course.
- C. Shoulders: Place shoulders along edges of base course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each base course layer. Compact and roll at least a 12-inch width of shoulder simultaneous with the compaction and rolling of each layer of base course.
- D. Placing: Place base course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting base material during placement operations.
  - 1. When a compacted base course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches when compacted.
  - 2. Compact individual lifts of the base to a minimum of 100% of the ASTM D-1557 maximum dry density at  $\pm 2\%$  of the optimum moisture content.

# 3.13 BUILDING SLAB DRAINAGE COURSE

- A. General: Drainage course consists of placing aggregate in layers of indicated thickness over subgrade surface to support concrete building slabs.
- B. Placing: Place aggregate on prepared subgrade in layers of uniform thickness, conforming to the indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.
  - 1. When a compacted drainage course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer shall be more than 6 inches or less than 3 inches when compacted.
  - 2. Compact the individual lifts of the drainage course with a vibratory compactor as directed by ESG.

#### 3.14 FIELD QUALITY CONTROL

- A. Quality Assurance consisting of testing and observation of a limited sampling of construction materials will be paid for using the testing allowance for acceptance purposes. Passing test results are not a warranty, guarantee, or certification by the testing agency, or ESG that all work was performed in conformance with the plans and specifications. Therefore, the Contractor should not rely solely on test results generated by the quality assurance process as an indication of the suitability of the construction.
- B. It is entirely the Contractor's responsibility to perform quality control as necessary to construct the project in conformance with the plans and specifications. Deviations from the plans and specifications, whether identified during construction or following the completion of construction, must be corrected by the Contractor at no cost to ESG.
- C. Quality Control Testing During Construction: Allow testing service (to be selected by ESG) to test each subgrade and fill layer before further backfill or construction work is performed.
  - 1. Perform field density tests on each lift of fill in accordance with ASTM D 2937

(Drive Cylinder Method), ASTM D 2922 (Nuclear Method), ASTM D 7830 (Electromagnetic Method), or ASTM D 1556 (sand cone method).

- In conjunction with each density test, the natural moisture content shall be determined in accordance with ASTM D 3017 (nuclear method), ASTM D 4959 (direct heating), ASTM D 7830 (electromagnetic method) or other method approved by ESG.
- b. If field tests are performed using nuclear or electromagnetic methods, make calibration checks using alternate methods of both density and moisture results on each different type of material encountered and at intervals as directed by ESG.
- 2. Footing Subgrade: For all soil on which footings will be placed, perform tests to verify required design bearing capacities. ESG shall be notified to observe and approve each footing subgrade. Engineering evaluation may include the excavation of hand augers or test pits. The contractor shall provide suitable equipment to excavate test pits as directed by ESG.
- 3. Paved Areas and Building Slab Subgrade: Perform at least one field density test per lift for every 2,500 sq. ft. of area, but in no case fewer than three tests.
- 4. Foundation Wall Backfill: Perform at least two field density tests on each lift of fill placed at locations directed by ESG.
- D. If in opinion of ESG, based on testing reports or Engineering judgement, subgrade or fill that have been placed are unsuitable, perform additional compaction and testing until specified density is obtained. Do not place additional fill over materials that have not been approved by ESG. Work to recompact and retest unsuitable areas will be at the expense of the contractor.

#### 3.15 EROSION CONTROL

- A. Provide erosion control methods in accordance with requirements of authorities having jurisdiction and/or as described in the Plans.
- B. Unless otherwise specified in the Plans, the contractor is responsible to apply for and obtain any required permits in the contractor's name associated with current NPDES guidelines. Requirements for implementing and maintaining an acceptable Best Management Practices Plan shall be the responsibility of the contractor. The contractor is responsible to maintain the NPDES permit in good standing with the regulatory authority and comply with applicable NPDES regulations during construction, and terminate permit upon completion and approval at no additional cost to ESG.

#### 3.16 MAINTENANCE

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill

material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

## 3.17 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from Job Site: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off Job Site.
  - 1. Secure a disposal site and all necessary approvals for use.
  - 2. Remove excess excavated material, trash, debris, and waste materials and dispose of it off Job Site.
  - 3. Excavated material in area noted on plans shall be screened by geotechnical engineer. If classified "contaminated", it shall be stockpiled and monitored by the contractor at no additional cost.

## END OF SECTION

# SECTION 02311 ROUGH GRADING

## PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Excavating subsoil.
  - 2. Cutting, grading, filling, rough contouring, compacting, and site for structures, building pads, and drainage.
- B. Related Sections:
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

## B. ASTM International:

- 1. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- 2. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
- 3. ASTM D1556 Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
- 4. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
- 5. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- 6. ASTM D2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- 7. ASTM D2434 Standard Test Method for Permeability of Granular Soils (Constant Head).
- 8. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- 9. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

## 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures: Requirements for submittals.
- B. Samples: When required by ESG, Submit, in air-tight containers, two, 5-lb samples of each type of fill to testing laboratory.
- C. Materials Source: Submit name of imported materials suppliers.
#### 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

## PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Soil Fill: See Section 02300 Earthwork.
- B. Granular Fill: Type A1 as specified in Section 02060.

#### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01300 Administrative Requirements.
- B. Verify site conditions prior to beginning work.
- C. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

### 3.2 PREPARATION

- A. Call Alabama One Call service at 1-800-292-8525 not less than five working days before performing Work.
  - 1. Request underground utilities to be located and marked within and surrounding construction areas.
  - 2. Verify that all local utilities participate in the Alabama One Call service.
- B. Identify required lines, levels, contours, and datum.
- C. Notify each utility company concerning any potential conflict.
- D. Protect utilities indicated to remain from damage.
- E. Protect plant life, lawns, landscaping and other features remaining as portion of final landscaping.
- F. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

#### 3.3 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, relandscaped, or regraded, and stockpile without mixing with foreign materials for use in finish grading.
- B. Do not excavate wet topsoil.

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- C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion.
- D. Remove excess topsoil not intended for reuse, from site.
- E. Do not remove topsoil from site unless approved, in writing, by ESG.

## 3.4 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be further excavated or regraded.
- B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.
- C. When excavating through roots, perform Work by hand and cut roots with sharp axe.
- D. Remove excess subsoil not intended for reuse, from site.
- E. Stockpile subsoil in area designated on site to depth not exceeding 8 feet and protect from erosion.

## 3.5 FILLING

- A. Fill areas to contours and elevations with unfrozen materials.
- B. Place fill material in continuous layers and compact in accordance with schedule at end of this section.
- C. Maintain optimum moisture content of fill materials to attain required compaction density.
- D. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise.
- E. Make grade changes gradual. Blend slope into level areas.
- F. Repair or replace items indicated to remain damaged by excavation or filling.

## 3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.

# 3.7 FIELD QUALITY CONTROL

- A. Perform laboratory material tests in accordance with ASTM D1557.
- B. Perform in place compaction tests in accordance with the following:
  - 1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
  - 2. Moisture Tests: ASTM D3017.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

# SECTION 02316 ROCK REMOVAL

## PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Removing discovered rock during excavation.
  - 2. Expansive tools to assist rock removal.

#### B. Related Sections:

1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

#### 1.2 REFERENCES

A. National Fire Protection Association:

#### 1.3 DEFINITIONS

A. Rock: Solid mineral material of size that cannot be removed with 12 metric ton excavator.

#### 1.4 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Shop Drawings: Indicate intended rock removal method.
- C. Survey Report: Submit survey report on conditions of buildings near locations of rock removal.

#### 1.5 QUALITY ASSURANCE

#### 1.6 PROJECT CONDITIONS

A. Conduct survey and document conditions of buildings near locations of rock removal, prior to removal, and photograph existing conditions identifying existing irregularities.

#### 1.7 SCHEDULING

- A. Section 01300 Administrative Requirements.
- B. Schedule Work to avoid disruption to occupied buildings nearby.

## **PART 2 PRODUCTS**

Not Used

## **PART 3 EXECUTION**

#### 3.1 EXAMINATION

- A. Section 01300 Administrative Requirements.
- B. Verify site conditions and note subsurface irregularities affecting Work of this section.

#### 3.2 PREPARATION

- A. Rock excavation shall be performed by mechanical methods, such as jack hammers, rippers, hydraulic hammers, or other approved methods by the ESG.
- B. Identify required lines, levels, contours, and datum.

## 3.3 ROCK REMOVAL BY MECHANICAL METHOD

- A. Excavate and remove rock by mechanical method.
  - 1. Drill holes and use expansive tools, wedges or mechanical disintegration compound to fracture rock.
- B. Cut away rock at bottom of excavation to form level bearing.
- C. Remove shaled layers to provide sound and unshattered base for footings.
- D. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.
- E. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 02300 or as directed by ESG.

### 3.4 FIELD QUALITY CONTROL

- A. Section 01400 Quality Requirements.
- B. Excavated rock may not be reused as fill on the site unless expressly authorized by ESG. Remove excavated material from site.

## SECTION 02324 UTILITY TRENCHING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Excavating trenches for utilities.
  - 2. Backfilling and compaction.

### B. Related Sections:

1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
  - 1. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 2. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
  - 3. ASTM D1556 Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
  - 4. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
  - 5. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
  - 6. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 7. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

## 1.3 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.
- B. Structures: Buildings, foundations, slabs, tanks, pavements, walks, curbs, cut slopes, fill embankments, utilities, or other man-made stationary features occurring above or below ground surface.
- C. Structural Areas: Those plan locations containing a structure plus a minimum of 5 feet beyond the outside edge of the structure including appurtenances or as defined elsewhere in the project documents.
- D. Structural Fill: Materials placed as fill in Structural Areas.

## 1.4 SUBMITTALS

- A. Product Data: Submit data for geotextile fabric indicating fabric and construction.
- B. Materials Source: Submit name of imported fill materials suppliers.

## 1.5 QUALIFICATIONS

- A. Prepare erosion control plan and submit to ESG prior to start of construction.
- B. Refer to Section 02374, Erosion Control Devices.

## 1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

## 1.7 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

## PART 2 PRODUCTS

- 2.1 FILL MATERIALS
  - A. General fill: As specified in Section 02300.
  - B. Aggregate Fill: As specified in Section 02300, Section 02060, and the Plans.
  - C. Structural Fill: As specified in Section 02300.
  - D. Concrete: Structural concrete as specified in Section 03300 with compressive strength of 3,000 psi.
  - E. Lean Concrete: Non-structural concrete with a compressive strength of 2,000 psi.

## **PART 3 EXECUTION**

#### 3.1 LINES AND GRADES

- A. Lay pipes to lines and grades indicated on Drawings.
  - 1. ESG reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- B. Use laser-beam instrument with qualified operator to establish lines and grades.
- C. Maintain proper horizontal alignment of utilities not laid on grade.

## 3.2 PREPARATION

A. Call Alabama One Call service at 1-800-292-8525 not less than three working days before performing Work.

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- 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum locations.
- C. Protect plant life, lawns, and other features remaining as portion of final landscaping.
- D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities indicated to remain.
- F. Establish temporary traffic control and detours when trenching is performed in public rightof-way. Relocate controls and reroute traffic as required during progress of Work.

## 3.3 TRENCHING

- A. Erect erosion control devices prior to excavation.
- B. Excavate subsoil required for utilities to the depth indicated on the Drawings.
- C. Remove lumped subsoil, boulders, and rock up of 1/6 cubic yard, measured by volume. Remove larger material as specified in Section 02316.
- D. Perform excavation within 24 inches of existing utility in accordance with utility's requirements.
- E. Do not advance open trench more than 400 feet ahead of installed pipe.
- F. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 12 inches of clearance on each side of pipe or conduit.
- G. Remove water or materials that interfere with Work.
- H. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil and bedding material. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- I. Do not interfere with 45 degree bearing splay of building foundations or roadbeds.
- J. When subsurface materials at bottom of trench are loose or soft, notify ESG, and request instructions.
- K. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type A1 and compact to density equal to or greater than requirements for subsequent backfill material.
- L. Correct over excavated areas with compacted backfill as specified for authorized excavation or replace with concrete as directed by ESG.
- M. Remove excess subsoil not intended for reuse, from site.

N. Maintain trench depth sufficient to provide a minimum cover of 30 inches over utility pipe unless otherwise noted in the Drawings. Maintain a minimum of 36 inches cover under highway ditches.

## 3.4 STABILITY OF EXCAVATIONS

- A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction. Design of retaining structures must be performed, signed and sealed by a registered engineer licensed in the state in which the project is located.
- B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.
  - 1. Provide permanent steel sheet piling or reinforced concrete drilled shaft walls wherever subsequent removal of retaining structure might permit lateral movement of soil under adjacent structures. Cut off tops a minimum of 2'-6" below final grade and leave permanently in place.
- D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

## 3.5 BACKFILLING

- A. Backfill trenches as follows:
  - 1. In non-structural areas, use excavated material to backfill to existing contours and elevations, unless such material does not conform to the requirements of General Fill as outlined in Section 02300. In such instances, borrow material meeting those requirements shall be brought in to backfill the trench. The final lift shall be the required thickness of topsoil.
  - 2. In structural areas, use structural fill as shown on the Plans or as directed by ESG. Backfill to elevations reflected on the plans, or to match surrounding grade. The final lift shall be as indicated on the plans. If subgrade is unstable, prepare subgrade beneath pipe in accordance with Section 2300 prior to fill placement.
  - 3. Use aggregate as indicated on the plans in areas determined by ESG to be unsuitable for pipe bedding. Shape excavation bottom to fit bottom 90 degrees of cylinder.
  - 4. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings or that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
    - a. Concrete is specified in Section 03300.

- b. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by ESG. Use care in backfilling to avoid damage or displacement of pipe systems.
- 5. Provide 4-inch-thick concrete base slab support for piping or conduit less than 24" below surface of roadways. After installation and testing of piping or conduit, provide minimum 4-inch-thick encasement (sides and top) of concrete prior to backfilling or placement of roadway base.
- B. Place, moisture condition, and compact fill material in accordance with Section 02300.
- C. Employ placement method that does not disturb or damage utilities in trench, or structures near the trench.
- D. Do not leave trench open at end of working day.
- 3.6 **PROTECTION OF FINISHED WORK** 
  - A. Reshape and re-compact fills subjected to vehicular traffic during construction.

# SECTION 02371 RIPRAP AND ROCK LINING

## PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Riprap placed loose.
  - 2. Riprap placed in bags.

#### B. Related Sections:

1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

#### 1.2 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data: Submit data for riprap bags, binder and geotextile fabric.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

#### 1.3 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

#### **PART 2 PRODUCTS**

#### 2.1 MATERIALS

- A. Riprap: Limestone type; broken stone; solid and nonfriable; class as specified on Drawings.
- B. Bags: Woven jute, where shown on Drawings.
- C. Binder: Portland cement, not required unless detailed on Drawings.
- D. Geotextile Fabric: Non-biodegradable, non-woven, 8 oz. minimum weight.

#### **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Do not place riprap over frozen or spongy subgrade surfaces.

## 3.2 PLACEMENT

- A. Place geotextile fabric over substrate, lap edges and ends.
- B. Place riprap at culvert pipe ends, at embankment slopes, and as indicated on Drawings.
- C. Installed Thickness Per Class:
  - 1. Class 1 Thickness = 18"; Tolerance 0", +6"
  - 2. Class 2 Thickness = 24"; Tolerance -3", +15"
  - 3. Class 3 Thickness = 30"; Tolerance -3", +15"
  - 4. Class 4 Thickness = 32"
  - 5. Class 5 Thickness = 36"

## 3.3 SCHEDULES

- A. Culvert Pipe Ends: Loose riprap, placed one layer thick, 18 inch average thickness, extend a minimum of two feet beyond culvert wall in each direction.
- B. Sloped Grade: Loose riprap units, 18 inch thickness; placed prior to finish topsoil.

# SECTION 02374 EROSION CONTROL DEVICES

## PART 1 GENERAL

- 1.1 SUMMARY
  - A. Section Includes:
    - 1. Silt Fences.
    - 2. Diversion Channels.
    - 3. Rock Energy Dissipater.
    - 4. Paved Energy Dissipater.
    - 5. Rock Basin.
    - 6. Rock Barriers.
    - 7. Sediment Ponds.
    - 8. Sediment Traps.
  - B. Related Sections:
    - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T88 Standard Specification for Particle Size Analysis of Soils.
  - 2. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18") Drop.
- B. American Concrete Institute:
  - 1. ACI 301 Specifications for Structural Concrete.
- C. ASTM International:
  - 1. ASTM C127 Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
  - 2. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
  - 3. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
  - 4. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 5. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- D. Precast/Prestressed Concrete Institute:
  - 1. PCI MNL-116S Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

## 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data: Submit data on joint filler joint sealer and geotextile.

- C. Submit Erosion Control Plan along with application for Stormwater NPDES permit to ESG prior to placement of erosion control devices.
- D. Submit manufacturer's catalog sheets and other pertinent information on filter fabrics showing that they meet or exceed the requirements of this specification.

## 1.4 CLOSEOUT SUBMITTALS

A. Section 01700 - Execution Requirements.

## 1.5 ENVIRONMENTAL REQUIREMENTS

- A. Section 01600 Product Requirements.
- B. Do not place grout when air temperature is below freezing.
- C. Do not place concrete when base surface temperature is less than 40° F, or surface is wet or frozen.
- D. Silt fence should not be installed across streams, ditches, waterways, or other concentrated flow areas.

# PART 2 PRODUCTS

#### 2.1 SILT FENCE MATERIALS

- A. Geotextile fabric shall be a 36" wide, nonwoven filter fabric composed of polypropylene, polyethylene, ethylene, or polyamide material.
- B. Minimum grab strength shall be 100 lbs. in any direction.
- C. Apparent opening size shall be 30 (maximum sieve size).
- D. Flow rate shall be 25 gallons/minute/square foot.
- E. Ultraviolet ray inhibitors and stabilizers shall provide a maximum of six (6) months of expected usable life.
- F. Type A silt fence shall include a 36" wide, 12½ gauge galvanized wire fence reinforcement to be placed with the geotextile material. Wire fence shall have openings no larger than 6" by 6". Type B silt fence shall be a 36" wide fabric with no wire fence reinforcement.
- G. Fence posts shall be minimum 2" x 2" oak, 60" long or steel T-post for Type B silt fence.
  Steel T-posts or 4" x 4" pressure treated wood posts shall be required for Type A silt fence.
  Minimum bury depth for wood posts is 24".

- 2.2 ROCK
  - A. Rock: Sound, hard and angular shape; well graded; without shale seams, structural defects and foreign substances; with width and thickness greater than one third its length. Refer to Section 02371.
- 2.3 CONCRETE MATERIALS AND REINFORCEMENT
  - A. Concrete: As specified in Section 03300.
  - B. Water: Clean and not detrimental to concrete.
  - C. Reinforcement Steel: As specified in Section 03200.
- 2.4 BLOCK, STONE, AGGREGATE, AND SOIL MATERIALS
  - A. Precast Solid Concrete Block.
  - B. Soil Backfill: Soil as specified in Section 02300.
- 2.5 PLANTING MATERIALS
  - A. Seeding and Sodding: As specified in Section 02926.
  - B. Mulch: As specified in Section 02926.

#### 2.6 PIPE MATERIALS

- A. Pipe: Corrugated Plastic (HDPE).
- 2.7 SOURCE QUALITY CONTROL (AND TESTS)
  - A. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.
  - B. Make rock available for inspection at producer's quarry prior to shipment. Notify ESG at least seven days before inspection is allowed.
  - C. Allow witnessing of inspections and testing at manufacturer's test facility. Notify ESG at least seven days before inspections and tests are scheduled.

#### **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Verify location of existing streams, drainage structures and environmentally sensitive areas prior to placing erosion control devices.

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- C. Verify compacted subgrade, granular base or stabilized soil is acceptable and ready to support devices and imposed loads.
- D. Verify gradients and elevations of base or foundation for other work are correct.

## 3.2 SILT FENCE

- A. The silt fence should be purchased in a continuous roll cut to length to avoid the use of joints. When joints are unavoidable, fabric should be spliced together at a post with a minimum 6" overlap.
- B. Post installation should start at the center of the low point with remaining posts spaced 10' apart for Type A and 7' apart for Type B fence.
- C. Anchor fabric by entrenching the bottom edge in a 6" deep trench and backfilling.
- D. Hay or straw bales shall be placed at each end of the silt fence.

## 3.3 DIVERSION CHANNELS

- A. Windrow excavated material on low side of channel.
- B. Compact to 95% maximum density.
- C. On entire channel area, apply soil supplements and sow seed as specified in Section 02926.
- D. Mulch seeded areas with hay as specified in Section 02926.

#### 3.4 ROCK ENERGY DISSIPATOR

A. Excavate to indicated depth of rock lining or nominal placement thickness as follows. Remove loose, unsuitable material below bottom of rock lining, then replace with suitable material. Thoroughly compact and finish entire foundation area to firm, even surface.

NCSA Class	Nominal Placement Thickness		
R8	48"		
R7	36"		
R6	30"		
R5	24"		
R4	18"		
R3	12"		

- B. Lay and overlay geotextile fabric over substrate. Lay fabric parallel to flow from upstream to downstream. Overlap edges upstream over downstream and upslope over downslope. Provide a minimum overlap of 3'. Offset adjacent roll ends a minimum of 5' when lapped. Cover fabric as soon as possible and in no case leave fabric exposed more than four (4) weeks.
- C. Carefully place rock on geotextile fabric to produce an even distribution of pieces, with minimum of voids and without tearing geotextile.

- D. Unless indicated otherwise, place full course thickness in one operation to prevent segregation and to avoid displacement of underlying material. Arrange individual rocks for uniform distribution.
  - 1. Saturate rock with water. Fill voids between pieces with grout, for at least top 6". Sweep surface with stiff broom to remove excess grout.
  - 2. Moist cure grouted rock for at least three (3) days after grouting, using water saturated burlap in accordance with Section 03300.

## 3.5 PAVED ENERGY DISSIPATER

- A. Excavate to the required paving depth. Remove loose, unsuitable material below bottom of paving, and then replace with suitable material. Thoroughly compact and finish entire foundation area to firm, even surface.
- B. Place forms and hold reinforcement firmly in position during placing of concrete.
- C. Mix, place and finish concrete, as specified in Section 03300.
- D. Embed stones or blocks 4" in plastic concrete at indicated separation on slopes and channel bottom.
- E. Pave in uniform 10' lengths or sections.
- F. Pave in shorter sections as necessary for closures or curves.
- G. Place premolded expansion joint filler,  $\frac{1}{2}$ " thick, cut to conform to paving cross sections, at ends of curved sections at intervals of not more than 100', at end of day's work, and where paving is adjacent to rigid structure. Use joint filler with depth of  $\frac{1}{2}$ " less than paving depth and press firmly against adjacent concrete.
- H. Form intermediate joints between sections, with two (2) thicknesses of bituminous paper cut neatly to paving cross section.

## 3.6 ROCK BASIN

A. Construct generally in accordance with rock energy dissipator requirements to indicated shape and depth. Rock courses may be placed in several operations but minimum depth of initial course must be 3' or greater.

## 3.7 ROCK BARRIER

- A. Determine length required for ditch or depression slope and excavate compact and foundation area to firm, even surface.
- B. Produce an even distribution of rock pieces, with minimum voids to the indicated shape, height and slope.
- C. Construct coarse aggregate filter blanket against upstream face of rock barrier to the indicated thickness.

#### 3.8 SITE STABILIZATION

- A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.
- B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.
- C. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than twenty (20) days.
  - 1. During non-germinating periods, apply mulch at recommended rates.
  - 2. Stabilize disturbed areas which are not at finished grade, and which will be disturbed within one year in accordance with Section 02926 at 90% of permanent application rate with no topsoil.
  - 3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 02926 permanent seeding specifications.
- D. Stabilize diversion channels, sediment traps, and stockpiles immediately.

### 3.9 FIELD QUALITY CONTROL

- A. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.
- B. Sediment should be removed from behind silt fence once it has accumulated to one-half the original height of the barrier. Fabric should be replaced whenever it has deteriorated to such an extent that the effectiveness of the fabric is reduced (approximately six (6) months).
- C. Hay bales shall be replaced every six (6) months regardless of condition.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.
- E. Do not damage structure or device during cleaning operations.
- F. Do not permit sediment to erode into construction or site areas or natural waterways.
- G. Clean channels when depth of sediment reaches approximately one-half channel depth|.

# SECTION 02511 FUSIBLE POLYVINYL CHLORIDE PIPE AND FITTINGS

## PART 1 GENERAL

### 1.1 SUMMARY

- A. Scope: This section specifies fusible polyvinyl chloride pipe (FPVC) and fittings for water utility use as indicated on the Drawings, and as specified herein.
  - 1. Furnish, Install, and Test FPVC pipe as indicated and specified in this section and the Drawings.
  - 2. The primary installation method is burial. The means and methods, including the testing for acceptance shall conform to all applicable standards as noted herein with the intention of providing a leak-free system to Energy Systems Group, LLC (ESG).
- B. Related Sections:
  - 1. Drawings and general provisions of the Contract including General and supplemental General Conditions, and Technical Specifications.

#### 1.2 REFERENCES

- A. AWWA <u>www.awwa.org</u>
  - 1. AWWA C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4in. through 12 in., for Water Distribution
  - 2. AWWA C905 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4in. through 12 in., for Water Distribution and Transmission.
  - 3. AWWA M23 Manual of Supply Practices, PVC Pipe Design and Installation, Second Edition
- B. NSF <u>www.nsf.org</u>
  - 1. NSF 14 Plastic Piping System Components and Related Materials
  - 2. NSF 61 Drinking Water System Components Health Effects
- C. ASTM <u>www.astm.org</u>
  - 1. ASTM D1784 Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
  - 2. ASTM D1785 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120
  - 3. ASTM D2152 Test Method of Degree of Fusion of Extruded Polyvinyl Chloride (PVC) Pipe and Molded Fittings by Acetone Immersion
  - 4. ASTM D2241 Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR)
  - 5. ASTM D3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings

#### 1.3 MANUFACTURER REQUIREMENTS

A. All piping shall be made from a PVC compound conforming to cell classification 12454 per ASTM D1784.

## 1.4 FUSION TECHNICIAN REQUIREMENTS

A. Fusion Technician shall be qualified by the pipe supplier to install fusible polyvinyl Chloride (FPVC) pipe of the type(s) and size(s) being used. Qualification shall be current as of the date of fusion performance on the project.

## 1.5 SPECIFIED PIPE SUPPLIERS

A. Fusible polyvinyl Chloride (FPVC) pipe shall be as manufactured under the trade name Fusible C-900, Fusible C-905 and FPVC for Underground Solutions, Inc. or equal.

## 1.6 WARRANTY

A. The pipe and the fusion service shall be warranted for one year from the date of completion of the project as designated by ESG. No pro-rated warranty is allowed.

## **PART 2 PRODUCTS**

## 2.1 FUSIBLE POLYVINYLCHLORIDE PIPE

- A. Fusible Polyvinyl Chloride pipe for Potable water shall conform to AWWA C900, AWWA C905, ASTM D2241 or ASTM D1784, as applicable. Testing shall be in accordance with the referenced AWWA standards for all pipe types.
- B. Pipe shall be marked verifying suitability for potable water service per NSF 61.
- C. Fusible Polyvinyl Chloride pipe for non-potable water or pressurized wastewater not conforming to AWWA C905 dimensionally shall conform to AWWA C900, ASTM D2241 or ASTM D1785, as applicable. Testing shall be in accordance with the referenced AWWA standards.
- D. Fusible Polyvinyl Chloride pipe for non-potable water or pressurized wastewater conforming to AWWA C905 dimensionally shall conform to AWWA C905.
- E. Fusible Polyvinyl Chloride pipe for non-pressure storm wastewater not conforming to AWWA C905 dimensionally shall conform to AWWA C900, ASTM D2241 or ASTM D1785, ASTM D3034 or ASTM F679 form standard dimensions as applicable. Testing shall be in accordance with the applicable standard used.
- F. Fusible Polyvinyl Chloride pipe for non-pressure storm or wastewater conforming to AWWA C905 dimensionally shall conform to AWWA C905.
- G. Fusible polyvinyl chloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
- H. Fusible polyvinyl chloride pipe shall be manufactured in a standard 40' nominal length of custom lengths as specified.

- I. Fusible polyvinyl chloride pipe shall be blue in color for potable water use, purple for reclaim water use, reuse water or other non-potable water use, green for wastewater use, and white for storm water use.
- J. Pipe shall be marked as follows:
  - 1. Nominal pipe size
  - 2. PVC
  - 3. Dimension Ratio, Standard Dimension Ratio or Schedule
  - 4. AWWA pressure class, or standard pressure rating for non-AWWA pipe
  - 5. AWWA standard designation number or pipe type for non-AWWA pipe
  - 6. Extrusion production record code
  - 7. Trademark or trade name
  - 8. Call classification 12454 and/or PVC material code 1120
- K. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign materials, blisters, or other visible deleterious faults.

## 2.2 FUSION JOINTS

- A. Unless otherwise specified, FPVC pipe lengths shall be assembled in the field with buttfused joints.
- B. The fusion technician shall follow the pipe supplier's guidelines for butt fusion of the joints.

#### 2.3 FUSIBLE POLYVINYL CHLORIDE SWEPS OR BENDS

- A. Fusible polyvinyl chloride sweeps or bends shall conform to the same sizing convention, diameter, dimensional tolerances and pressure class of the pipe being joined by the sweep or bend.
- B. Fusible polyvinyl chloride sweeps or bends shall be manufactured from the same fusible polyvinyl chloride pipe being used for the installation, and shall have at least 2 feet of straight section on either end of the sweep or bend to allow for fusion of the sweep to the pipe. There shall be no gasketed connections utilized with a fusible polyvinyl chloride sweep or bend.
- C. Standard fusible polyvinyl chloride sweep or bend angles shall not be greater than 22.5 degrees, and shall be used in nominal diameters ranging from 4 inch through 16 inch.

## PART 3 EXECUTION

#### 3.1 PIPE HANDLING AND STORAGE

- A. Pipe shall be off-loaded, loaded, installed, handled, stored and stacked per the pipe supplier's guidelines. These guidelines include compliance with the minimum recommended bend radius and maximum safe pull force for the specific pipe being used.
- B. The general best practices of the industry per AWWA M23 shall also be observed.

## 3.2 FUSION PROCESS

- A. Fusible polyvinyl chloride pipe shall be handled in a safe and non-destructive manner before, during and after the fusion process and in accordance with this specification and the supplier's guidelines.
- B. Fusible polyvinyl chloride pipe shall be fused by qualified fusion technicians holding current qualification credentials for the pipe size being fused, as documented by the pipe supplier.
- C. The pipe supplier's procedures shall be followed at all times during the fusion operations.
- D. Each fusion joint shall be recorded and logged by an approved electronic monitoring device (data logger) connected to the fusion machine, which utilizes a current version of the pipe supplier's recommended and compatible software.
- E. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. This includes requirements for safety, maintenance, and operation with modifications made for PVC.

## 3.3 TESTING

- A. Pressure test system to the greater of 1.25 times the working pressure at the highest point in the test segment or 1.5 times the working pressure at the point of testing, not to exceed the pipeline or valve pressure rating in the test segment. Repair leaks and re-test.
  - 1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of ESG, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
  - 2. Provide all equipment required to perform leakage and hydrostatic pressure tests including water storage means, acceptable water volume measurement means, pumps, piping, calibrated pressure gauges, and chart recorder. Upon request of ESG, provide certification of calibration of equipment acceptable to ESG.
  - 3. Test Pressure: The greater of 1.25 times the working pressure at the highest point in the test segment or 1.5 times the working pressure at the point of testing, not to exceed the pipeline or valve pressure rating in the test segment. Obtain working pressure from ESG.
  - 4. Conduct hydrostatic test for at least six-hour duration.
  - 5. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, apply test pressure. At conclusion of tests, close and permanently seal resulting piping openings.
  - 6. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
  - 7. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
  - 8. Maintain test pressure within +/- 5 psi throughout test duration by pumping additional water in to the test segment. Accurately record test segment pressure

continuously on chart recorder and volume of additional water supplied to test segment.

- 9. No pipeline installation will be approved with leakage
- B. Compaction Testing for Bedding: In accordance with ASTM D1557.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

## 3.4 DISINFECTING

A. Flush and disinfect system in accordance with Section 02516.

#### SECTION 02513 WATER DISTRIBUTION SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Water distribution piping.
  - 2. Water service connections.
  - 3. Valves and Boxes.
  - 4. Fire Hydrants.
  - 5. Master Water Meter.
  - 6. Positive displacement meters.
  - 7. Underground pipe markers.
  - 8. Aboveground pipe markers.
  - 9. Precast concrete vault.
  - 10. Meter Boxes.
  - 11. Pipe Supports and Anchoring.
  - 12. Pile Support Systems.
  - 13. Concrete Encasement and Cradles.
  - 14. Mechanical Join Restraint.
  - 15. Flange Adaptor.
  - 16. Bolt-through Adaptor.
  - 17. Restrained Coupling.
  - 18. Bedding and cover materials.
  - 19. Finishing Steel.
  - 20. Adjustable Roller Hanger
- B. Related Sections:
  - 1. Plans and general provisions of the Contract including General Conditions, and Technical Specifications.

#### 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. American Society of Mechanical Engineers:
  - 1. ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
- C. ASTM International:
  - 1. ASTM A36/A36M Standard Specification for Carbon Structural Steel.
  - 2. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 3. ASTM A242 Standard Specification for High-Strength Low-Alloy Structural Steel.
  - 4. ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
  - 5. ASTM A674 Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water and Other Liquids.

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- 6. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
- 7. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
- 8. ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- 9. ASTM D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- 10. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- 11. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- 12. ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- 13. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- D. American Water Works Association:
  - 1. ANSI/AWWA C104/A21.4 Standard for Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
  - 2. ANSI/AWWA C105/A21.5 Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
  - 3. ANSI/AWWA C110/A21.10 Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm), for Water.
  - 4. ANSI/AWWA C111/A21.11 Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - 5. ANSI/AWWA C115/A21.15 Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
  - 6. ANSI/AWWA C116/A21.16 Standard for Protective Fusion-bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings.
  - 7. ANSI/AWWA C150/A21.50 Standard for the Thickness Design of Ductile-Iron Pipe.
  - 8. ANSI/AWWA C151/A21.51 Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
  - 9. ANSI/AWWA C153/A21.53 Standard for Ductile-Iron Compact Fittings for Water Service.
  - 10. AWWA C200 Steel Water Pipe 6 In. (150 mm) and Larger.
  - 11. AWWA C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
  - 12. AWWA C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. and Larger - Shop Applied.
  - 13. AWWA C206 Field Welding of Steel Water Pipe.
  - AWWA C207 Steel Pipe Flanges for Waterworks Service Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
  - 15. AWWA C208 Dimensions for Fabricated Steel Water Pipe Fittings.
  - 16. AWWA C213 Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
  - 17. AWWA C300 Reinforced Concrete Pressure Pipe, Steel-Cylinder Type.
  - 18. AWWA C301 Prestressed Concrete Pressure Pipe, Steel-Cylinder Type.
  - 19. AWWA C515 Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service.

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- 20. ANSI/AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances.
- 21. AWWA C605 Water Treatment Underground Installation of Polyvinyl Chloride PVC Pressure Pipe and Fittings for Water.
- 22. AWWA C606 Grooved and Shouldered Joints.
- 23. AWWA C700 Cold-Water Meters Displacement Type, Bronze Main Case.
- 24. AWWA C701 Cold-Water Meters Turbine Type, for Customer Service.
- 25. AWWA C702 Cold-Water Meters Compound Type.
- 26. AWWA C706 Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
- AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings,4 In. through 12 In. (100 mm Through 300 mm), for Water Distribution.
- AWWA C905 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 36 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution.
- 29. AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission
- 30. AWWA M6 Water Meters Selection, Installation, Testing, and Maintenance.
- E. Manufacturer's Standardization Society of the Valve and Fittings Industry:
  - 1. MSS SP-60 Connecting Flange Joint between Tapping Sleeves and Tapping Valves.
- F. National Fire Protection Agency:
  - 1. NFPA 24 Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

## 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Shop Drawings: Indicate piping layout, including piping specialties.
- C. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories.
- D. Manufacturer's Certificates: Submit Statement of Compliance, supporting data, from material suppliers attesting that valves, hydrants, and accessories provided meet or exceed AWWA Standards and specification requirements.
- E. Fusion Technician Qualification: HDPE or Fusible PVC pipe manufacturer or pipe supplier qualification to butt-fuse pipe products.

## 1.4 QUALIFICATIONS

- A. Manufacturer: company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

## 1.5 CLOSEOUT SUBMITTALS

- A. Section 01700 Execution Requirements.
- B. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 Product Requirements.
- B. Deliver and store materials in shipping containers with labeling in place.
- C. Block individual and stockpiled pipe lengths to prevent moving.
- D. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
- E. Store polyethylene and PVC materials out of direct sunlight.
- F. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

### 1.7 MAINTENANCE MATERIALS

- A. Furnish one valve tee wrench and one fire hydrant wrench to Energy Systems Group, LLC (ESG).
- 1.8 FIELD MEASUREMENTS
  - A. Verify field measurements prior to fabrication.

## PART 2 PRODUCTS

#### 2.1 WATER DISTRIBUTION PIPING

- A. Ductile Iron Pipe: AWWA C151.
  - 1. Coatings and Lining:
    - a. Outside: Bituminous coating, 1-mil minimum.
      - 1) Zinc outside coating if indicated in the Plans and/or Bid Form. ISO 8179-1
    - b. Inside: Cement-mortar lining with Sealcoat, ANSI/AWWA C104/A21.4.
      - 1) Cement-mortar, double thickness if indicated in the Plans and/or Bid Form.
  - 2. Pipe Class: AWWA C151, for nominal thickness, rated water working pressure and maximum depth of cover. Pressure Classification as required on drawings for normal installation. Class 56 for pipe installation on river channel bottom.

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- 3. Fittings: Ductile iron, AWWA C110. Compact fittings AWWA C153.
  - a. Coating and Lining:
    - 1) Bituminous Coating: AWWA C110.
    - 2) Cement Mortar Lining: AWWA C104, double thickness.
    - 3) Fusion-bonded Epoxy if indicated in the Plans and/or Bid Form: AWWA C116.
- 4. Joints:
  - a. Mechanical and Push-On Joints: AWWA C111.
  - b. Flanged Joints: AWWA C115.
  - c. Restrained Joints: Refer to Section 2.14.
  - d. Gaskets: Manufacturer's standard for push-on joint pipe. Refer to Section 2.14.
- 5. Encasement: AWWA C105 polyethylene encasement, 10 mil minimum thickness.
- B. Polyvinyl Chloride (PVC): AWWA C900 and AWWA C905, Pressure Class 200:
  - 1. Fittings: Ductile iron, AWWA C110. Compact fittings AWWA C153.
    - a. Coating and Lining:
      - 1) Bituminous Coating: AWWA C110.
      - 2) Cement Mortar Lining: AWWA C104, double thickness.
      - 3) Fusion-bonded Epoxy if indicated in the Plans and/or Bid Form: AWWA C116.
  - 2. Joints:
    - a. ASTM D3139 PVC flexible elastomeric seals. Solvent-cement couplings are not permitted.
- C. Polyvinyl Chloride (PVC): ASTM D2241, SDR-21 for 200 psig rating:
  - 1. Fittings: Ductile iron, AWWA C110. Compact fittings AWWA C153.
    - a. Coating and Lining:
      - 1) Bituminous Coating: AWWA C110.
      - 2) Cement Mortar Lining: AWWA C104, double thickness.
      - 3) Fusion-bonded Epoxy if indicated in the Plans and/or Bid Form: AWWA C116.
  - 2. Joints:
    - a. ASTM D3139 PVC flexible elastomeric seals. Solvent-cement couplings are not permitted.
    - b. Butt-fusion, per pipe supplier's written instructions and qualified fusion technician.
- D. Fusible PVC: Refer to Section 02511
- E. High Density Polyethylene (HDPE): Refer to Section 02514
- F. Steel Pipe: AWWA C200 Fabricated Pipe, minimum wall thickness 0.375 inches for pipe diameters up to 8 inches and 0.50 inches for pipe diameters greater than 8 inches.
  - 1. Fittings and Special Sections: AWWA C208.
  - 2. Flanges: AWWA C207 slip-on.
  - 3. Field Welding Materials:
    - a. Pipe: AWWA C206.
    - b. Joints: AWWA C205.
  - 4. Interior Cement Mortar Lining: AWWA C205.
  - 5. Buried Steel Pipe Exterior Lining:

a. AWWA C213, fusion-bonded epoxy coating.

## 2.2 WATER SERVICE CONNECTIONS

A. Furnish materials and install in conformance with Section 02515.

## 2.3 VALVES AND BOXES

A. Furnish materials and install in conformance with Section 02085.

## 2.4 FIRE HYDRANTS

A. Furnish materials and install in conformance with Section 02088.

## 2.5 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed with "Water Service" in large letters, minimum 6" wide by 4 mil thick, manufactured for direct burial service.
- B. Trace Wire (for non-metallic pipe): No. 12 gauge copper clad steel (CCS) reinforced with blue plastic covering, imprinted.

## 2.6 ABOVEGROUND PIPE MARKERS

- A. Manufacturer:
  - 1. Markers to Locations: Furnish at valves, casing ends, major bends, and other locations requested by ESG.
- B. Marker: Install according to manufacturer's instructions. Color and markings shall be blue unless otherwise indicated.

## 2.7 PRECAST CONCRETE VAULTS

A. Precast Concrete Vaults: Conform to Section 02086.

### 2.8 PIPE SUPPORTS AND ANCHORING

- A. Metal for pipe support brackets: Structural steel, thoroughly coated with epoxy paint.
- B. Metal tie rods and clamps or lugs: Galvanized steel sized in accordance with NFPA 24.

### 2.9 PILE SUPPORT SYSTEMS

- A. Pipe piers shall be field cast, 4000 psi, 28-day mix, as detailed in the Plans.
- B. Timber Piles: Conform to Section 02643.
- C. Timber for Cradle: Southern Yellow Pine well-seasoned conforming to Section 06100 and surfaced on all sides with preservative treatment.
- D. Preservative Treatment for Timber: Conform to Section 02463.

## 2.10 CONCRETE ENCASEMENT AND CRADLES

- A. Concrete: Conforming to Section 03300, 4,000 psi 28-day reinforced concrete, rough troweled finish.
- B. Concrete Reinforcement: Conform to Section 03200.

### 2.11 STEEL CASING AND TUNNEL LINER

A. Refer to Section 02444 – Casing Pipe and Tunnel Liner.

## 2.12 JOINT RESTRAINT

- A. Type I: Mechanical Joint Restraint
  - 1. Restraint devices for nominal pipe sizes 3" 36" shall consist of multiple gripping wedges incorporated into a retainer gland meeting the requirements of ANSI/AWWA C111/A21.11, except for HDPE pipe.
  - 2. The devices shall have a working pressure rating equal to that of the pipe on which it is used. Ratings are for water pressure and must include a minimum safety factor of 2:1 in all sizes.
  - 3. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron.
  - 4. Mechanical joint restraint shall be as follows:
    - a. Series 2000PV by EBAA Iron, Inc. or equal for connecting PVC to mechanical joint fittings.
    - b. Series 1100 by EBAA Iron, Inc. or equal for connecting ductile iron pipe to mechanical joint fittings.
  - 5. HDPE shall be fully restrained with fused-on flange adaptors, MJ adaptors, or other approved method or fitting. All recommendations and instructions for fitting from manufacturer shall be followed. No gripper-style restraints will be allowed.
  - 6. HDPE connections shall be longitudinally restrained per the design by restrained fittings, anchor blocks, or other approved method.
- B. Type II: Restrained Joint Pipe
  - 1. Restrained Joint Pipe: AWWA C111.
  - 2. Flexible restrained push-on type equivalent to "TR Flex" as manufactured by U.S. Pipe, or "Flex-Ring" as manufactured by American Cast Iron Pipe Company.
  - 3. Restrained Joint Pipe shall be stored, installed, and tested in accordance with manufacturer's instructions.
- C. Type III: Restraining Gaskets
  - 1. Restraining Gaskets: ANSI/AWWA C111/A21.11
  - 2. Push on joint pipe specified with restraining gaskets shall incorporate gaskets equivalent to "Field-Lok 350 Gaskets" as manufactured by U.S. Pipe, or "Fast-Grip Gaskets" as manufactured by American Cast Iron Pipe Company.
  - 3. Restraining Gaskets shall not be used at pipe end terminations.
  - 4. Restraining Gaskets shall be stored, installed, and tested in accordance with manufacturer's instructions.

## 2.13 FLANGE ADAPTOR

- A. Flange adaptors may be used in lieu of threaded or welded flanges of plain end ductile pipe where allowed by ESG. These shall not be used with HDPE.
- B. The restraints shall be manufactured of ductile iron conforming to ASTM A536.
- C. The bolt circles and bolt holes shall conform to ANSI/AWWA C110/A21.10.
- D. The restraint shall be Series 1000-EZ Flange as manufactured by EBAA Iron, Inc. or equal.

## 2.14 BOLT-THROUGH ADAPTOR

- A. A bolt-through mechanical adaptor may be used or required in lieu of standard flange adaptors. These shall not be used with HDPE.
- B. The restraints shall be manufactured of ductile iron conforming to ASTM A536.
- C. The bolt circles and bolt holes shall conform to ANSI/AWWA C110/A21.11 and ASTM A242.
- D. The adaptor shall be the "Foster" adaptor as manufactured by Infact Corporation or equal.

## 2.15 RESTRAINED COUPLING

- A. Restrained couplings are used for joining and restraining two plain end pipes of the same or dissimilar materials.
- B. Coupling shall be capable of being used on ductile iron, steel, PVC or HDPE pipe.
- C. Coupling shall be constructed of ASTM A536 ductile iron and designed with a 2:1 safety factor.
- D. Internal pipe wall stiffeners must be used when restraining HDPE.
- E. The restraint mechanism shall incorporate a plurality of individually actuating gripping surfaces to maximize restraint capability and have torque limiting twist off nuts to insure proper actuating of the restraint devices.
- F. The restraint devices shall be coated using fusion bonded epoxy approved for potable water contact.
- G. The coupling sleeve internal surface (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.
- H. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16.
- I. The restrained joining system shall meet the applicable requirements of AWWA C219, ANSI/AWWA C111/A21.11, and ASTM D2000.

- J. The restrained coupling system shall be Series 3800 manufactured by EBAA Iron, Inc. or and approved equal.
- 2.16 BEDDING AND COVER MATERIALS
  - A. Bedding: Fill Type A2 as specified in Section 02060.
  - B. Cover: Fill Type as specified in Section 02300 and the Plans.
  - C. Soil Backfill from Above Pipe to Finish Grade: Soil as specified in Section 02300.
- 2.17 ACCESSORIES
  - A. Concrete for Thrust Restraints: Conform to Section 03300.
  - B. Steel rods, bolts, lugs and brackets: ASTM A36/A36M or ASTM A307 carbon steel.
  - C. Protective Coating: Bituminous coating.
- 2.18 FINISHING STEEL
  - A. Galvanizing: ASTM A123/A123M; minimum 2.0 oz/sq ft coating thickness; galvanize after fabrication.

#### **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Verify existing utility water main size, location, and type is as indicated in the Plans.
  - C. Determine exact location and size of valves and hydrants from the Plans; obtain clarification and directions from ESG prior to execution of work.
  - D. Verify invert elevations of existing work prior to excavation and installation of valves and fire hydrants.
  - E. All pipe and fittings must be inspected for damage from prior to installation. Any damaged piping must be replaced prior to installation.

## 3.2 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs. Use only equipment specifically designed for pipe material being cut. The use of chisels or hand saws will not be permitted. Grind edges smooth with beveled end for push-on connections.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.
- D. Do not interrupt existing utilities without permission and without arranging to provide temporary utility services.

CDG, Inc Water Distribution Systems 02513 - 9 1. Notify ESG not less than two days in advance of proposed utility interruption.

## 3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 02300 for Work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated in the Plans.
- B. Dewater excavations to maintain dry conditions and preserve final grades at bottom of excavation.
- C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 8 inches compacted depth; compact to 95 percent.

#### 3.4 INSTALLATION - PIPE

- A. Install pipe in accordance with AWWA C600. Trenching shall be in accordance with Section 02324. Directional boring shall be in accordance with Section 02448.
- B. Handle and assemble pipe in accordance with manufacturer's instructions and as indicated in the Plans.
- C. Steel Rods, Bolt, Lugs, and Brackets: Coat buried steel with one coat of coal tar coating before backfilling.
- D. Maintain a minimum of 5 feet horizontal separation of water main from sewer piping.
- E. Install ductile iron piping and fittings to AWWA C600.
- F. Weld pipe in accordance with AWWA C206. Weld joints in accordance with AWWA C205.
- G. Flanged Joints: Not to be used in underground installations except within structures.
- H. Route pipe in straight line. Relay pipe that is out of alignment or grade.
- I. Install pipe with no high points. If unforeseen field conditions arise which necessitate high points, install air release valves as directed by ESG.
- J. Install pipe to have bearing along entire length of pipe. Excavate bell holes to permit proper joint installation. Do not lay pipe in wet or frozen trench.
- K. Prevent foreign material from entering pipe during placement.
- L. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- M. Close pipe openings with watertight plugs during work stoppages.
- N. Install access fittings to permit disinfection of water system performed under Section 02516.
- O. Establish elevations of buried piping with not less than three feet of cover. Measure depth of cover from final surface grade to top of pipe barrel.

- P. Install plastic ribbon tape continuous 12 inches below final grade of surface.
- Q. Install trace wire continuous 12 inches above any non-metallic pipe.

### 3.5 POLYETHYLENE ENCASEMENT

- A. Encase piping in polyethylene where indicated on the Plans to prevent contact with surrounding backfill material or concrete thrust blocks.
- B. Install in accordance with AWWA C105 and ASTM A674.
- C. Terminate encasement 3 to 6 inches above ground where pipe is exposed.

## 3.6 THRUST RESTRAINT

- A. Provide valves, tees, bends, caps, and plugs with concrete thrust blocks, Type I, II, or III restraint as indicated in the Plans. For concrete thrust blocks, pour against undisturbed earth. Locate thrust blocks such that pipe and fitting joints will be accessible for repair.
- B. Install tie rods, clamps, set screw retainer glands, concrete anchors or restrained joints as indicated in the Plans. Protect metal restrained joint components against corrosion, when in contact with concrete, by applying a bituminous coating, or by concrete mortar encasement of metal area. Do not encase pipe and fitting joints to flanges.
- C. Install thrust blocks, tie rods, and type I or II joint restraint at dead ends of water main as shown in the Plans.

#### 3.7 SERVICE CONNECTIONS

A. Install service connections in accordance with Section 02515.

#### 3.8 BACKFILLING

- A. Backfill around sides and to top of pipe with cover fill in maximum lifts of 6 inches, tamp in place and compact in accordance with the Plans and Specifications. Place and compact material immediately adjacent to pipes to avoid damage to pipe and prevent pipe misalignment.
- B. Maintain optimum moisture content of bedding material to attain required compaction density.
- 3.9 DISINFECTION OF POTABLE WATER PIPING SYSTEM
  - A. Flush and disinfect system in accordance with Section 02516.

### 3.10 FIELD QUALITY CONTROL

- A. Refer to Section 02514 for pressure test requirements for high density polyethylene (HDPE) piping.
- B. In piping systems with multiple material types, HDPE piping must be pressure tested separately from ductile iron and/or PVC piping, unless otherwise indicated by the ESG. CDG, Inc

Following an approved test for HDPE piping, the connections can be made, and the entire system can be tested as described below.

- C. Pressure test system to the greater of 1.25 times the working pressure at the highest point in the test segment or 1.5 times the working pressure at the point of testing, not to exceed the pipeline or valve pressure rating in the test segment. Repair leaks and re-test.
  - 1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of ESG, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
  - 2. Provide all equipment required to perform leakage and hydrostatic pressure tests including water storage means, acceptable water volume measurement means, pumps, piping, calibrated pressure gauges, and chart recorder. Upon request of ESG, provide certification of calibration of equipment acceptable to ESG.
  - 3. Test Pressure: The greater of 1.25 times the working pressure at the highest point in the test segment or 1.5 times the working pressure at the point of testing, not to exceed the pipeline or valve pressure rating in the test segment. Obtain working pressure from ESG.
  - 4. Conduct hydrostatic test for at least six-hour duration.
  - 5. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, apply test pressure. At conclusion of tests, close and permanently seal resulting piping openings.
  - 6. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
  - 7. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
  - 8. Maintain test pressure within +/- 5 psi throughout test duration by pumping additional water into the test segment. Accurately record test segment pressure continuously on chart recorder and volume of additional water supplied to test segment. Additional water supplied shall be designated as the leakage.
  - 9. No pipeline installation will be approved when leakage is greater than that determined by the following formula:
    - $L = \frac{SD\sqrt{P}}{C}$
    - L = allowable, in gallons per hour
    - S = length of pipe tested, in feet
    - D = nominal diameter of pipe, in inches
    - p= average test pressure during leakage test, in pounds per square inch gauge
    - C = 133,200
  - 10. When leakage exceeds specified acceptable rate, locate source and make repairs. Repeat test until specified leakage requirements are met.

# SECTION 02514 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS

## PART 1 GENERAL

#### 1.1 SUMMARY

- A. Scope This section specifies high density polyethylene pipe (HDPE) and fittings for water and sewer utility use as indicated on the Plans, and as specified herein.
  - 1. Furnish, install, and test HDPE pipe as indicated and specified in this section and the Plans.
  - 2. The primary installation method is burial. The means and methods, including the testing for acceptance shall conform to all applicable standards as noted herein with the intention of providing a leak-free system to Energy Systems Group, LLC (ESG).
- B. Related Sections:
  - 1. Plans and general provisions of the Contract including General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. ANSI/AWWA <u>www.awwa.org</u>
  - 1. ANSI/AWWA C901-08 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76mm) for Water Service.
  - 2. ANSI/AWWA C906-07 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 IN. (1,600 mm), for Water Distribution and Transmission.
  - 3. ANSI/AWWA C651 Standard for Disinfecting Water Mains.
  - 4. AWWA M55 Manual of Water Supply Practices, PE Pipe Design and Installation
- B. Plastics Pipe Institute, PPI <u>www.plasticpipe.org</u>
  - 1. PPI Handbook of Polyethylene Pipe 2009 (2<sup>nd</sup> Edition)
  - 2. PPI TR-33 Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe
  - 3. PPI TR-34 Disinfection of Newly Constructed Polyethylene Water Mains
  - 4. PPI TR-41 Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping
  - 5. PPI TN-42 Recommended Minimum Training Guidelines for PE Pipe Butt Fusion
    - Joining Operators for Municipal and and Industrial Projects (2009)
  - 6. PPI TR-46 Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines
- C. NSF <u>www.nsf.org</u>
  - 1. NSF / ANSI 61 Drinking Water System Components Health Effects
- D. ASTM <u>www.astm.org</u>
  - 1. ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
  - 2. ASTM F905 Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
  - 3. ASTM F 1055 Standard Specification for Electofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

- 4. ASTM F 1290 Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.
- 5. ASTM F 1412 Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems
- 6. ASTM F 1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
- 7. ASTM F 2164 Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure
- 8. ASTM F 2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock
- 9. ASTM D 2239 Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
- 10. ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- 11. ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
- 12. ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
- 13. ASTM 2737 Standard Specification for Polyethylene (PE) Plastic Tubing
- 14. ASTM D 2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping
- 15. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- 16. ASTM D 3350-08 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

## 1.3 SYSTEM DESIGN PARAMETERS

- A. The polyethylene system working pressure rating accommodates the normal operating pressure and the repetitive surges. The pressure rating applies at 80°F or less.
- B. Per AWWA C901 and C906, the repetitive surge pressure allowance is equal to the pressure class of the pipe. Allowable total pressure during recurring surge conditions equals 1.5 times the pipe's pressure class. Allowable total pressure during occasional surge conditions equals 2.0 times the pipe's pressure class.
- C. Table 1 gives the Pressure Class per AWWA C901, pressure rating and allowable total pressure during recurring and occasional surge for PE 4710 pipe at 80°F or less.

Pipe Dimension Ration (DR)	Pressure Class	Pressure Rating	Allowable Total Pressure During Recurring Surge	Allowable Total Pressure During Occasional Surge
DR 9	250 psi	250 psi	375 psi	500 psi
DR 11	200 psi	200 psi	300 psi	400 psi

*Table 1. Pressure Class per AWWA C901 for PE 4710 at 80°F or less*
DR 13.5	160 psi	160 psi	240 psi	320 psi
DR 17	125 psi	125 psi	185 psi	250 psi
DR 21	100 psi	100 psi	150 psi	200 psi

## 1.4 SUBMITTALS

- A. Quality Assurance / Control Submittals
  - 1. Affirmation that product shipped meets or exceeds the standards set forth in this specification. This shall be in the form of a written document from the manufacturer attesting to the manufacturing process meeting the standards. (The specifier can also ask for various test results to be supplied that are done according to the standards)
  - 2. Manufacturers recommended fusion procedures for the products.
  - 3. Fusion Technician Qualifications: Contractor shall submit to ESG, prior to start of work, copies of current certification card for each fuser to be used on the Project.

## 1.5 DELIVERY – STORAGE - HANDLING

- A. Handle the pipe in accordance with the PPI *Handbook of Polyethylene Pipe (2<sup>nd</sup> Edition), Chapter 2* using approved strapping and equipment rated for the loads encountered. Do not use chains, wire rope, forklifts or other methods or equipment that may gouge or damage the pipe or endanger persons or property. Field storage is to be in compliance with AWWA Manual of Practice M55 Chapter 7.
- B. If any gouges, scrapes, or other damage to the pipe results in loss of 10% of the pipe wall thickness, cut out that section or do not use.

## 1.6 DATA LOGGER

- A. Contractor shall utilize a data logger to record and document all parameters of each fusion joint including butt fuse and sidewall fuse.
- B. Data logger shall record pipe material, DR rating, heat plate temperature, fusion time, cooling time, climatic conditions, fusion machine used, operator, project name, date, time, take pictures before, during and after fusion, and record GPS coordinates of each fusion.
- C. All data from the data logger shall be uploaded to a secure server. ESG shall have full access to all data recorded.

## 1.7 QUALIFICATIONS

- A. Manufacturer: company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

## PART 2 PRODUCTS

## 2.1 HDPE PIPE, 3 INCH AND SMALLER

- A. Polyethylene pipe shall be made from a HDPE material having a minimum material designation code of PE 4710. The material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE445474C for PE 4710. In addition, the pipe shall be listed as meeting NSF-61.
- B. The pipe shall meet the requirements of AWWA C901.
- C. HDPE pipe shall be rated for use at a pressure class as shown in the Plans and as listed on the Bid Schedule. The outside diameter of the pipe shall be based upon the IPS sizing system.
- D. Unless otherwise specified all HDPE pipe shall be PE 4710.
- E. Fittings
  - 1. Butt Fusion Fittings
    - a. Fittings shall be made of either PE 4710, with a minimum Cell Classification as noted in 2A.01A. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans.
    - b. Markings for molded fittings shall comply with the requirements of ASTM D 3261. Fabricated fittings shall be marked in accordance with ASTM F 2206. Socket fittings shall meet ASTM D 2683.
  - 2. Electrofusion Fittings Fittings shall be PE 4710, with a minimum Cell Classification as noted in 2A.01A. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.
  - 3. Flanges and Mechanical Joint Adapters (MJ Adapters)
    - a. Flanges and Mechanical Joint Adapters (MJ Adapters) Flanges and Mechanical Joint Adapters shall be PE 4710, with a minimum Cell Classification as noted in 2A.01A. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

Markings for molded or machined flange adapters or MJ Adapters shall be per ASTM D 3261. Fabricated (including machined) flange adapters shall be per ASTM F 2206.

b. Van-Stone style, metallic (including stainless steel), convoluted or flatplate, back-up rings and bolt materials shall follow the guidelines of Plastic Pipe Institute Technical Note #38, and shall have the bolt-holes and bolt-circles conforming to one of these standards: ASME B-16.5 Class 150, ASME B-16.47 Series A Class 150, ASME B-16.1 Class 125, or AWWA C207 Class 150 Series B, D, or E. The back-up ring shall provide a long-term pressure rating equal to or greater than the pressureclass of the pipe with which the flange adapter assembly will be used, and such pressure rating shall be marked on the back-up ring. The backup ring, bolts, and nuts shall be protected from corrosion by a system such as paint, coal-tar epoxy, galvanization, polyether or polyester fusion bonded epoxy coatings, anodes, or cathodic protection, as specified by ESG.

- F. Service Connections
  - 1. Service connections shall be electrofusion saddles with a brass or stainless steel threaded outlet, electrofusion saddles, sidewall fusion branch saddles, tapping tees, or mechanical saddles.
  - 2. For electrofusion saddles with threaded outlet the size of the outlet shall be <sup>3</sup>/<sub>4</sub> inch IPS unless a larger size is shown on the plans. Electrofusion saddles shall be made from materials required in part 2.2 B. Electrofusion Fittings.
  - 3. For sidewall fusion saddles, the size of the saddle shall be as indicated on the plans. The saddle can be made in accordance to ASTM D 3261 or ASTM F 2206. After installation, approximately <sup>1</sup>/<sub>4</sub>" of the PE pipe shall be visible beyond the saddle to confirm that proper surface preparation occurred. Saddle faces that do notprovide <sup>1</sup>/<sub>4</sub> inch of area beyond the saddles are not acceptable.
  - 4. Tapping tees shall be made to ASTM D3261 or D2683.
  - 5. Mechanical strap-on saddles can only be used where their use on PE pipe is approved by the mechanical saddle manufacturer. The body of the saddle shall be stainless steel, epoxy coated cast iron or brass. The gasket material and design must be acceptable for PE pipe. The outlet shall be threaded for one inch IPS unless a larger size is shown on the plans. Mechanical strap-on saddles will be installed per the manufacturer's instructions.

## 2.2 PIPE AND FITTING IDENTIFICATION

- A. The pipe shall be marked in accordance with the standards to which it is manufactured.
- B. Color identification by the use of stripes on pipe to identify pipe service shall be required. Stripes or colored exterior pipe product shall be blue for potable water.
- C. Tracing wire shall be placed parallel and above, but separate from the pipe and shall be 10 AWG or ESG approved equal.
- D. Marking tape shall be approved by ESG and placed between 6 and 12 inches above the crown of pipe.
- 2.3 HDPE PIPE, 4 INCH AND LARGER
  - A. Polyethylene pipe shall be made from HDPE material having a material designation code of PE 4710 or higher. The material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE345464C. In addition, the material shall have a minimum cell classification of PE345464C. In addition, the material shall be listed as meeting NSF-61.
  - B. The pipe and fittings shall meet the requirements of AWWA C906.
  - C. HDPE pipe shall be rated for use at a pressure class as shown in the Plans and as listed on the Bid Schedule. The outside diameter of the pipe shall be based upon the IPS sizing system.

- D. Unless otherwise specified all HDPE pipe shall be PE 4710.
- E. Fittings 1.
  - Butt Fusion Fittings
    - a. Fittings shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as noted in 2B.01A Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All fittings shall meet the requirements of AWWA C906.
    - b. Markings for molded fittings shall comply with the requirements of ASTM D 3261. Fabricated fittings shall be marked in accordance with ASTM F 2206. Socket fittings shall meet ASTM D 2683.
  - 2. Electrofusion Fittings Fittings shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as noted in 2B.01A. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and have nominal burst values of four times the Working Pressure Rating (WPR) of the fitting. Markings shall be according to ASTM F 1055.
  - 3. Flanges and Mechanical Joint Adapters (MJ Adapters)
    - a. Flanges and Mechanical Joint Adapters shall have a material designation code of PE 4710 or higher and a minimum Cell Classification as noted in 2B.01A. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ Adapters shall be per ASTM D 3261. Fabricated (including machined) flange adapters shall be per ASTM F 2206.
    - b. Van-Stone style, metallic (including stainless steel), convoluted or flatplate, back-up rings and bolt materials shall follow the guidelines of Plastic Pipe Institute Technical Note # 38, and shall have the bolt-holes and bolt-circles conforming to one of these standards: ASME B-16.5 Class 150, ASME B-16.47 Series A Class 150, ASME B-16.1 Class 125,

or AWWA C207 Class 150 Series B, D, or E. The back-up ring shall provide a long-term pressure rating equal to or greater than the pressureclass of the pipe with which the flange adapter assembly will be used, and such pressure rating shall be marked on the back-up ring. The backup ring, bolts, and nuts shall be protected from corrosion by a system such as paint, coal-tar epoxy, galvanization polyether or polyester fusion bonded epoxy coatings, anodes, or cathodic protection, as specified by ESG.

- F. Service Connections
  - 1. Service Connections shall be electrofusion saddles with a brass or stainless steel threaded outlet, electrofusion saddles, sidewall fusion branch saddles, tapping tees, or mechanical saddles.
  - 2. For electrofusion saddles with threaded outlet the size of the outlet shall be  $\frac{3}{4}$  inch

CDG, Inc High Density Polyethylene Pipe and Fittings 02514 - 6 IPS unless a larger size is shown on the plans. Electrofusion saddles shall be made from materials required in 2.2 B. Electrofusion Fittings.

- 3. For sidewall fusion saddles the size of the saddle shall be as indicated on the plans. The saddle can be made in accordance to ASTM D 3261 or ASTM F 2206. After installation, approximately <sup>1</sup>/<sub>4</sub>" of the PE pipe shall be visible beyond the saddle to confirm that proper surface preparation occurred. Saddle faces that do notprovide <sup>1</sup>/<sub>4</sub> inch of area beyond the saddle are not acceptable.
- 4. Tapping tees shall be made to ASTM D3261 or D2683.
- 5. Mechanical strap-on saddles can only be used where their use on PE pipe is approved by the mechanical saddle manufacturer. The body of the saddle shall be stainless steel, epoxy coated cast iron or brass. The gasket material and design must be acceptable for PE pipe. The outlet shall be threaded for one inch IPS unless a larger size is shown on the plans. Mechanical strap-on saddles will be installed per the manufacturer's instructions.

## 2.4 PIPE AND FITTING IDENTIFICATION

- A. The pipe shall be marked in accordance with the standards to which it is manufactured.
- B. Color identification by the use of stripes on pipe to identify pipe service shall be required. Stripes or colored exterior pipe product shall be blue for potable water, or green for wastewater/sewage, or purple (lavender) for reclaimed water.
- C. Tracing wire shall be placed parallel and above, but separate from the pipe and shall be 10 AWG or ESG approved equal.
- D. Marking tape shall be approved by ESG and placed between 6 and 12 inches above the crown of pipe.

## **PART 3 EXECUTION**

## 3.1 JOINING METHODS

- A. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.
- B. Saddle fusion: Saddle fusion shall be done in accordance with ASTM F 2620 or TR-41 or the fitting manufacturer's recommendations and PPI TR-41. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project. (Saddle fusion is used to fuse branch saddles, tapping tees, and other HDPE constructs onto the wall of the main pipe) (ASTM F905).
- C. Socket Fusion: Molded socket fusion fittings are only to be used for joining of HDPE pipe from ½ inch to 2 inch in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer's recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously, and pressed together so the outside wall of the male end is fused to the

inside wall of the female end. Qualification of the fusion technician shall be demonstrated by evidence of socket fusion training within the past year on the equipment to be utilized on this project. (Socket fusion is not widely used, and the specifier may decide to prohibit its use)

- D. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290 and PPI TN 34. The process of electrofusion require3s an electric source, a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting, that is compatible with the type of electrofusion box used. The electrofusion box must be capable of reading and storing the input parameters and fusion results for later download to a record file. Qualification of the fusion technician shall be demonstrated by evidence of electrofusion training within the past year on the equipment to be utilized for this project.
- E. Mechanical:
  - 1. Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with the PPI Handbook of Polyethylene Pipe, Chapter 9 and AWWA Manual of Practice M55, Chapter 6.
  - 2. Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or fittings, or to a transition to another material. The use of stab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.
  - 3. Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.
  - 4. Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
  - 5. Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project.
- F. Joint Recording The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

# 3.2 INSTALLATION

- A. Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7.
- B. Pipe embedment Embedment material should be Class I, Class II, or Class III, materials as defined by ASTM D-2321 Section 6. The use of Class IV and Class V materials is not recommended; however it may be used only with the approval of ESG and appropriate compaction.

C. Bedding: Pipe bedding shall be in conformance with ASTM D2321 Section 8. Compaction rates should be as specified in ASTM D2321. Deviations shall be approved by the ESG.

# 3.3 TESTING

- A. Testing shall be as outlined in ASTM F2164.
- B. The maximum test pressure should be measured at the lowest elevation in the test section. For pressure piping systems that include polyethylene pipe or fittings, the maximum permissible test pressure is the lower of:
  - 1. 150% of the PE pipe system's design pressure rating for the application and application service temperature, provided that all components in the test section are rated for the test pressure.
  - 2. The pressure rating of the lowest pressure rated component in the test section. Lower pressure-rated components or devices may include pipe or fittings made from other plastics or metals, appurtenances such as valves, hydrants, regulators, and pressure relief devices, or some types of mechanical connections such as lower pressure-rated compression couplings or flanges with lower pressure-rated backup rings.
- C. Test Temperature: The pipe should be allowed to thermally stabilize and equalize before pressurizing the pipe to test pressure. All thermoplastic pipes have reduced strength at elevated temperature. Test pressure must be reduced when the test section is at elevated temperature either from service conditions or from environmental conditions such as being warmed by the sun. Multiply the test pressure by the Table 1 multiplier to determine the allowable elevated temperature test pressure.

Test Section Temperature °F (°C)	<u>≤80 (&lt;</u> <u>27)†</u>	<u>≤90 (&lt;</u> 32)	≤100 (< 38)	≤110 (< 43)	≤120 (< 49)	≤130 (< 54)	<u>≤140 (≤</u> <u>60)</u> ‡
Multiplier	1.0	0.9	0.8	0.8	0.7	0.7	0.6

Table 1 Elevated Temperature Multiplier

<sup>†</sup> Use the 80°F (27°C) multiplier for 80°F (27°C) and lower temperatures.

<sup>‡</sup> The maximum service temperature for PE pressure piping is 140°F (60°C).

- D. Test Duration:
  - 1. When testing at pressures above the system design pressure up to 150% of the system design pressure, the maximum test duration is eight (8) hours including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize the test section. If the test is not completed due to leakage, equipment failure, or for any other reason, depressurize the test section completely, and allow it to relax for at least eight (8) hours before pressurizing the test section again. CAUTION Testing at excessive pressures or for excessive time may damage the piping system.
  - 2. When testing at the system design pressure or less, test duration including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize should be limited to a practical time period given that the test section is not to be left unsupervised at any time during leak testing.

- E. Filling: Fill the restrained test section completely with water. After filling, allow time for the system to reach thermal equilibrium and allow for any dissolved air to exit the system air vents. No air shall be trapped in the test section.
- F. Initial Expansion Phase
  - 1. Gradually pressurize the test section to test pressure and add make-up water as necessary to maintain the maximum test pressure for four (4) hours. During the initial expansion phase, polyethylene pipe will expand slightly due to elasticity and Poisson effects.
  - 2. Additional test liquid will be required to maintain pressure.
  - 3. If test pressure cannot be attained, or if it takes an unreasonably long time to reach test pressure, there may be faults such as excessive leakage, entrapped air, or open valving, or the pressurizing equipment may be inadequate for the size of the test section. If such faults exist, discontinue pressurizing and correct them before continuing.
- G. Test Phase
  - 1. Immediately following the initial expansion phase, reduce test pressure by 10 psi and stop adding test liquid. Monitor the pressure for 1 hour.
  - 2. If no visual leakage is observed and test pressure remains steady (within 5% of the target value) for one (1) hour, no leakage is indicated.
- H. Depressurization: Depressurize the test section by reducing pressure or releasing test liquid at a controlled rate. Sudden depressurization can cause water hammer.
- I. Low Pressure Air Testing of Gravity Flow Systems: For gravity flow and low or intermittent pressure applications such as sewer and odor control, leak testing in accordance with ASTM F1417 is required.

# END OF SECTION

# SECTION 02515 WATER SERVICE CONNECTIONS

## PART 1 GENERAL

- 1.1 SUMMARY
  - A. Section Includes:
    - 1. Pipe and fittings for domestic water service connections to buildings.
    - 2. Corporation stop assembly.
    - 3. Curb stop assembly.
    - 4. Underground pipe markers.
    - 5. Bedding and cover materials.
  - B. Related Sections:
    - 1. Plans and general provisions of the Contract including General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. American Society of Mechanical Engineers:
  - 1. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings.
  - 2. ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- C. American Society of Sanitary Engineering:
  - 1. ASSE 1012 Backflow Preventer with Intermediate Atmospheric Vent.
  - 2. ASSE 1013 Reduced Pressure Principle Backflow Preventers.
- D. ASTM International:
  - 1. ASTM A48/A48M Standard Specification for Gray Iron Castings.
  - 2. ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings.
  - 3. ASTM B88 Standard Specification for Seamless Copper Water Tube.
  - 4. ASTM C858 Standard Specification for Underground Precast Concrete Utility Structures.
  - 5. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kNm/m3)).
  - 6. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kNm/m3)).
  - 7. ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
  - 8. ASTM F2164 Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
  - 9. ASTM D2241 Standard Specification for Poly (Vinyl Chloride)

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(PVC) Pressure-Rated Pipe (SDR Series).

- 10. ASTM D2466 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- 11. ASTM D2855 Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- 12. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- 13. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- E. American Welding Society:
  - 1. AWS A5.8 Specification for Filler Metals for Brazing and Braze Welding.
- F. American Water Works Association:
  - 1. AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances.
  - 2. AWWA C700 Cold-Water Meters Displacement Type, Bronze Main Case.
  - 3. AWWA C701 Cold-Water Meters Turbine Type, for Customer Service.
  - 4. AWWA C702 Cold-Water Meters Compound Type.
  - 5. AWWA C706 Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
  - 6. AWWA C800 Underground Service Line Valves and Fittings.
  - 7. AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.
  - 8. AWWA M6 Water Meters Selection, Installation, Testing, and Maintenance.

# 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data: Submit data on pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, , service saddles, and accessories.

## 1.4 CLOSEOUT SUBMITTALS

- A. Section 01700 Execution Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of piping mains, curb stops, connections, thrust restraints, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 Product Requirements.
- B. During loading, transporting, and unloading of materials and products, exercise care to prevent any damage.
- C. Store products and materials off ground and under protective coverings and custody, away from walls and in manner to keep these clean and in good

condition until used.

D. Exercise care in handling precast concrete products to avoid chipping, cracking, and breakage.

# PART 2 PRODUCTS

## 2.1 WATER PIPING AND FITTINGS

- A. Copper Tubing: ASTM B88, Type K, annealed:
  - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
  - 2. Joints: Compression connection or AWS A5.8, BCuP silver braze.
- B. PVC Pipe: SDR-21 for 200 psig rating:
  - 1. Fittings: SDR-21 PVC.
  - 2. Joints: Compression. Solvent weld not acceptable.
- C. Polyethylene Pipe: 200 psig pressure rating:
  - 1. Fittings: AWWA C901, molded.
  - 2. Joints: Compression.

## 2.2 CORPORATION STOP ASSEMBLY

- A. Manufacturers:
  - 1. Mueller Company.
  - 2. Ford Meter Box Co.
  - 3. A. Y. McDonald Manufacturing.
  - 4. Substitutions: Section 01600 Product Requirements.
- B. Corporation Stops:
  - 1. Manufactured in accordance with AWWA C 800 and ASTM B584.
    - a. Any brass part of the fitting or valve which may possibly contact potable water shall be manufactured of "no-lead brass" constructed of either UNC Copper Alloy C 89520 or C 89833.
    - b. Any brass part of the fitting which will not possibly contact potable water shall be manufactured of brass constructed of UNS Copper Alloy C 83600 meeting the requirements of ASTM B 62.
  - 2. Inlet end threaded for tapping.
  - 3. Outlet end suitable for service pipe material as recommended by the manufacturer.
- C. Service Saddles:
  - 1. Double strap type, designed to hold pressures in excess of pipe working pressure.

# 2.3 CURB STOP ASSEMBLY

- A. Manufacturers:
  - 1. Mueller Company.
  - 2. Ford Meter Box Co.
  - 3. A. Y. McDonald Manufacturing.
  - 4. Substitutions: Section 01600 Product Requirements.

- B. Curb Stops:
  - 1. Manufactured in accordance with AWWA C 800 and ASTM B584.
    - a. Any brass part of the fitting or valve which may possibly contact potable water shall be manufactured of "no-lead brass" constructed of either UNC Copper Alloy C 89520 or C 89833.
    - b. Any brass part of the fitting which will not possibly contact potable water shall be manufactured of brass constructed of UNS Copper Alloy C 83600 meeting the requirements of ASTM B 62.
  - 2. Brass or red brass alloy body conforming to ASTM B62.
  - 3. Ball valve type with padlock wings. End connections shall be appropriate for the service pipe material as recommended by the manufacturer

## **PART 3 EXECUTION**

## 3.1 EXAMINATION

- A. Section 01300 Administrative Requirements.
- B. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

## 3.2 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

## 3.3 INSTALLATION - CORPORATION STOP ASSEMBLY

- A. Make connection for each different kind of water main using suitable materials, equipment and methods approved by ESG.
- B. Provide service clamps for mains other than of cast iron or ductile iron mains.
- C. Screw corporation stops directly into tapped and threaded iron main at 10 and 2 o'clock position on main's circumference; locate corporation stops at least 12 inches apart longitudinally and staggered.
- D. For plastic pipe water mains, provide full support for service clamp for full circumference of pipe, with minimum 2 inches width of bearing area; exercise care against crushing or causing other damage to water mains at time of tapping or installing service clamp or corporation stop.
- E. Use proper seals or other devices so no leaks are left in water mains at points of tapping; do not backfill and cover service connection until approved by ESG.

## 3.4 BEDDING

A. Excavate pipe trench in accordance with Section 02300 for Work of this Section.

- B. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 8 inches compacted depth; compact to 95 percent.
- C. Backfill around sides and to top of pipe in accordance with Section 02300.
- D. Place fill material in accordance with Section 02300.

## 3.5 INSTALLATION - PIPE AND FITTINGS

- A. Group piping with other site piping work whenever practical.
- B. Route pipe in straight line.
- C. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- D. Install access fittings to permit disinfection of water system.
- E. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.
- F. Backfill trench in accordance with Section 02300.

## 3.6 INSTALLATION - CURB STOP ASSEMBLY

- A. Set curb stops on gravel bed and connect to inlet side of meter.
- B. Center and plumb meter box over meter/curb stop assembly. Set box cover 1" above finished grade.

## 3.7 SERVICE CONNECTIONS

- A. Install water service in accordance with utility company requirements with double check valve backflow preventer and pressure reducing valves where line pressure exceeds 80 psi.
- B. Install water meter and backflow preventer in meter box located on site.
- C. Flush and pressure test service line prior to connection of meter.

## 3.8 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with Section 02516.

## 3.9 FIELD QUALITY CONTROL

A. Perform pressure test on water distribution system in accordance with Section 02513.

## END OF SECTION

# SECTION 02516 DISINFECTION OF POTABLE WATER SYSTEM

# PART 1 GENERAL

## 1.1 SUMMARY

- A. Section includes disinfection of potable water distribution and transmission system; and testing and reporting results.
- B. Related Sections:
  - 1. Plans and general provisions of the Contract including General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Water Works Association:
  - 1. AWWA B300 Hypochlorites.
  - 2. AWWA B301 Liquid Chlorine.
  - 3. AWWA B302 Ammonium Sulfate.
  - 4. AWWA B303 Sodium Chlorite.
  - 5. AWWA C600 Installation of Ductile-Iron Water Mains and Their Appurtenances.
  - 6. AWWA C651 Disinfecting Water Mains.

## 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.
- C. Test Reports: Indicate results comparative to specified requirements.
- D. Certificate: Certify cleanliness of water distribution system meets or exceeds specified requirements.

## 1.4 CLOSEOUT SUBMITTALS

- A. Disinfection Report:
  - 1. Type and form of disinfectant used.
  - 2. Date and time of disinfectant injection start and time of completion.
  - 3. Test locations.
  - 4. Name of person collecting samples.
  - 5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
  - 6. Date and time of flushing start and completion.
  - 7. Disinfectant residual after flushing in ppm for each outlet tested.

- B. Bacteriological Report:
  - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
  - 2. Time and date of water sample collection.
  - 3. Name of person collecting samples.
  - 4. Test locations.
  - 5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
  - 6. Coliform bacteria test results for each outlet tested.
  - 7. Certify water conforms, or fails to conform, to bacterial standards of Alabama Department of Environmental Management.
- 1.5 QUALITY ASSURANCE
  - A. Perform Work in accordance with AWWA C651.
- 1.6 QUALIFICATIONS
  - A. Testing Firm: Company specializing in testing potable water systems.
  - B. Submit bacteriologist's signature and authority associated with testing.

# PART 2 PRODUCTS

- 2.1 DISINFECTION CHEMICALS
  - A. Chemicals: AWWA B300, Hypochlorite, and AWWA B303, Sodium Chlorite.

# **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Verify piping system has been cleaned, inspected, and pressure tested.
  - C. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

## 3.2 INSTALLATION

- A. Provide and attach required equipment to perform the Work of this section.
- B. Perform disinfection of water distribution system and installation of system and pressure testing. Refer to Section 02513.
- C. Introduce treatment into piping system.

- D. Maintain disinfectant in system for 24 hours.
- E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
- F. Replace permanent system devices removed for disinfection.

# 3.3 FIELD QUALITY CONTROL

- A. Section 01400 Quality Requirements.
- B. Disinfection, Flushing, and Sampling:
  - 1. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted
  - 2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
  - 3. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
  - 4. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test and certify water quality suitable for human consumption.

## END OF SECTION

# **SECTION 02536 FORCE MAINS**

## PART 1 GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Force mains.
  - 2. Bedding and cover materials.
- B. Related Sections:
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18") Drop.
- B. ASTM International:
  - 1. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
  - 2. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
  - 3. ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
  - 4. ASTM D2241 Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
  - 5. ASTM D2466 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
  - 6. ASTM D2467 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  - 7. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 8. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- C. American Water Works Association:
  - 1. AWWA C104 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
  - 2. AWWA C110 American National Standard for Ductile-Iron and Grey-Iron Fittings, 3" through 48" (75 mm through 1200 mm), for Water and Other Liquids.
  - 3. AWWA C111 American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - 4. AWWA C151 American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
- D. Ductile Iron Pipe Research Association:
  - 1. DIPRA Section 1X, Thrust Restraint.

## 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Submit shop drawings for ductile iron pipe. Indicate piece numbers and locations and restrained joint locations.
- C. Product Data: Submit data indicating pipe material used, pipe accessories, restrained joint details and materials.
- D. Design Data: Submit restrained joint design data and calculations for ductile iron pipe establishing lengths of restrained joint piping required.
- E. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 CLOSEOUT SUBMITTALS

- A. Section 01700 Execution Requirements: Requirements for submittals.
- B. Project Record Documents: Record location of pipe runs, connections, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

## 1.5 QUALITY ASSURANCE

A. Design ductile iron pipe restrained joints in accordance with DIPRA Section 1X Standards.

## 1.6 FIELD MEASUREMENTS

A. Verify field measurements and elevations are as indicated.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 Product Requirements.
- B. During loading, transporting and unloading, exercise care to prevent damage to materials.
- C. Do not drop pipe or fittings.
- D. Avoid shock or damage to pipe.
- E. Take measures to prevent damage to exterior surface or internal lining of pipe.
- F. Do not stack pipe higher than recommended by pipe manufacturer.

G. Store gaskets for mechanical and push-on joints in cool, dry location out of direct sunlight and not in contact with petroleum products.

## 1.8 COORDINATION

- A. Section 01300 Administrative Requirements.
- B. Coordinate the Work of connection to existing sewer force mains, manholes, or other facilities with Energy Systems Group, LLC.

# PART 2 PRODUCTS

## 2.1 FORCE MAIN

- A. Ductile Iron Pipe: AWWA C151; standard cement mortar lining (AWWA C104) or Ceramic Epoxy lining (Protecto 401), outside coated.
  - 1. Pipe 3" to 12": Pressure Class 350 psi.
  - 2. Pipe 14" to 24": Pressure Class 250 psi.
  - 3. Pipe 30" to 48": Pressure Class 150 psi.

## B. Ductile Iron Fittings:

- 1. AWWA C110; 350 psi pressure rating.
- 2. Fitting to be cement mortar or ceramic epoxy lined and outside coated as for ductile iron pipe.
- C. Joints: AWWA C111, where not specifically indicated on Drawings.1. Type: Mechanical joint or push-on joint.
- D. Rubber Gaskets, Lubricants, Glands, Bolts and Nuts: AWWA C111.
- E. High Density Polyethylene Pipe and Fittings:1. Refer to Section 02514

# 2.2 POLYVINYL CHLORIDE (PVC) PIPE

A. PVC Pressure Sewer Pipe and Fittings - 12" Nominal Pipe Size and Smaller:
1. ASTM D2241, PVC 1120; SDR 26.

# 2.3 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6" wide by 4 mil thick, manufactured for direct burial service.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Sewage Force Main" in large letters.
- 2.4 BEDDING AND COVER MATERIALS
  - A. Bedding: Fill Type A2 as specified in Section 02060.

- B. Cover: As specified in Section 02300.
- C. Soil Backfill from Above Pipe to Finish Grade: As specified in Section 02300.

## 2.5 CONCRETE

A. Concrete in accordance with Section 03300.

## **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Verify project is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

## 3.2 PREPARATION

- A. Correct over excavation with coarse aggregate.
- B. Remove large stones or other hard matter capable of damaging pipe or impeding consistent backfilling or compaction.

## 3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 02300.
- B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6".
- 3.4 INSTALLATION PIPE
  - A. Install pipe, fittings, and accessories in accordance with Drawings.
  - B. Route piping in straight line.
  - C. Refer to Section 02300 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.
  - D. Connect to municipal sewer system as shown on the Drawings.
  - E. Install detectable underground utility marking tape continuous over top of pipe.

## 3.5 INSTALLATION - THRUST RESTRAINT

A. Provide pressure pipeline with restrained joints or concrete thrust blocking at bends, tees, and changes in direction; construct concrete thrust blocking in accordance with Drawings.

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## 3.6 INSTALLATION - CRADLES AND ENCASEMENT

A. Provide concrete cradles and encasement for pipeline where indicated on Drawings as specified in Section 03300.

## 3.7 FIELD QUALITY CONTROL

- A. 01700 Execution Requirements.
- B. Pressure test system to the greater of 1.25 times the working pressure at the highest point in the test segment or 1.5 times the working pressure at the point of testing, not to exceed the pipeline or valve pressure rating in the test segment. Repair leaks and re-test.
  - 1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Energy Systems Group, LLC, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
  - 2. Provide all equipment required to perform leakage and hydrostatic pressure tests including water storage means, acceptable water volume measurement means, pumps, piping, calibrated pressure gauges, and chart recorder. Upon request of Energy Systems Group, LLC, provide certification of calibration of equipment acceptable to Energy Systems Group, LLC.
  - 3. Test Pressure: The greater of 1.25 times the working pressure at the highest point in the test segment or 1.5 times the working pressure at the point of testing, not to exceed the pipeline or valve pressure rating in the test segment. Obtain working pressure from Energy Systems Group, LLC.
  - 4. Conduct hydrostatic test for at least six-hour duration.
  - 5. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, apply test pressure. At conclusion of tests, close and permanently seal resulting piping openings.
  - 6. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
  - 7. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
  - 8. Maintain test pressure within +/- 5 psi of specified test by pumping additional water in to the test segment. Accurately record test segment pressure continuously on chart recorder and volume of additional water supplied to test segment. Additional water supplied shall be designated as the leakage.
  - 9. No pipeline installation will be approved when leakage is greater than that determined by the following formula:

L	=	$SD\sqrt{P}$
		С
L	=	allowable, in gallons per hour
S	=	length of pipe tested, in feet
D	=	nominal diameter of pipe, in inches
р	=	average test pressure during leakage test, in pounds per square inch gauge
С	=	133,200

- 10. When leakage exceeds specified acceptable rate, locate source and make repairs. Repeat test until specified leakage requirements are met.
- C. Request inspection prior to and immediately after placing bedding.
- D. When tests indicate Work does not meet specified requirements, remove work, replace and retest.

## 3.8 PROTECTION OF FINISHED WORK

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

# END OF SECTION

# SECTION 02630 SITE STORM DRAINAGE

## PART 1 GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Site Storm drainage piping.
  - 2. Accessories.
  - 3. Underground pipe markers.
  - 4. Catch basins and plant area drains.
  - 5. Cleanouts.
  - 6. Bedding and cover materials.
- B. Related Sections:
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

### 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
  - 1. ASTM A74 Standard Specification for Cast Iron Soil Pipe and Fittings.
  - 2. ASTM C14 Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
  - 3. ASTM C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
  - 4. ASTM C443 Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
  - 5. ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
  - 6. ASTM C924 Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
  - 7. ASTM C969 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
  - 8. ASTM C1103 Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
  - 9. ASTM D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
  - 10. ASTM D1557 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).
  - 11. ASTM D2235 Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
  - 12. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

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- 13. ASTM D2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
- 14. ASTM D2729 Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 15. ASTM D2751 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- 16. ASTM D2855 Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- 17. ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- 18. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- 19. ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- 20. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

# 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data: Submit data indicating pipe, pipe accessories, and precast structures.
- C. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

# 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents:
  - 1. Accurately record actual locations of pipe runs, connections, catch basins, and invert elevations.
  - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

# 1.5 COORDINATION

- A. Section 01300 Administrative Requirements.
- B. Coordinate the Work with termination of storm sewer connection outside building, trenching, connection to foundation drainage system, connection to roof drain system, and connection to municipal storm sewer system.

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# **PART 2 PRODUCTS**

# 2.1 STORM DRAINAGE PIPING

- A. Concrete Pipe: ASTM C14, Class 3; unreinforced; maximum inside nominal diameter of 12 inches, bell and spigot ends.
  - 1. Fittings: Concrete.
  - 2. Joints: ASTM C443, rubber compression gasket joint.
- B. Reinforced Concrete Pipe: ASTM C76, Class III with Wall Type B; mesh reinforcement; bell and spigot ends.
  - 1. Fittings: Reinforced concrete.
  - 2. Joints: ASTM C443, rubber compression gasket.
- C. Plastic Pipe: ASTM D3034, Type PSM, Polyvinyl Chloride (PVC) material; bell and spigot style rubber ring sealed gasket joint.
  - 1. Fittings: PVC.
  - 2. Joints: ASTM F477, elastomeric gaskets.
- D. Corrugated Steel Pipe: plain end joints; helical lock seam; coated inside and out with 0.050 inch thick bituminous coating.
  - 1. Fittings: Corrugated steel.
  - 2. Joints: Corrugated steel pipe coupling bands, galvanized steel, 0.052 inches thick x 10 inches wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

## 2.2 ACCESSORIES

- A. Filter Fabric: Non-biodegradable, non-woven.
- B. Grout: Specified in Section 03300.

# 2.3 CATCH BASINS AND PLANT AREA DRAINS

- A. Catch Basin/Inlet Construction:
  - 1. Concrete block and mortar.
  - 2. Cast-in-place reinforced concrete.
  - 3. Pre-cast concrete.
  - 4. Polyethylene.
  - 5. Substitutions: Refer to Section 01600 Product Requirements.

## B. Catch Basin/Inlet Lid and Frame:

- 1. Construction: Cast iron.
- 2. Load Design: Traffic rated unless otherwise shown on Drawings.
- 3. Lid Shape: Round Junction Box Lid; Square or Rectangle Inlet Lid; As shown on Drawings.
- C. Base Pad: Cast-in-place concrete of type specified in Section 03300.

## 2.4 BEDDING AND COVER MATERIALS

- A. Bedding: Fill Type A1 as specified in Section 02060.
- B. Cover: Fill Type: Fill type A2, as specified in Section 02060.
- C. Soil Backfill from Above Pipe to Finish Grade: Soil type as specified in Section 02300

## **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

## 3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.
- B. Remove large stones or other hard matter, which could damage piping or impede consistent backfilling or compaction.

## 3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 02324 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches compacted depth.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

## 3.4 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D2321. Seal joints watertight.
- B. Place pipe on minimum 6 inch deep bed of Type A1 filter aggregate.
- C. Lay pipe to slope gradients noted on drawings with maximum variation from indicated slope of 1/8 inch in 100 feet.
- D. Install aggregate at sides of pipe.
- E. Refer to Section 02320 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

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- F. Connect to building downspouts where required.
- G. Connect to subdrainage tile system piping. Refer to Section 02620.
- H. Install site storm drainage system piping to 5 feet of building. Connect to building storm drainage system.

## 3.5 INSTALLATION - CATCH BASINS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place Cast-In-Place Concrete base pad, with provision for storm sewer pipe end sections.
- C. Level top surface of base pad; sleeve concrete shaft sections to receive storm sewer pipe sections.
- D. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.
- E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

## 3.6 FIELD QUALITY CONTROL

- A. Request inspection prior to placing aggregate cover over pipe.
- B. When tests indicate work does not meet specified requirements, remove work, replace and retest.
- C. Infiltration Test: Test in accordance with ASTM 969.

# 3.7 PROTECTION OF FINISHED WORK

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
  - 1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.
  - 2. Repair or replace pipe that is damaged or displaced from construction operations.

# END OF SECTION

# SECTION 02821 CHAIN LINK FENCES AND GATES

## PART 1 GENERAL

- 1.1 SUMMARY
  - A. Section Includes:
    - 1. Fence framework, fabric, and accessories.
    - 2. Excavation for post bases.
    - 3. Concrete foundation for posts.
    - 4. Manual gates and related hardware.
    - 5. Privacy slats.
    - 6. Twisted strand barbed wire.
    - 7. Electric operator.
  - B. Related Sections:
    - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

## 1.2 REFERENCES

- A. ASTM International:
  - 1. ASTM A121 Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.
  - 2. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 3. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 4. ASTM A392 Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
  - 5. ASTM A491 Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
  - 6. ASTM A585 Standard Specification for Aluminum-Coated Steel Barbed Wire.
  - 7. ASTM A792/A792M Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
  - 8. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
  - 9. ASTM B429 Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
  - 10. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete.
  - 11. ASTM F567 Standard Practice for Installation of Chain-Link Fence.
  - 12. ASTM F668 Standard Specification for Poly (Vinyl Chloride) (PVC)-Coated Steel Chain Link Fence Fabric.
  - 13. ASTM F900 Standard Specification for Industrial and Commercial Swing Gates.
  - 14. ASTM F934 Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
  - 15. ASTM F1043 Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.

- 16. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- 17. ASTM F1184 Standard Specification for Industrial and Commercial Horizontal Slide Gates.
- B. Chain Link Fence Manufacturers Institute:
  - 1. CLFMI Product Manual.

## 1.3 SYSTEM DESCRIPTION

- A. Fence Height: As indicated on Drawings.
- B. Line Post Spacing: At intervals not exceeding 10' on straight sections and 8' on curved sections.

## 1.4 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
- C. Product Data: Submit data on fabric, posts, accessories, fittings, and hardware.

## 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.
- B. Operation and Maintenance Data: Procedures for submittals.

# 1.6 QUALITY ASSURANCE

- A. Supply material in accordance with CLFMI Product Manual.
- B. Perform installation in accordance with ASTM F567.

# 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five (5) years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three (3) years documented experience.
- 1.8 DELIVERY, STORAGE AND HANDLING
  - A. Section 01600 Product Requirements.
  - B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.
  - C. Identify each package with manufacturer's name.

D. Store fence fabric and accessories in secure and dry place.

# **PART 2 PRODUCTS**

## 2.1 MATERIALS

- A. Framing (Steel): ASTM F1083 Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 25 ksi; coating conforming to ASTM F1043 Type A on pipe exterior and interior.
- B. Fabric Wire (Steel): ASTM A392 zinc coated wire fabric.
- C. Barbed Wire: ASTM A121 galvanized steel with galvanized steel barbs; 12-gauge thick wire, three (3) strands, four (4) points at 3" oc.
- D. Concrete: Type specified in Section 03300.

## 2.2 COMPONENTS

- A. Line Posts: 2.375" outside diameter, commercial quality.
- B. Corner and Terminal Posts: 3.0" outside diameter, commercial quality.
- C. Gate Posts: 4.0" outside diameter, commercial quality for all gates with an opening greater than 6'. Openings less than 6' shall require 3.0" outside diameter posts.
- D. Top and Brace Rail: 1.625" diameter, plain end, sleeve coupled.
- E. Gate Frame: 1.625" diameter for welded fabrication.
- F. Fabric: 2" diamond mesh interwoven wire, 11gauge thick, top salvage knuckle end closed, bottom selvage knuckle end closed.
- G. Tension Wire: 7-gauge thick steel, single strand.
- H. Tie Wire: Aluminum alloy steel wire.

## 2.3 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; aluminum.
- C. Extension Arms: Cast steel galvanized, to accommodate three (3) strands of barbed wire, single arm, sloped to 45°.
- D. Gate Hardware: Fork latch with gravity drop; Center gate stop and drop rod; Mechanical keepers; two (2) 180° gate hinges for each leaf and hardware for padlock.

- 2.4 GATES
  - A. General:
    - 1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
    - 2. Factory assemble gates.
    - 3. Design gates for operation by one person.
  - B. Swing Gates:
    - 1. Fabricate gates to permit 180<sup>o</sup> swing.
    - 2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.
  - C. Sliding Gates:
    - 1. Framing and Posts: ASTM F1184, Class 2 for internal rollers.
    - 2. Rollers for overhead and cantilever sliding gates: Bearing type. Furnish non-sealed bearings with grease fitting for periodic maintenance.
    - 3. Secure rollers to post or frame without welding.
  - D. Cantilever Sliding Gates:
    - 1. Fabricate gate leaf frames and tracks of aluminum conforming to ASTM B429 alloy 6063-T6 or as required to meet performance requirements of ASTM F1184.
    - 2. Frame Members: Minimum 2" 0.91 lb/ft aluminum tubing welded assembly forming rigid, one-piece unit.
    - 3. Install fabric securely stretched and held in center of tubing.
    - 4. Brace cantilever overhang frames with <sup>3</sup>/<sub>8</sub>" brace rods. For gate leaf sizes greater than 23', fabricate with additional lateral support rail welded adjacent to top and bottom horizontal rails.
    - 5. Provide minimum overhang for each leaf opening size as follows:

Opening	Overhang
Up to 10'-0"	6'-6"
10'-0" -14'-0"	7'-6"
14'-1" -22'-0"	10'-0"
22'-1" - 30'-0"	12'-0"

- 6. Track: Combined, integral track and rail.
- 7. Rail: Aluminum extrusion; minimum total weight of 3.72 lb/ft; designed to withstand reaction load of 2,000 lbs.
- 8. Roller Track Assembly: Two swivel type, zinc, die cast trucks having four, sealed lubricant ball bearing wheels minimum 2" diameter by 9/16" width designed for same reaction load as rail. Provide two side-rolling wheels for each gate leaf to maintain alignment of truck in track.
- 9. Fasten trucks to post brackets by minimum 7/8" diameter,  $\frac{1}{2}$ " shank ball bolts.
- 10. Provide galvanized steel guide wheel assemblies consisting of two rubber wheels of minimum 4" diameter with oil-impregnated bearings for each supporting post.
- 11. Attach guide wheel assembly to post so bottom horizontal member rolls between wheels and permitting adjustment to maintain plumb gate frames and proper alignment.

## 2.5 PRIVACY SLATS

A. Privacy Slats: Vinyl strips, flat configuration, sized to fit fence fabric, color as selected.

## 2.6 FINISHES

- A. Components and Fabric: Galvanized to ASTM A123/A123M for components; ASTM A153/A153M for hardware; ASTM A392 for fabric; 1.2 oz/sq ft coating.
- B. Components and Fabric: Vinyl coating, color in accordance with ASTM F934 as selected.
- C. Vinyl Components: color to match fabric as selected.
- D. Hardware: Galvanized to ASTM A153/A153M, 1.8 oz/sq ft coating.
- E. Accessories: Same finish as fabric.

# **PART 3 EXECUTION**

## 3.1 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Set intermediate, terminal, gate, and all other posts plumb, in concrete footings with top of footing 2" above finish grade. Slope top of concrete for water runoff.
- C. Line Post Footing Depth Below Finish Grade: ASTM F567, 2.0'.
- D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567, 3.0'.
- E. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.
- F. Install top rail through line post tops and splice with 6" long rail sleeves.
- G. Install center and bottom brace rail on corner gate leaves.
- H. Place fabric on outside of posts and rails.
- I. Do not stretch fabric until concrete foundation has cured seven (7) days.
- J. Stretch fabric between terminal posts or at intervals of 100' maximum, whichever is less.
- K. Position bottom of fabric 2" above finished grade.
- L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15" on centers.
- M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

- N. Install bottom tension wire stretched taut between terminal posts.
- O. Install support arms sloped outward and attach barbed wire, tension and secure.
- P. Support gates from gate posts. Do not attach hinged side of gate from building wall.
- Q. Install gate with fabric and barbed wire overhang to match fence. Install three (3) hinges on each gate leaf, latch, catches, drop bolt.
- R. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
- S. Connect to existing fence at existing terminal post.
- T. Install posts with 6" maximum clear opening from end posts to buildings, fences, and other structures.
- U. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.
- V. Center and align posts. Place concrete around posts and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.

# 3.2 PRIVACY SLATS

- A. Install slat inserts in diagonal pattern woven through fence fabric.
- B. Fasten slats according to manufacturer's instructions.

## 3.3 ERECTION TOLERANCES

- A. Maximum Variation from Plumb:  $\frac{1}{4}$ ".
- B. Maximum Offset from Indicated Position: 1".
- C. Minimum distance from property line: 12".

# END OF SECTION

## SECTION 02926 SEEDING AND SODDING

## PART 1 GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Preparation of subsoil
  - 2. Placing topsoil
  - 3. Fertilizing
  - 4. Seeding
  - 5. Laying Sod
  - 6. Hydroseeding
  - 7. Mulching
  - 8. Soil testing and fertilizer
  - 9. Maintenance
- B. Related Sections:
  - 1. Plans and general provisions of the Contract including General Conditions and Technical Specifications.

## 1.2 REFERENCES

- A. ASTM International:
  - 1. ASTM C602 Standard Specification for Agricultural Liming Materials.
- B. Turfgrass Producers International:
  - 1. TPI Guideline Specifications to Turfgrass Sodding.
- C. Alabama Department of Transportation (ALDOT) Standard Specifications for Highway Construction (SSHC), Latest Edition:
  - 1. Section 652 Ground Preparation, Vegetation Establishment and Mowing
  - 2. Section 654 Solid Sodding
  - 3. Section 860 Roadside Improvement Materials

## 1.3 DEFINITIONS

 Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

## 1.4 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data:
  - 1. Submit data for seed mix, fertilizer, mulch, and other accessories.
  - 2. Submit data for sod grass species, fertilizer, mulch, and other accessories.

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## 1.5 CLOSEOUT SUBMITTALS

- A. Section 01700 Execution Requirements.
- B. Operation and Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

### 1.6 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.
- B. Provide sod capable of supporting its own weight without tearing when suspended vertically by holding upper two corners. Sod must be alive or dormant when placed.

## 1.7 QUALIFICATIONS

- A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum five years of experience.
- B. Sod Producer: Company specializing in manufacturing Products specified in this section with minimum five years of experience.
- C. Installer: Company specializing in performing work of this section with minimum three years documented experience.

### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 Product Requirements.
- B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
- C. Deliver sod on pallets. Protect roots from dehydration.
- D. Do not deliver more sod than can be laid within 48 hours.
- E. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

### 1.9 COORDINATION

- A. Section 01300 Administrative Requirements.
- B. Coordinate with installation of underground sprinkler system piping and watering heads.

#### 1.10 MAINTENANCE SERVICE

A. Section 01700 - Execution Requirements.

B. Maintain seeded and/or sodded areas immediately after placement until grass is well established and exhibits vigorous growing condition.

## **PART 2 PRODUCTS**

#### 2.1 SEED PLANTING SCHEDULE

A.	Established lav	vns and residential are	as shall utilize the follo	owing schedule:

RATE – (LB/ACRE)	FROM	ТО	SEED
30	March 1	May 1	Kentucky 31
20	April 1	August 1	Common Bermuda
30	August 1	November 1	Kentucky 31 Fescue and Unhulled Bermuda
20	November 1	March 1	Annual Rye

#### B. Unimproved areas may utilize the following schedule:

Planting Dates	March 1 to May 15	May 16 to August 1	March 1 to May 15	Sept. 1 to Nov. 15
Hulled Bermuda Grass	15	20	10	-
Unhulled Bermuda	10	-	10	-
Tall Fescue	-	-	50	50
Annual Lespedeza	-	30	-	-
Reseed Crimson Clover	-	-	30	-

#### 2.2 SOD

Reference Section 654 of the ALDOT SSHC, Latest Edition. A.

#### 2.3 SOIL MATERIALS

Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant A. growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0. May be excavated from site or from offsite locations.

#### 2.4 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- B. Fertilizer: Commercial grade; recommended for type of grass used; of proportion necessary to eliminate deficiencies of topsoil to the following proportions: Nitrogen 13 percent, phosphoric acid 13 percent, soluble potash 13 percent.
- C. Water: Clean, fresh and free of substances or matter capable of inhibiting vigorous growth of grass.
- D. Erosion Fabric: SC150 BN by North American Green or Equal,
  - 1. 70% straw, 30% coconut fiber mat.
  - 2. Longevity: up to 18 months.
  - 3. Blanket covered top and bottom with 100% biodegradable woven natural fiber netting.
  - 4. Shall meet type 3.8 Specification of Erosion Control Technology Council (ECTC) and Federal Highway Administration's (FHWA) FP-03 Section 713.17.
- E. Stakes/Pegs: Softwood lumber, chisel pointed. Of sufficient size and length to anchor sod on slopes.
- F. String: Inorganic fiber.
- G. Plastic Mesh: Interwoven hexagonal plastic mesh of 2-inch size.
- H. Edging: Painted steel.

## 2.5 HARVESTING SOD

A. Reference Section 654 of the ALDOT SSHC, Latest Edition.

### 2.6 SOURCE QUALITY CONTROL

- A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH values.
- B. Provide recommendation for fertilizer and lime application rates for specified seed or sod species.
- C. Testing is not required when recent tests are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

# **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Verify prepared soil base is ready to receive the Work of this section.

### 3.2 PREPARATION OF SUBSOIL

- A. Prepare sub-soil to eliminate uneven areas and low spots.
- B. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- C. Remove foreign materials, weeds and undesirable plants and their roots.
- D. Remove contaminated subsoil.
- E. Scarify subsoil to depth of 4 inches where topsoil is to be placed.
- F. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.

# 3.3 PLACING TOPSOIL

- A. Spread topsoil to minimum depth of 4 inches over area to be seeded. Rake until smooth.
- B. Place topsoil during dry weather and on dry unfrozen subgrade.
- C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
- D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
- E. Install edging at periphery of seeded and/or sodded areas in straight lines to consistent depth.

### 3.4 FERTILIZING

- A. Apply fertilizer at application rate recommended by soil analysis.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine used to apply seed.
- D. Mix fertilizer thoroughly into upper 2 inches of topsoil.
- E. Lightly water soil to aid dissipation of fertilizer. Irrigate top level of soil uniformly.

### 3.5 SEEDING

- A. Apply seed at rate of 5.5 lbs per 1000 sq ft evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Do not sow immediately following rain, when ground is too dry, or when winds are over 12 mph.

- D. Immediately following seeding, apply mulch to thickness of 1/4 inches. Maintain clear of shrubs and trees.
- E. Apply water with fine spray immediately after each area has been mulched. Saturate top4 inches of soil.

### 3.6 LAYING SOD

- A. Moisten prepared surface immediately prior to laying sod.
- B. Lay sod within 48 hours after harvesting to prevent deterioration.
- C. Lay sod tight with no open joints and no overlapping. Stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.
- D. Lay smooth. Align with adjoining grass areas.
- E. Place top elevation of sod  $\frac{1}{2}$  inch below adjoining paving and/or curbs.
- F. On slopes 6 inches per foot and steeper, lay sod perpendicular to slope and secure every row with wooded pegs at a maximum 3 feet on center. When using "big roll", lay sod parallel to slope. Drive pegs flush with soil portion of sod.
- G. Do not place sod when temperature is lower than 40 degrees F.
- H. Prior to placing sod, on slopes exceeding 8 inches per foot or where indicated on Drawings, place mesh over topsoil. Securely anchor wire mesh in place with wood pegs sunk firmly into ground.
- I. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.
- J. After sod and soil have dried, roll sodded areas to bond sod to soil and to remove minor depressions and irregularities.

#### 3.7 MAINTENANCE OF SOD

- A. Mow grass at regular intervals to maintain a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at each mowing.
- B. Neatly trim edges and hand clip where necessary.
- C. Immediately remove clippings after mowing and trimming.
- D. Water to prevent grass and soil from drying out.
- E. Roll surface of sod to prevent irregularities.
- F. Control growth of weeds. Apply herbicides. Remedy damage resulting from improper use of herbicides.
- G. Immediately replace sod or re-seed areas showing deterioration or bare spots.

H. Protect sodded areas with warning signs or tape during maintenance period.

# 3.8 HYDROSEEDING

- A. Apply fertilizer, mulch and seeded slurry with hydraulic seeder at rate established by manufacturer.
- B. After application, apply water with fine spray immediately after each area has been hydroseeded. Saturate to 4 inches of soil and maintain moisture levels two to four inches.

### 3.9 SEED PROTECTION

- A. Cover seeded slopes where grade is 3:1 or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.
- B. Lay fabric smoothly on surface, bury top end of each section in 6-inch-deep excavated topsoil trench. Overlap edges and ends of adjacent rolls minimum 12 inches. Backfill trench and rake smooth, level with adjacent soil.
- C. Secure outside edges and overlaps at 36-inch intervals with stakes.
- D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
- E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

### END OF SECTION

# SECTION 03200 CONCRETE REINFORCEMENT

# PART 1 GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Reinforcing bars.
  - 2. Welded wire fabric.
  - 3. Reinforcement accessories.
- B. Related Sections:
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

# 1.2 REFERENCES

- A. American Concrete Institute:
  - 1. ACI 301 Specifications for Structural Concrete.
  - 2. ACI 318 Building Code Requirements for Structural Concrete.
  - 3. ACI SP-66 ACI Detailing Manual.
- B. ASTM International:
  - 1. ASTM A82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
  - 2. ASTM A184/A184M Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
  - 3. ASTM A497 Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
  - 4. ASTM A615/A615M Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 5. ASTM A641/A641M Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
  - 6. ASTM A704/A704M Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
  - 7. ASTM A706/A706M Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
  - 8. ASTM A767/A767M Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
  - 9. ASTM A775/A775M Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
  - 10. ASTM A884/A884M Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
  - 11. ASTM A934/A934M Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
  - 12. ASTM A996/A996M Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
  - 13. ASTM D3963/D3963M Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars.

C. American Welding Society:

- 1. AWS D1.4 Structural Welding Code Reinforcing Steel.
- D. Concrete Reinforcing Steel Institute:
  - 1. CRSI Manual of Standard Practice.
  - 2. CRSI Placing Reinforcing Bars.

# 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules.
- C. Certificates: Submit AWS qualification certificate for welders employed on the Work.
- D. Submit certified copies of mill test report of reinforcement materials analysis.

# 1.4 QUALITY ASSURANCE

A. Perform Work in accordance with CRSI - Manual of Standard Practice and ACI 301.

# 1.5 QUALIFICATIONS

A. Welders: AWS qualified within previous 12 months.

### 1.6 COORDINATION

- A. Section 01300 Administrative Requirements.
- B. Coordinate with placement of formwork, formed openings and other Work.

# PART 2 PRODUCTS

- 2.1 REINFORCEMENT
  - A. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade; deformed billet steel bars, unfinished.
  - B. Reinforcing Steel Plain Bar and Rod Mats: ASTM A704/A704M, ASTM A615/A615M, Grade 60; steel bars or rods, unfinished.
  - C. Stirrups Steel: ASTM A82, unfinished.
  - D. Welded Steel Wire Fabric: ASTM A497 Deformed Type; in flat sheets or coiled rolls; galvanized finish.

### 2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type.

- B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor retarder puncture.
- C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic tipped steel type; size and shape to meet Project conditions.
- D. Reinforcing Splicing Devices: Exothermic welding type; full tension and compression; sized to fit joined reinforcing.

### 2.3 FABRICATION

A. Fabricate concrete reinforcement in accordance with CRSI Manual of Practice.

## **PART 3 EXECUTION**

## 3.1 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor retarder.
- C. Accommodate placement of formed openings.
- D. Maintain concrete cover around reinforcement as follows:

Item	<u>Coverage</u>
Concrete in contact with soil	3 inches
Exterior concrete	
Bars larger than No. 5	2 inches
No. 5 bars and smaller	1-1/2 inches
Interior concrete	
Bars larger than No. 11	1-1/2 inches
No. 11 bars and smaller	3/4 inch
Stirrups	1-1/2 inches

- E. Conform to applicable code for all other conditions.
- F. Splice reinforcing in accordance with splicing device manufacturer's instructions.

G. Lap length shall be as follows unless otherwise noted on the Drawings:

Bar Size	Lap Length
No. 3	12 inches
No. 4	12 inches
No. 5	15 inches
No. 6	18 inches
No. 7	24 inches
No. 8	30 inches

# 3.2 FIELD QUALITY CONTROL

A. Section 01700 - Execution Requirements.

# END OF SECTION

# SECTION 03300 CAST-IN-PLACE CONCRETE

# PART 1 GENERAL

### 1.1 SUMMARY

- A. Section includes:
  - 1. Cast-in-place concrete.
  - 2. Formwork.
  - 3. Reinforcing.
  - 4. Mix Design.
  - 5. Control, expansion and contraction joint devices.
  - 6. Placement procedures.
  - 7. Finishes.
  - 8. Testing requirements.
- B. Related Documents:
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

# 1.2 REFERENCES

- A. American Concrete Institute:
  - 1. ACI 301 Specifications for Structural Concrete.
  - 2. ACI 305 Hot Weather Concreting.
  - 3. ACI 306.1 Standard Specification for Cold Weather Concreting.
  - 4. ACI 318 Building Code Requirements for Structural Concrete.
- B. ASTM International:
  - 1. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  - 2. ASTM C33 Standard Specification for Concrete Aggregates.
  - 3. ASTM C94 Standard Specification for Ready-Mixed Concrete.
  - 4. ASTM C150 Standard Specification for Portland Cement.
  - 5. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete.
  - 6. ASTM C330 Standard Specification for Lightweight Aggregates for Structural Concrete.
  - 7. ASTM C494 Standard Specification for Chemical Admixtures for Concrete.
  - 8. ASTM C595 Standard Specification for Blended Hydraulic Cements.
  - 9. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
  - 10. ASTM C1017 Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
  - 11. ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
  - 12. ASTM C1116 Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
  - 13. ASTM D994 Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

- 14. ASTM D1190 Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type.
- 15. ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- 16. ASTM D1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- 17. ASTM E1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
- 18. ASTM E1745 Standard Specification for Plastic Water Vapor Retarders Usedin Contact with Soil or Granular Fill under Concrete Slabs.

### 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Product Data: Submit data on joint devices, attachment accessories, and admixtures.
- C. Design Data:
  - 1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
    - a. Hot and cold weather concrete work.
    - b. Air entrained concrete work.
  - 2. Identify mix ingredients and proportions, including admixtures.
- D. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent Work.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Section 01700 Execution Requirements.
- B. Project Record Documents: Accurately record actual locations of embedded utilities and components concealed from view in finished construction.

#### 1.5 QUALITY CONTROL / QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301.
- B. Maintain one copy of each document on site.
- C. Acquire cement and aggregate from one source for Work.
- D. Conform to ACI 305 when concreting during hot weather.
- E. Conform to ACI 306.1 when concreting during cold weather.
- F. Concrete Testing Service: Contractor shall employ a qualified company to provide quality assurance testing during construction. Contractor is responsible to provide suitable quality

control of materials, procedures, and of the mix design process to ensure the concrete conforms to the project plans and specifications. Submit quality control plan and proposed concrete mix designs to ESG prior to concrete placement.

#### 1.6 COORDINATION

- A. Section 01300 Administrative Requirements.
- B. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

### 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.
  - 1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form", Class 1.
  - 2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class 1, Exterior Grade or better, mill-oiled and edge sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for a tight fit.
- C. Form Coatings: Provide commercial formulation form coating compounds with a maximum VOC of 350 mg/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Form Ties: Factory fabricated, adjustable length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal.

#### 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615, Grade 60, deformed.
- B. Welded Wire Fabric: ASTM A185 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 plastic protected (CRSI, class 1) or stainless steel protected (CRSI, class 2).

- 3. For sand blasted or intentionally roughened concrete surfaces, provide supports of stainless steel (CRSI, class 2).
- D. Reinforcing Bars to be Welded: ASTM A706, "Specifications for Low Alloy Steel Deformed Bars for Concrete Reinforcement".
- E. Bar and Rod Mats: ASTM A184 "Specifications for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement".
- F. Threaded Dowels: Continuous Threaded high-strength steel bars. Provide inserts compatible with dowels, designed for ultimate pull-out force indicated on the Drawings.
- G. Mechanical Splices: Equal to "Cadweld Rebar Splices", as manufactured by Erico Products, Inc., "C" Series, for developing 125% of minimum ASTM specified yield strengths, unless otherwise noted on Drawings.
- H. Steel Shapes, Plates and Rods: Conform to ASTM A36 "Specifications for Structural Steel".
- I. Do not weld reinforcing steel unless specifically noted on Drawings. If welding is shown, conform to latest revision of AWS D12.1, "Reinforcing Steel Welding Code of the American Welding Society". Perform all welding with certified welders qualified per AWS.

### 2.3 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I Normal, Portland type for all applications other than structures used in conjunction with wastewater projects. All wastewater related structures shall use Type V Sulfate Resistant, Portland Cement.
- B. Fly Ash: ASTM C618, Type C or Type F.
  1. Limit use of fly ash to not exceed 20 percent of cement content by weight.
- C. Normal Weight Aggregate: ASTM C33 and as herein specified. Provide aggregates from a single source for exposed concrete.
  - 1. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
- D. Water: Clean, potable.
- E. Admixtures, General: Provide admixtures for concrete that contain not more than 0.1 percent chloride ions.
- F. Air-Entraining Admixtures: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
- G. Water Reducing Admixtures: ASTM C494, Type A.
- H. High Range Water Reducing Admixtures (Super Plasticizer): ASTM C494, Type F or Type G.

- I. Water Reducing, Non-Chloride Accelerating Admixture: ASTM C494, Type E.
- J. Water Reducing, Retarding Admixture: ASTM C494, Type D.
- K. All admixtures shall be supplied by the same manufacturer.

## 2.4 ACCESSORIES

- A. Vapor Retarder: ASTM E1745 Class A; 6 mil thick fabric-reinforced plastic film, 0.03 perms; rated for below grade application. Furnish joint tape recommended by manufacturer.
- B. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.
- C. Concrete Reinforcing Fibers: ASTM C1116, high strength industrial-grade fibers specifically engineered for secondary reinforcement of concrete. Tensile strength 130 ksi; toughness 15 ksi; 3/4 inch long fibers, 34 million/lb fiber count.
- D. Waterstops: Provide flat, dumbbell-type or centerbulb-type waterstops at construction joints and other joints as shown on the Drawings.
- E. Granular Base: Evenly graded mixture of fine and course aggregates to provide, when compacted, a smooth and even surface below slabs on grade.
- F. Sand Cushion: Clean, manufactured or natural sand.
- G. Nonslip Aggregate Finish: Provide fused aluminum oxide granules or crushed emery as abrasive aggregate for nonslip finish. Material shall be factory graded, rustproof, non-glazing, and is unaffected by freezing, moisture, and cleaning materials.
- H. 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 ESG.
- I. Bonding Compound: Polyvinyl acetate or acrylic base.
- J. Epoxy Adhesive: ASTM C881, two-component material suitable on dry or damp surfaces. Provide material type, grade and class to suit project requirements.

## 2.5 JOINT DEVICES AND FILLER MATERIALS

- A. Joint Filler Type A: ASTM D994; Asphalt impregnated fiberboard or felt, thickness as indicated on the drawings; tongue and groove profile.
- B. Joint Filler Type B: ASTM D1751; cellular bonded fiber material, non-extruding, resiliency recovery of 70 percent if not compressed more than 50 percent of original thickness.

- C. Construction Joint Devices: Integral galvanized steel, formed to tongue and groove profile, with removable top strip exposing sealant trough, knockout holes spaced at 6 inches, ribbed steel spikes with tongue to fit top screed edge.
- D. Expansion and Contraction Joint Devices: ASTM B221 alloy, extruded aluminum; resilient neoprene filler strip with Shore A hardness of 35 to permit plus or minus 25 percent joint movement with full recovery; extruded aluminum of longest manufactured length at each location, flush mounted.
- E. Joint Sealant: ASTM C920, Type S; single component, self leveling, premium grade polyurethane sealant, equal to Sikaflex-1C SL.

### 2.6 CONCRETE MIX

- A. Mix concrete in accordance with ACI 301. Deliver concrete in accordance with ASTM C94.
- B. Select proportions for normal weight concrete in accordance with ACI 301 trial mixtures.
- C. Provide concrete to the following criteria:

Unit Measurement		
Compressive Strength (f'c at 28 day)	As Indicated in Plans	
Aggregate Size (maximum)	1 inch	
Air Entrainment	4 to 6 percent	
Slump	3 to 5 inches	

- D. Prepare design mixes for each type and strength of concrete by either laboratory trial mixture or field experience methods as specified in ACI 318-89 Section 5.3.
- E. Mix design based on historical performances in accordance with ACI 318-89 Section 5.3, may be provided by a qualified concrete supplier or precast concrete manufacturer for concrete designs. Mix design shall be certified by an independent testing laboratory.
- F. All concrete mix designs shall include the following information:
  - 1. Proportions of cement, fine and course aggregates and water.
  - 2. Water/cement ratio, design strength, slump and air content.
  - 3. Type and source of cement and aggregates.
  - 4. Type and dosage of all admixtures.
  - 5. Any special characteristics of the mix which require precautions in the mixing, placing or finishing techniques to achieve the finished product specified.
- G. ESG to review and approve mix designs prior to start of concrete production.
- H. Design mixes to provide normal weight concrete.
- I. 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 ESG.

J. All mix design information and data shall not be older than 18 months from the date of the submittal.

# 2.7 ADMIXTURES

- A. Use water reducing admixture or high range water reducing admixture (superplasticizer) in concrete as required for placement and workability.
- B. Use high range water reducing admixture in pumped concrete, concrete required to be watertight, and concrete with water/cement ratio below 0.50.
- C. Use nonchloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F.
- D. Use air-entraining admixture in concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete having an air content of 4% to 6% at the point of placement.
- E. Use admixtures for water reduction and set control in strict compliance with manufacturer's directions.
- F. Temperature Limit: Do not place concrete if the concrete temperature exceeds 90°F or the ambient temperature is 40°F or less and falling.
- G. Slump Limit: Proportion and design mixes to result in concrete slump of 3 to 5 inches at point of placement.

### 2.8 CONCRETE MIXING

- A. Provide batch ticket for each batch used on the project. Batch ticket must indicate project name, contractor's name, date, mix type, mix time, batch time, quantity, and amount of water introduced.
- B. Ready-Mix Concrete: Comply with requirements of ASTM C94, and as specified.
  - 1. Addition of water to batch for material with insufficient slump will be permitted in accordance with ACI 301.
  - 2. When air temperature is between 85 degrees F. and 90 degrees F., reduce mixing and delivery time from 1-1/2 hours to 75 minutes. When air temperature exceeds 90 degrees F. reduce mixing and delivery time to 60 minutes.
  - 3. Concrete shall only be placed when the air temperature is above 40 degrees F. and rising.

# **PART 3 EXECUTION**

- 3.1 EXAMINATION
  - A. Section 01300 Administrative Requirements.
  - B. Verify requirements for concrete cover over reinforcement.

C. Verify anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

# 3.2 FORMS

- A. General: Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads.
- B. Maintain formwork construction tolerances complying with ACI 301 Table 4.3.1.
- C. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, chamfers, blocking, bulkheads, anchorages, and other features required in work.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.
- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar.
- F. Chamfer exposed edges and corners as indicated using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items.
- H. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed.

### 3.3 VAPOR BARRIER

- A. General: Following leveling and tamping of granular base for slabs-on-grade, place vapor barrier sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6 inches and seal vapor barrier joints with manufacturer's recommended mastic and pressure-sensitive tape.
- C. After placement of vapor barrier, cover with sand cushion and compact to depth as shown on Drawings.

# 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 herein specified.

- 1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- 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 required.
- D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### 3.5 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls, slabs, beams and between walls and footings.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops according to manufacturer's printed instructions.
- F. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
- G. Contraction (Control) Joints in Slabs-On-Grade: Construct contraction joints in slabs-onground to form panels of patterns as shown. Use saw cuts 1/8 inch wide by 1/4 slab depth or approved inserts, unless otherwise indicated. Make saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregates.
  - 1. With prior approval from ESG contraction joints may be formed 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. Refer to drawings for scoring pattern as shown. If joint pattern not shown, provide

joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible.

#### 3.6 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.
- B. Coat contact surfaces of forms with an approved, noresidual, low-VOC, form-coating compound before reinforcement is placed. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- C. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

### 3.7 CONCRETE PLACEMENT

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

- prior to beginning finishing operations
- 3. Maintain reinforcing in proper position during concrete placement.
- H. Cold-Weather Placing: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When placing concrete in cold weather, 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.
  - 2. Concrete shall only be placed when the air temperature is above 40 degrees F. and rising.
  - 3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 4. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- I. Hot-Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI305 and as herein specified.
  - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
  - 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
  - 3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
  - 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, when acceptable to ESG.

# 3.8 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with the holes and defective areas repaired and patched. Fins and other projections exceeding 1/4 inch in height shall be rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaced, which have received smooth form finish treatment, not later than one day after form removal.

1. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.

- D. Grout-Cleaned Finish: Provide grout-cleaned finish to scheduled concrete surfaces that have received smooth form finish treatment.
  - 1. Combine one part Portland dement to 1-1/2 parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to consistency of thick paint. Blend standard Portland cement and white Portland cement, amount determined by trial patches, so that final color of dry grout will match adjacent surfaces.
  - 2. Thoroughly wet concrete surfaces apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.
- E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
- F. Unless otherwise noted on the Drawings, all exposed surfaces shall receive a smooth rubbed finish.

# 3.9 SLAB FINISHES

- A. After placing slabs, plane surface to tolerances for floor flatness (Ff) of 15 and floor levelness (Fl) of 13. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushed, brooms, or rakes, as required.
- B. Float Finish: Apply float finish to slab surfaces to receive trowel finish and other finishes as hereinafter specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and as otherwise indicated.
  - 1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand floating if area is small or inaccessibly to power units. Check and level surface plane to tolerances of Ff 18-Fl 15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- C. Trowel Finish: Apply trowel finish to slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
  - 1. After floating, begin first trowel finish operation using a power-driven trowel. Being final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 20-Fl 17. Grind smooth surface defects that would telegraph through applied floor covering system.

- D. Nonslip Broom Finish: Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with ESG before application.
- E. Nonslip Aggregate Finish: Apply nonslip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and elsewhere as indicated.
- F. After completion of float finishing and before starting trowel finish, uniformly spread 25 lbs. of dampened nonslip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.
- G. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose nonslip aggregate.

### 3.10 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. 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: Perform curing of concrete by curing and sealing compound, b moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
- D. Provide moisture curing by following methods.
  - 1. Keep concrete surface continuously wet by covering with water.
  - 2. Use continuous water-fog spray.
  - 3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.

### 3.11 REMOVAL OF FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 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 until approved by ESG's structural engineer.
- 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.

#### 3.12 CONCRETE SURFACE REPAIRS

- A. General: No surface shall be patched or repaired until ESG has reviewed the defective condition and approved the Contractor's submitted repair and/or patching materials and procedures.
- B. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to ESG.
  - 1. Cut of honeycomb, rock pockets, and 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 of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.
  - 2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- C. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of ESG. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.
  - 1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- D. Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.
  - 1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01 in wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
  - 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
  - 3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to ESG.
  - 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch

in diameter, when acceptable to ESG by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

- E. Repair isolated random cracks and single holes not over 1 inch in diameter by dry-pack method when acceptable to ESG. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
- F. Perform structural repairs with prior approval of ESG's Structural Engineer for method and procedure, using specified epoxy adhesive and mortar.
- G. Repair methods not specified above may be used, subject to acceptance of ESG.

# 3.13 FIELD QUALITY ASSURANCE, CONTROL AND TESTING DURING CONSTRUCTION

- A. General: Energy System's Group, LLC may employ the Engineer or another professional firm to perform quality assurance testing during construction. The Contractor will notify ESG at least 72 hours prior to requiring tests. The Contractor is responsible to provide equipment to allow sampling and testing of the concrete at the point of placement.
- B. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94. Perform the following tests.
  - 1. Slump: ASTM C 143; one test at point of placement for each set of compression test specimens; additional tests when concrete properties appear to have changed.
  - 2. Air Content: ASTM C 173 (volumetric method for lightweight or normal weight concrete) or ASTM C 231 (pressure method for normal weight concrete); one test at point of placement for each set of compression test specimens; additional tests when concrete properties appear to have changed.
  - 3. Concrete Temperature: ASTM C 1064; test hourly when air temperature is 40°F and below or 80°F and above, and each time a set of compression test specimens is made.
  - 4. Compression Test Specimen: ASTM C 31; one set of 4 cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
  - 5. Compressive Strength Tests: ASTM C 39; one set for each 50 cubic yards or fraction thereof for 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.
  - 6. When frequency of testing will provide fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

- C. Test results will be reported in writing to ESG, 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 supplier and testing agency, concrete type and class, location of concrete placed in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but **shall not** be used as the sole basis for acceptance or rejection.
- E. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by ESG. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.
- F. Quality Assurance consisting of testing and observation of a limited sampling of construction materials will be provided by Energy System's Group, LLC for acceptance purposes. Passing test results are not a warranty, guarantee, or certification by the testing agency, Engineer, or Energy System's Group, LLC that all work was performed in conformance with the plans and specifications. Therefore, the Contractor should not rely solely on test results generated by the quality assurance process as an indication of the suitability of the construction.
- G. It is entirely the Contractor's responsibility to perform quality control as necessary to construct the project in conformance with the plans and specifications. Deviations from the plans and specifications, whether identified during construction or following the completion of construction, must be corrected by the Contractor at no cost to Energy System's Group, LLC.

### 3.14 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by ESG.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of ESG for each individual area.

# END OF SECTION

# SECTION 11217 PACKAGED LIFT STATION

## PART 1 GENERAL

### 1.1 SUMMARY

- A. Description:
  - 1. The General Contractor shall furnish, install, test and place in satisfactory operation, as shown on the Plans and specified, two (2) wet-pit, non-clog submersible pump(s) and related accessories in a new prefabricated fiberglass lift station, controls, and all appurtenances, accessories and spare parts as will be required to produce a complete and workable installation.
- B. Related Sections:
  - 1. Drawings and general provisions of the Contract including General and Supplemental General Conditions, and Technical Specifications.

# 1.2 REFERENCES

- A. American National Standards Institute (ANSI) and American Water Works Association (AWWA)
  - 1. ANSI B16.1 Cast iron pipe flanges and flanged fittings.
  - 2. ANSI/AWWA C115/A21.51 Cast/ductile iron pipe with threaded flanges
  - 3. ANSI 253.1 Safety Color Code for Marking Physical Hazards
  - 4. ANSI B40.1 Gauges, Pressure and Vacuum
  - 5. AWWA C508 Single Swing Check Valves
  - 6. AWWA C504 Plug Valves
- B. American Society for Testing and Materials (ASTM)
  - 1. ASTM A48 Gray Iron Castings
  - 2. ASTM A126 Valves, Flanges, and Pipe Fittings
  - 3. ASTM A307 Carbon Steel Bolts and Studs
  - 4. ASTM F593 Stainless Steel Bolts, Hex Cap Screws, and Studs
  - 5. ASTM A36 Structural Steel
- C. Institute of Electrical and Electronics Engineers (IEEE)
  - 1. ANSI/IEEE Std. 100 Standard Dictionary of Electrical Terms
  - 2. ANSI/IEEE Std. 112 Test Procedure for Polyphase Induction Motors
  - 3. IEEE Std. 242 Protection of Industrial and Control Power Systems
- D. National Electric Code (NEC), National Electrical Manufacturers Association (NEMA)
  - 1. NEC National Electric Code
  - 2. NEC 701 National Electric Code article 701
  - 3. NEMA Std. MG1 Motors and Generators

### 1.3 SUBMITTALS

- A. Section 01330 Submittal Procedures.
- B. Shop Drawings:

- 1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
- 2. Include manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.
- C. Product Data: Submit information concerning materials of construction and fabrication.
- D. Manufacturer's Installation Instructions: Submit detailed instructions on installation requirements including storage and handling procedures, anchoring, and layout.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- F. Manufacturer's Field Reports: Certify equipment has been installed in accordance with manufacturer's instruction.
- G. Other Information: Technical manuals, parts list, warranty information, equipment storage recommendations.

# 1.4 CLOSEOUT SUBMITTALS

- A. Section 01700 Execution Requirements.
- B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.
- C. Operation and Maintenance Data:
  - 1. Submit five (5) copies of operation and maintenance data in three-ring hard-backed binder, with cover indicating Energy Systems Group, LLC (ESG) specified station name.
  - 2. Submit maintenance instructions for equipment and accessories.
  - 3. Furnish list of equipment and tools needed to maintain and calibrate equipment.
  - 4. Include detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, electrical motor data, installation and anchoring requirements, fasteners, recommended spare parts list, equipment start-up documentation.
  - 5. Motor performance chart exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. Data to include motor starting and no-load characteristics.

# 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with Energy Systems Group, LLC's standard.
- B. Maintain one copy of each document on site.

### 1.6 QUALIFICATIONS

A. The manufacturer shall have a minimum of five (5) installations of the exact combination of pump and motor model proposed to be furnished for this project. Installations must be in operation for a minimum of five (5) years and shall list the pump model, motor model

and horsepower, date of installation, duty point, and contact information including telephone number. A list of these installations shall be furnished to ESG with submittals.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 Product Requirements.
- B. Inspect for damage.
- C. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces. Store and handle products in accordance with manufacturer's recommendations.

#### 1.8 SEQUENCING

- A. Section 01100 Summary.
- B. Sequence work to prevent interference with Energy Systems Group, LLC's operation.

#### 1.9 SCHEDULING

- A. Section 01300 Administrative Requirements.
- B. Schedule work to install pumps in wet well prior to connecting piping work.

#### 1.10 COORDINATION

- A. Section 01300 Administrative Requirements.
- B. Coordinate installation and start-up with Energy Systems Group, LLC and Engineer.

#### 1.11 MAINTENANCE MATERIALS

- A. Section 01700 Execution Requirements.
- B. Furnish one (1) complete rebuild kit for each pump.
- C. Furnish special tools required for equipment maintenance.

# **PART 2 PRODUCTS**

- 2.1 STATION ENCLOSURE
  - A. Tank Construction
    - 1. All tank vessels shall be fabricated of fiberglass suitable for condensate catch basins. All walls shall be continuous and watertight and shall be supported by reinforcing members where required. Fabrication and erection shall conform to the appropriate requirements. Connections shall conform to the requirements of the American Plumbing Code and shall develop the full strength of the member.

- 2. Materials of construction used in the tank vessel shall be commercial grade and shall either be evaluated as a laminate by test or determined by previous service to be acceptable for the environment.
- 3. The resins used shall not contain fillers except as required for viscosity control. Up to five percent by weight of thixotropic agent, which will not interfere with visual inspection, may be added to the resin for viscosity control. Resins may contain pigments and dyes by agreement between the fabricator and the purchaser, recognizing that such additions may interfere with visual inspection of laminate quality.
- 4. The reinforcing material shall be a commercial grade of glass fiber having a coupling agent, which will provide a suitable bond between the glass reinforcing and the resin.
- 5. The tank vessel shall be of the laminated type construction. The laminate shall consist of an inner surface, an interior layer, and an exterior layer of laminate body.
- 6. The inner surface shall be free of cracks and crazing with a smooth finish and with an average of not over two pits per square foot, providing the pits are less than 1/8" in diameter and not over 1/32" deep and are covered with sufficient resin to avoid exposure of inner surface fabric. Same waviness is permissible as long as the surface is smooth and free of pits. Between 0.010 and 0.020" of resin-rich surface shall be provided. This will be a gel-cote surface.
- 7. A minimum of 0.100" of the laminate next to the inner surface shall be reinforced with not less than 20% or more than 30% by weight of non-continuous glass strands having fiber lengths from 0.5 to 2.0".
- 8. The exterior layer of body of laminate shall be of construction suitable for the service intended and contain sufficient glass by weight to provide aggregate strength necessary to meet the tensile and flexural requirements. Where separate layers such as mat, cloth or woven roving are used, all layers shall be lapped a minimum of one inch. Laps shall be staggered as much as possible. If woven roving of cloth is used, a layer of chopped strand glass shall be placed as alternate layers. The exterior surface shall be relatively smooth with no exposed fibers of sharp projections. Handwork finished is acceptable, but enough resin shall be present to prevent fiber show.
- 9. SURFACE HARDNESS The laminate shall have a Barcol hardness of at least 90% of the resin manufacturer's minimum specified hardness for the cured resin when tested. This applies to both interior and exterior surfaces.
- 10. APPEARANCE The finished laminate shall be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, air bubbles, pin holes, pimples, and delamination.
- B. Anti-Floatation Flange
  - 1. When the basin is constructed an anti-floatation flange is applied; pump-mounting studs are located in the basin bottom. Studs are stainless steel and mounted in a 1/4" steel plate. The plate is drilled and tapped 3/8" for studs to thread into. Studs are welded on the bottom of the plate. The stud plate is fastened in place and another laminate of fiberglass is molded to the bottom to complete the basin construction.
- C. Wetwell Chamber
  - 1. A wetwell chamber shall be provided and shall be of the sufficient capacity to provide an efficient pumping operation. The wetwell shall be equipped with access

lid, air vent and bug screen, submersible pump system, inlet and outlet connections, electrical control panel and level sensors.

- 2. The access lid and frame assembly shall be provided in the top of the wetwell structure. The access door shall have means of locking and a latch to hold the door in the open position.
- 3. Air vent and bug screen shall be constructed of the configuration shown on the plans and shall be fitted with manufactured screen to prevent intrusion of insects or birds into the vent piping.
- 4. The structure dimensions of the wetwell chamber shall be as shown on the Drawings.

### 2.2 CONDENSATE PUMPS

- A. Manufacturers:
  - 1. KSB
  - 2. Ebara
  - 3. ABS
  - 4. Sulzer
  - 5. Substitutions: Section 01600 Product Requirements
- B. General:
  - 1. The condensate pumping units shall be vertical, non-clogging, centrifugal sewage pumps with bottom inlet and side discharge. The pumps shall be direct driven by integral squirrel cage, electric induction motors. Each pump shall include motor, bearings, quick removal system, anchor bolts and all accessories specified herein.
  - 2. Pump Materials of Construction: Compatible with condensate.
  - 3. Pump and motor produced by same manufacturer.
- C. Power Cable:
  - 1. Minimum 50' of submersible cable (SUBCAB) suitable for submersible pump applications, sized in accordance with NEC and ICEA standards and meeting P-MSHA approval.
- D. Lifting Cable:
  - 1. Minimum 30' per pump of stainless-steel cable capable of lifting loads 5 (five) times greater than actual pumping unit weight.
- E. Pump Design:
  - 1. Pump designed to automatically and firmly connect to the discharge connection, guided by no less than two guide bars extending from top of station to discharge connection.
  - 2. Provide intermediate guide brackets for installations greater than 20'.
  - 3. Sealing of pumping unit to discharge elbow accomplished by machined metal-tometal watertight contact.
- F. Pump Construction:
  - 1. Major pump components shall be grey cast iron ASTM A-48, Class 35, with smooth surfaces free of blow holes or other irregularities.
  - 2. Exposed nuts or bolts of stainless-steel construction.

- 3. Factory applied spray coating of acrylic dispersion zinc phosphate primer with polyester resin paint finish on exterior pump surfaces coming into contact with sewage.
- 4. Metal to metal contact sealing design on machined surfaces.
- 5. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings.
- G. Cooling System:
  - 1. Integral, closed-loop motor cooling system encircling stator housing providing for dissipation of motor heat, consisting of integral impeller driven by pump shaft.
  - 2. Cooling system to include one (1) fill port and one (1) drain port integral to the cooling jacket.
  - 3. Cooling system to provide continuous pump operation at liquid or ambient temperatures up to 104°F.
- H. Cable Entry Seal:
  - 1. Dual cylindrical elastomer grommets, flanked by washers, all having close tolerance fit against cable outside diameter and entry inside diameter.
  - 2. Grommets compressed by cable entry unit, providing strain relief function.
  - 3. Cable entry junction chamber and motor sealed from each other.
- I. Motor:
  - 1. NEMA B, induction type with squirrel cage rotor, shell type design, housed in air-filled watertight chamber.
  - 2. Stator windings insulated with moisture resistant Class F insulation rated for 180°C.
  - 3. Stator insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in winding fill factor of no less than 95%.
  - 4. Inverter duty rated in accordance with NEMA MGA, Part 31.
  - 5. Stator heat shrink fitted into cast iron stator housing.
  - 6. Motor designed for continuous duty while handling pumped media up to 104°F.
  - 7. Motor designed to withstand no less than 15 evenly spaced starts per hour.
  - 8. Rotor bars and short-circuit rings constructed of aluminum.
  - 9. Three thermal switches embedded in stator end coils, one per phase winding to monitor stator temperature.
  - 10. Junction chamber sealed from stator housing containing a terminal board for connection of power and pilot sensor cables using threaded compression type terminals.
  - 11. Motor service factor of 1.15.
  - 12. Motor voltage tolerance of +/-10%.
  - 13. Motor designed for continuous operation up to 40°C ambient temperature with NEMA Class B maximum operating temperature rise of 80°C.
  - 14. Motor horsepower sufficient for pump to be non-overloading throughout entire performance curve, from shut-off to run-out.
  - 15. Motor and cable capable of continuous submergence underwater without loss of watertight integrity up to and including to a depth of 65'.
- J. Bearings:
  - 1. Integral pump/motor shaft to rotate on two (2) bearings.

- 2. Motor bearings sealed and permanently grease lubricated with high temperature grease.
- 3. Two row angular contact ball bearing on upper motor bearing.
- 4. Two row angular contact ball bearing on lower motor bearing designed to handle both thrust and radial forces.
- 5. Minimum  $L_{10}$  bearing life of 50,000 hours at any useable point on the pump curve.
- K. Mechanical Seals:
  - 1. Provide pumps with positively driven, dual, tandem mechanical shaft seal system consisting of two seal sets, each with independent spring.
  - 2. Lower primary seal, located between pump and seal chamber, containing one stationary and one positively driven rotating corrosion resistant tungsten-carbide ring.
  - 3. Upper secondary seal, located between seal chamber and seal inspection chamber, containing one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring.
  - 4. Provide pumps with lubricant chamber for shaft sealing system. Lubricant chamber designed to prevent overfilling and providing capacity for lubricant expansion. Lubricant chamber designed with one drain plug and one inspection plug accessible from exterior of motor unit.
  - 5. Separate seal leak chamber capable of capturing leakage occurring past upper secondary mechanical seal prior to leakage entry into motor stator housing. Leakage chamber provided with float type switch that will signal if chamber reaches 50% capacity.
- L. Pump/Motor Shaft:
  - 1. Single piece unit, ASTM A479 S43100-T stainless steel.
- M. Impeller:
  - 1. ASTM A-48 Class 35 grey cast iron, dynamically balanced, non-clog design.
  - 2. Mechanically self-cleaned automatically upon each rotation as passing across spiral groove located on volute suction.
  - 3. Impeller leading edges hardened to Rc 45.
  - 4. Impellers shall be key driven and securely held to the shaft by a streamlined impeller washer and bolt assembly specifically designed to reduce friction in the suction eye of the impeller. The arrangement shall be such that the impeller cannot unscrew or be loosened by torque from either forward or reverse rotation.
- N. Volute:
  - 1. ASTM A-48, Class 35 single piece grey cast iron, with smooth passages of sufficient size to pass any solids entering impeller.
  - 2. Volute to have integral spiral-shaped, sharp-edged grooves cast into suction cover.
  - 3. Internal volute bottom shall provide effective sealing between the impeller and volute. All mating surfaces requiring a watertight seal shall be machined and fitted with Buna-n O-rings. Paper gaskets are not acceptable.
- O. Discharge Base Elbow:
  - 1. ASTM A-48, Class 35 grey cast iron, ANSI class 125-pound flange, coated with coal tar epoxy.

- 2. The discharge base elbow shall be provided to support the full weight of the submersible pump in the installation and provide a leak proof connection in which the pump coupling mates using a conformed Buna N Seal which is held in place by the combined weight of the cantilevered pump and motor. The hydraulic pressure generated while the pump is in operation also aids the sealing.
- P. Guide Rails:
  - 1. 304 stainless steel guide rails supported by upper and intermediate brackets of 316 stainless steel shall guide each pump.
  - 2. The guide rails shall consist of standard dimension schedule 40 piping with a 2" diameter as shown on the drawings. The guide rails shall be supported by a 316 upper guide rail bracket that will be mounted in the opening of the access cover to support and guide the pump/motor into and out of the wet well. Intermediate guide rail brackets will be provided for all installations deeper than 20'.
- Q. Operating Characteristics:

Pumping units as specified herein include units installed at the location(s) as shown on the Drawings. The design characteristics are summarized as follows:

I ump Station	
Design Conditions:	30 GPM @ 90' TDH
Minimum Hydraulic Efficiency at Design Point:	25.1%
Electrical Service:	230 V/ 3Ø/ 60Hz
Motor Hp and Max. Speed:	3.5 Hp – 3,500 RPM
Discharge Elbow Size:	2"

- R. Pump Warranty:
  - 1. Pump manufacturer shall warrant units supplied against defects in workmanship and materials for a period of five (5) years or 10,000 hours under normal use, operation and service. Warranty period to extend from date of start-up.

# 2.3 PUMP CONTROLS

- A. The following pump control panel types shall be provided with the pumps by the pump supplier:
  - 1. Condensate Pump Station:
    - a. Enclosure Type: NEMA 4X Stainless Steel
    - b. Input Voltage: 480V-3Phase
    - c. Pump Controls: For DUPLEX pump station as summarized below.
    - d. Float Switches: Four (4) float switches as specified below.

# B. Enclosures:

- 1. The enclosure shall be free standing with depth as required adequately house all the components.
- 2. For NEMA 4X enclosures, a polished aluminum dead front inner door shall be provided, mounted on a continuous aircraft type hinge. For NEMA 12 enclosures, the outer door of the panel shall be the dead front door. The dead front door shall contain cutouts for mounted equipment and provide protection of personnel from live internal wiring. Cutouts for breaker handles shall be provided to allow operation of breakers without entering the compartment. All control switches, indicator pilot lights, elapsed time meters, and other operational devices shall be

mounted on the external surface of the dead front. The dead front shall open a minimum of  $150^{\circ}$  to allow access to equipment for maintenance. A <sup>3</sup>/<sub>4</sub>" break shall be formed around the perimeter of the dead front to provide rigidity.

- 3. The back plate shall be manufactured of 12-gauge sheet steel and be finished with a primer coat and two (2) coats of baked on white enamel. All hardware mounted to the subpanel shall be accomplished with machine thread tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified using engraved name plates. Use of DYMO type labels is not acceptable.
- C. Electrical:
  - 1. All breakers shall be mounted such as to be accessible from the outside of the dead front panel without requiring the operator to be exposed to live/energized parts.
  - 2. All circuit breakers shall be heavy duty thermal magnetic or motor circuit protectors similar and equal to SQUARE D type FAL.
- D. Pump controls:

5.

- 1. Provide relay-based controls to provide the functionality summarized below.
- 2. Provide intrinsically safe relaying and associated barriers within control panel (to isolate intrinsically safe components/connections per code requirements) to monitor each of the proposed wet well float switches.
- 3. For pump control panels where pump starters are WITHIN the pump control panel provide the following dead front-door-mounted devices for EACH pump:
  - a. Black Reset momentary-contact pushbutton.
  - b. 3-position HOA (Hand-Off-Auto) switch.
  - c. Green "RUN" pilot indicator light.
  - d. Red "OFF" pilot indicator light.
  - e. Black "START" momentary-contact pushbutton.
  - f. RED "STOP" momentary-contact pushbutton.
  - g. Elapsed time meter (to indicate in hours [6 digits] and tenths and shall be non-resettable).
  - h. RVSS HMI device.
  - i. Submersible pump monitoring relay (for pump leakage and overtemp monitoring) to be furnished by pump supplier and to be factory-installed within control panel by panel supplier. Monitoring relay shall have integral leakage/overtemp alarm lights that are visible from the front of the inner panel door, or panel supplier shall provide separate 30mm indicator lights to indicate these alarm conditions. Pump monitoring relay settings/shutdown conditions shall be set as directed by the pump supplier.
- 4. Provide the following additional dead front-door-mounted device:
  - a. Amber "HIGH LEVEL ALARM" pilot indicator light.
  - b. Green "LAG FLOAT TIPPED" pilot indicator light.
  - c. Green "LEAD FLOAT TIPPED" pilot indicator light.
  - d. Amber "LOW LEVEL ALARM" pilot indicator light.
  - e. LEAD PUMP SELECTOR switch
    - i. For Duplex Stations: Provide 3-position switch labeled ("ALTERNATE PUMP 1 PUMP 2")
  - f. Black "GENERAL ALARM SILENCE" momentary-contact pushbutton.
  - Pump Alternator: Provide an octal 8-pin, plug-in style duplex alternator relay (as required by application) with dry contact(s) required. Interconnect with dead front-door-mounted LEAD PUMP SELECTOR SWITCH as described above.

- 6. Surge Protection: A main surge protection device for the panel shall be provided per Specification Section 16480 requirements.
- 7. Dry Contacts: The pump control panel (by contractor/pump supplier) shall be provided with the following dry contacts:
  - For Pump Control Panels WITH integral pump starters:
    - i. "LOSS OF PHASE/POWER" alarm from control panel phase monitor.
    - ii. "RUN" status of each pump starter.
    - iii. "HOA SWITCH NOT IN AUTO" for each pump starter.
    - iv. "STARTER ALARM" status of each pump starter.
    - v. "OVERTEMP ALARM" status of each pump monitoring relay.
    - vi. "LEAKAGE ALARM" status of each pump monitoring relay.
    - vii. "HIGH LEVEL ALARM" status
  - b. For Pump Control Panels WITHOUT integral pump starters:
    - i. "RUN" command for each pump starter.
    - ii. "HIGH LEVEL ALARM" status
- E. Float Switches:

a.

- 1. Float switches quantities shall be provided as described above. Float switches shall be polypropylene type meeting the following requirements:
  - a. Standard Specifications:
    - i. Chemical Resistant polypropylene casing.
    - ii. Suspended type unit with built-in weight.
    - iii. Enclosed/encapsulated mercury SPST switch rated for 100VA at up to 250V. N.O. and N.C. contacts shall be provided and shall be connected as indicated on wiring diagrams or required by application, coordinated by contractor and equipment supplier.
    - iv. Complete with factory-installed PVC-jacketed STO cable designed for industrial duty, length as required to be extended to contractor-furnished termination point.
  - b. Execution:
    - i. Install float switches at heights as directed by civil engineer at locations that do not risk damage to the float switches.
    - Contractor shall provide corrosion resistant junction box or other termination point above high-water level for splicing cables furnished with float switch(es) to cables furnished by contractor. Provide cord connectors at base of junction box (or similar) and stainless steel Kellems cord grips for proper strain relief of all float switch cables.
  - c. Manufacturer/ Model:
    - i. Anchor Scientific Roto-Float Type S with hardware/accessories as described above, or equal. Normally open/normally-closed contact types shall be coordinated by supplier and shall be as required by application
- F. Miscellaneous:
  - 1. A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. Schematics shall be done in ladder logic with wire numbers and line numbers. Real time cross referencing of relay contact to line numbers shall be given as well as written description of component function on each circuit of the

drawings. From/ to wire and termination reports shall be shown on the as built drawings. Drawings shall be available in HTML format. Terminal strip layouts shall be provided for ease of connecting external devices.

- 2. All component parts in the control panel shall be permanently identified with engraved legend plates as designated on the drawings. A list of all legends shall be available in Excel format and attached with the schematics on the panel door.
- 3. All equipment shall be tested to the operational requirements. Each control function shall be activated to check for proper indication.
- 4. The Warranty, (a) shall commence on the Project Substantial Completion Date and shall continue for a period of twelve (12) months after such Project Substantial Completion Date ("Warranty Period"); provided, however, that if any component of the Work is repaired or replaced pursuant to the Warranty Service, then the Warranty Period with respect to such component shall be continued until the expiration of the Warranty Period. Any component repaired or replaced during the Warranty Period shall extend the 12 month Warranty Period for that repaired or replaced component for a period equal to the number of days between the time the warranty request was made and the component was successfully repaired or replaced.
- 5. The manufacturer shall be a UL508 shop and provide evidence on the end product.
- G. Functional Description:
  - 1. When the HOA is switched to the "Auto" position, provide the following functionality:
    - a. Upon wet-well water level rising to operator-adjustable "LEAD PUMP ON" float, start lead pump and run at 100% speed.
    - b. Upon wet-well water level rising to operator-adjustable "LAG PUMP ON" float, start lag pump and run lead and lag pumps at 100% speed.
    - c. Upon wet-well water level rising to operator-adjustable "HIGH WATER" float, start all pumps and run each at 100% speed. Generate "HIGH LEVEL ALARM" signal and display alarm condition on indicator light and alarm light.
    - d. Upon wet-well water level falling to operator-adjustable "PUMPS OFF" float, stop all pumps.
    - e. Upon wet-well water level falling to operator-adjustable "LOW LEVEL" float, stop all pumps and generate "LOW LEVEL ALARM" signal, and display alarm condition on indicator light Provide the ability for the operator to select any of the pumps as lead pump, or alternate lead-lag status after each pumping cycle.
  - 2. When the HOA is switched to the "HAND" position, continue to monitor and display the aforementioned signals provide the following functionality.
    - a. When the "START" pushbutton is engaged, start the associated pump.
    - b. When the "STOP" pushbutton is engaged, shut down the associated pump.
  - 3. When the HOA is switched to the "OFF" position, shut down all pumps and continue to monitor and display the aforementioned signals.
  - 4. Provide overtemperature alarm monitoring / shutdown relaying interconnections. Upon receiving overtemperature alarm, shut down associated pump and generate "OVERTEMP ALARM" signal, display alarm condition on dead front door. Provide means to clear overtemperature alarms manually.
  - 5. Provide leakage alarm monitoring / shutdown relaying interconnections. Upon receiving leakage alarm, shut down associated pump and generate "LEAKAGE

ALARM" signal, display alarm condition on dead front door. Provide means to clear leakage alarms manually.

6. Provide a light on top of the control panel which illuminates red when any of the aforementioned alarm conditions are active.

## PART 3 EXECUTION

## 3.1 EXAMINATION

- A. Section 01300 Administrative Requirements.
- B. Verify layout and orientation of pumps, accessories, and piping connections.

# 3.2 INSTALLATION

- A. Install pumps where indicated on Drawings and in accordance with manufacturer's instructions.
- B. Provide and connect piping, power and control conduit and wiring to make system operational, ready for startup.
- C. Flush piping with clean water.

# 3.3 FIELD QUALITY CONTROL

- A. Section 01700 Execution Requirements.
- B. Pre-operational Check: Before operating system or components, make the following checks:
  - 1. Check pump and motor alignment.
  - 2. Check for proper motor rotation.
  - 3. Check pump and drive units for proper lubrication.
- C. Start-up and Performance Testing:
  - 1. Operate pump on clear water at design point for continuous period of two (2) hours, under supervision of manufacturer's representative and in presence of ESG.
- D. Verify pump performance by performing time/draw down test.
- E. Check pump and motor for high bearing temperature and excessive vibration in accordance with the manufacturer's recommendations. Check for motor overload by taking ampere readings.
- F. Equipment Acceptance:
  - 1. Adjust, repair, modify or replace system components that fail to perform as specified and rerun tests. Make final adjustments to equipment under direction of manufacturer's representative.

# 3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish services of manufacturer's representative experienced in installation of products furnished under this specification for not less than one eight-hour day on-site for
installation inspection and field testing and instructing Energy Systems Group, LLC's personnel in maintenance of equipment.

B. Certify that equipment has been properly installed and is ready for start-up and testing.

#### 3.5 DEMONSTRATION

- A. Section 01700 Execution Requirements.
- B. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Energy Systems Group, LLC's personnel.

#### END OF SECTION

## 221519 - AIR COMPRESSORS, AIR DRYER, RECEIVER

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Install two (2) motor-driven air compressors (AC-1; AC-2) complete with aftercooler, suction filter, controls and accessories as follows:
  - 1. Two rotary screw, air cooled, air compressors.
  - 2. Two air cooled aftercoolers, as specified. Aftercoolers shall be complete with interconnecting piping as specified.
  - 3. Common steel frame to properly support each compressor, motor and accessories.
  - 4. Compressor complete control panel including motor starters and controls for each compressor, as specified.
  - 5. Intake filter-silencer for each compressor, as specified.
  - 6. Lubrication system.
  - 7. All moisture separators required to drain the equipment furnished including, but not limited to, separators for each aftercooler, and all low points in piping where required. Separator installation shall include all piping, unions, strainers and isolation valves to facilitate ease of removal and maintenance.
  - 8. Piping and valves mounted on the unit as specified.
  - 9. Sound-dampening enclosure.
- B. Each unit shall be complete for connections to the air discharge line, condensate line, and power source.
- C. Install one (1) heaterless regenerative desiccant air dryer (AD-1) completely factory assembled including, but not limited to, the following.
  - 1. All necessary wiring, piping, fittings, valves and filters.
  - 2. Desiccant chambers.
  - 3. Desiccant.
  - 4. Controls and instruments.
  - 5. Accessories.
  - 6. Structural steel base and supports.
- D. Install one (1) air receiver (CAR-1) and associated components.

#### **1.2 CODES AND STANDARDS**

A. Design, fabricate, assemble and test equipment and materials so that upon installation in accordance with the manufacturer's recommended procedures for this application, the equipment will conform to the requirements of the Federal Occupational Safety and

Advanced Engineering Consultants Air Compressors-Air Dryer-Receiver 221519-1 (rev 07072023) Health Standards, and the applicable provisions of the following standards and others listed in this Section.

- 1. American Gear Manufacturers Association (AGMA):
  - a. 421-06.
- 2. American National Standards Institute (ANSI):
  - a. B16.5 Steel Pipe Flanges and Flanged Fittings.
  - b. B31.9 Process Piping Code.
  - c. C2 National Electrical Safety Code.
- 3. American Society for Testing and Materials (ASTM):
  - a. A36 Structural Steel.
  - b. A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  - c. A106 Seamless Carbon Steel Pipe for High-Temperature Service.
  - d. A283 Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.
  - e. A307 Carbon Steel Externally Threaded Standard Fasteners.
- 4. American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels, Section VIII.
- 5. Anti-Friction Bearing Manufacturer's Association (AFBMA).
- 6. Institute of Electrical and Electronics Engineers:
  - a. 100 Dictionary of Electrical and Electronics Terms.
- 7. Heat Exchange Institute (HEI).
- 8. National Electrical Manufacturers Association (NEMA).
- 9. National Electrical Code (NEC).
- 10. Steel Structures Painting Council (SSPC):
  - a. SP6 Commercial Blast Clean.

## **1.3 QUALITY ASSURANCE**

- A. Air compressor shall be (or equal):
  - 1. Atlas Copco, Model GA-18, 25 HP, Air Cooled, 460/3/60 Volt, 125 PSI.
- B. Factory Tests:

- 1. Notify Engineer and Owner two weeks prior to major factory tests so the Owner and Engineer, or their representatives, may be present if they so desire.
- 2. Each air compressor shall be completely factory assembled, statically and dynamically balanced, and tested for normal functioning at rated speed and pressure. Conduct all tests in accordance with manufacturer's standard test procedure to include leakage checks and mechanical integrity test of the compressor unit.
- 3. The equivalent "A" weighted sound level, measured at 1 meter elevation above the floor level and 1 meter horizontally from the base of any of the equipment furnished under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dB.
- 4. After completion of the shop tests, leave test gaskets in place. The air piping will be flushed with dry, oil-free air. Replacement test gaskets will not be required for final installation.
- 5. All motors shall receive the manufacturer's standard tests.
- C. The desiccant air dryer (AD-1) shall be:
  - 1. Air Tak Heatless Regenerative Dryer Model HLD200, includes purge saver system & moisture indicator.
- D. The pre/after filters shall be:
  - 1. Air Tak Pre and After Filters w/DP Gauges, Model F-14-C350 + F14-P350.
- E. The compressed air receiver (CAR-1) shall be:
  - 1. Silvan vertical receiver tank (120 gallons), Model No. 92-24-120-200, includes safety relief valve & pressure gauge
- F. Factory Tests:
  - 1. Include all manufacturer's standard factory tests on equipment and materials.
  - 2. After completion of shop tests, ready dryer for operation so that no field disassembly or cleaning is required.
  - 3. Shop test reports shall be submitted to the Engineer.

# **1.4 SUBMITTALS**

- A. General arrangement drawings showing arrangement of equipment and all clearances required for erecting and dismantling, and detailed dimensional data.
- B. Cross-sectional drawing indicating detailed features and materials of construction.
- C. Drawings showing foundation requirements, static and dynamic loadings for all Advanced Engineering Consultants Air Compressors-Air Dryer-Receiver 221519-3 (rev 07072023)

conditions of operation and anchor bolt locations.

- D. Details of all external connections which must be made to the equipment and allowable forces and movements on each connection.
- E. Electrical power and control schematics.
- F. Data defining electrical components in control panel.

#### **1.5 DESIGN PARAMETERS**

A. Each rotary screw air compressor shall be guaranteed to meet the following requirements:

1.	Type compressor:	Air cooled, rotary screw
	(For Plant Air & Instrument Air)	
2.	Number of stages:	As required
3.	Minimum delivery capacity, ACFM:	108 ACFM @ 125 PSIG
4.	Inlet air temperature, F:	70 (minimum = 50, max. = 105)
5.	Inlet air pressure ahead of inlet filter, psia:	14
6.	Site elevation, ft. above sea level	680
7.	Relative humidity of inlet air, percent:	20 (minimum = 0, maximum = 100)
8.	Design discharge pressure, psig:	125
9.	Operating range of discharge pressure psig:	95 to 125
10.	Maximum allowable aftercooler terminal temperature difference at design capacity with 80 degrees F cooling water, degrees F:	15
11	Compressor controls shall operate to pr	ovide stable operation at full canacity an

- 11. Compressor controls shall operate to provide stable operation at full capacity and at each mode of the unloading sequence.
- 12. Compressors shall be capable of running continuously in the fully unloaded condition.
- B. Air compressor unit shall be designed for 480 volt, 3 phase 60 hertz power supply. Provide voltage reduction as required for compressor controls and auxiliaries.

#### C. Dryer shall be designed for the following conditions:

1.	Inlet air temperature, degrees F	110**
2.	Inlet pressure, psig	95-125
3.	Ambient air temperature, degrees F	90
4.	Dryer design PDP*, degrees F	-40
	· · · ·	Advanced Engine

Advanced Engineering Consultants Air Compressors-Air Dryer-Receiver 221519-4 (rev 07072023) 5. Outlet air capacity, ACFM 200 \*PDP is defined as pressure dew point at 100 psig. \*\*110 degrees F saturated air.

## 1.6 OPERATION AND CONTROLS

- A. The compressor units will be operated as one on line, one stand-by to supply both service air and instrument air to the plant.
- B. Supply semi-automatic type operation as follows:
  - 1. Load compressor when system pressure falls to the preset (50 to 125 psig) loading pressure.
  - 2. Unload compressor when system pressure rises to the preset (50 to 125 psig) maximum pressure.
  - 3. Automatically shut down compressor after running unloaded for a 0 to 60 minute adjustable period.
  - 4. Supply time delay for sequential loading.
  - 5. Supply start-stop controls for each compressor.
  - 6. Automatic shutdown on:
    - a. Low oil pressure.
    - b. High outlet air temperature.
    - c. Motor overload.

# 1.7 SHIPPING, STORAGE AND HANDLING

- A. Adequately crate, identify, block, anchor and protect material for shipment. Items damaged during shipment shall be replaced without expense to the Owner.
- B. Adequately seal and protect equipment prior to shipment for outdoor storage at the plant site. Protect all bearings with grease packing or lubricating oil.
- C. Seal all openings for shipment after final shop inspection and flushing as follows:
  - 1. Cover flanged connections with 1/2-inch thick plywood covers bolted to the flange with not less than four bolts.
  - 2. All screwed connections shall be plugged or capped with standard pipe plugs or pipe caps.

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

#### 2.1 GENERAL DESIGN - COMPRESSOR

- A. Compressors shall be oil free within the compression chamber, directly connected to electric motor drive and enclosed by steel sound dampening canopy. Weatherproof for outdoor installation.
- B. Enclosing canopy shall have large doors to provide easy access to compressor. All doors and panels shall be removable for maintenance.
- C. Compressor shall be designed to minimize vibration when running loaded or unloaded.

#### 2.2 CASING

A. Cast iron.

#### 2.3 ROTORS

- A. One-piece stainless steel construction.
- B. Have corrosion-resistant coating.
- C. Dynamically balanced.

## 2.4 SHAFT SEALS

- A. Independent set of noncontactive air and oil seals that ensure no oil can enter the compressor chamber.
- B. Air seal shall consist of carbon rings guided in steel rings. Carbon rings shall be free for radial self-adjustment along the rotor shaft.
- C. Oil seal shall be a threaded screw seal which creates air circulation towards the bearings.
- D. There shall be an atmospheric drain between the air and oil seal.

## 2.5 BEARINGS

- A. Bearings shall be anti-friction type.
- B. Radial loads shall be carried by roller bearings.
- C. Axial loads shall be carried by ball bearings.

Advanced Engineering Consultants Air Compressors-Air Dryer-Receiver 221519-6 (rev 07072023) D. Compression axial loads shall be divided between the main and auxiliary thrust bearings through a balancing arrangement.

## 2.6 LUBRICATION SYSTEM

- A. Provisions shall be made to ensure an adequate supply of forced-feed cool oil to rotor bearings, timing gears, and drive gears.
- B. Provide all necessary equipment and accessories, changeable filters, coolers, reservoir, valves, pressure switches, necessary instrumentation, and all integral piping and other appurtenances required to form a complete lubrication system.
- C. Arrange piping to permit lubrication system components to be removed without dismantling piping.
- D. Provide lubricating oil of type and quantity required.
- E. Provide oil reservoir with a level indicator.

## 2.7 EQUIPMENT FRAME

- A. Provide full-length equipment frame to contain and support all compressor components.
- B. Designed strong and rigid to maintain equipment alignment.

## 2.8 SPEED INCREASING GEARS

- A. Speed increasing gears shall be heavy-duty, helical, parallel-shaft type.
- B. Design for service intended in accordance with AGMA 421-06 with a minimum service factor of 1.7.
- C. Gear train designed to be thrust canceling.

# 2.9 ACOUSTICAL INSULATION

A. Design to meet specified sound pressure limitations.

# 2.10 INTAKE FILTER SILENCER

- A. Provide manufacturer's standard air-intake filter mounted on compressor unit.
- 2.11 Piping shall be shop fabricated and assembled on the units to as great a degree as possible.

- A. Piping provided manufacturer shall include the following:
  - 1. Air piping between compressor and aftercooler. (Intercooler, if required)
  - 2. All instrumentation tubing and electrical conduit.
  - 3. Compressor air piping suction elbow shall be properly supported to limit the forces on the compressor suction connection as required.
- B. All piping between compressor and aftercooler shall include expansion joints where required.
- C. All air piping shall be manufacturer's standard.

# 2.12 Provide motor starter for air compressor motor. Provide voltage reduction transformer and all components required for compressor control and auxiliaries.

## 2.13 **Provide integral control system and instrumentation as follows:**

- A. Load unload control system providing function capabilities specified in PART 1 of this Section.
- B. Reset/start and stop push button controls.
- C. Indicator lamps:
  - 1. Power on.
  - 2. Auto operation.
  - 3. Loaded and unloaded indication.
  - 4. Motor overload.
  - 5. High air inlet filter vacuum.
  - 6. High outlet air temperature.
- D. Indicator gauges:
  - 1. Discharge pressure.
  - 2. Oil pressure.
  - 3. Outlet air temperature.
- E. Running time hour meter.

## 2.14 GENERAL DESIGN – DESSICANT DRYER

A. Dryer shall be skid mounted, completely factory-assembled, heaterless, fully automatic regenerative desiccant dryer. Dryer shall include all necessary wiring, piping, filters and controls for fully automatic operation.

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- B. Dryer shall be of dual-chamber design with one chamber being regenerated while the other chamber is in use drying the process air.
- C. Drying flow shall be downward.
- D. Regeneration shall be accomplished by passing a portion of the dried air through the desiccant to be regenerated. Regeneration purge flow shall be counter-current to the direction of flow of the wet inlet gas. Regeneration purge flow rate shall not exceed 15 percent of the dryer inlet air capacity at design conditions or cause fluidization of desiccant bed.
- E. Provide dryer with a repressurization circuit to allow the regenerated chamber to gradually repressurize prior to switch-over, and to allow a gradual reduction in pressure after switch-over for the chamber to be regenerated.
- F. The dryer shall be capable of continuously processing air from 0 100 percent of the design inlet air capacity without manual adjustments.
- G. Regeneration cycle (chamber purge) shall be automatically initiated based on moisture level in the drying service chamber. When high moisture level is sensed in the drying service chamber, switch-over shall occur. The high moisture chamber shall be purged for a period of three (3) minutes. After the purge is complete chamber switch-over shall not occur until the drying service chamber moisture level is high. Regeneration cycle control system shall be solid-state microprocessor based. Moisture sensing probes shall be of Teflon-coated stainless steel, not require calibration and be unaffected by contamination of desiccant.
- H. Any power interruption to the dryer shall not result in interruption of the air flow through the dryer.
- I. The total pressure drop through the dryer shall not exceed 5 psid at design conditions.
- J. Dryer shall not exceed 85 dBA sound level at a distance of three (3) feet from any surface in all operating modes.

## 2.15 **DESICCANT CHAMBERS**

- A. Provide each chamber with accessible safety pressure relief valves and moisture sensors, and NPT plugged accessible desiccant fill and drain connections.
- B. Chambers shall be designed to allow filling and removal of desiccant without dismantling the chamber or the connection piping. Chambers shall not be filled through safety valve openings.
- C. Chambers shall be designed, built and stamped in complete accordance with the ASME Advanced Engineering Consultants Air Compressors-Air Dryer-Receiver 221519-9 (rev 07072023)

Boiler and Pressure Vessel Code.

- D. Chambers shall be supported by a steel frame assembly.
- E. Inlet and outlet nozzles shall include perforated stainless steel desiccant retaining screens which are easily inspected and replaced.

## 2.16 DESICCANT

- A. Dryer desiccant shall be activated alumina.
- B. The quality of desiccant shall provide a minimum guaranteed bed life of three years with no replacement or addition of desiccant, without developing excessive pressure drop, and without exceeding design outlet dew point.

## 2.17 ACCESSORIES

- A. Provide each dryer with a purge air adjustment valve, pressure gauge and flow orifice for purge air flow control.
- B. Provide purge air exhaust muffler design to meet specified unit sound level requirements.
- C. Provide two-way nonlubricated switching valves suitable for this service. Provide corrosion resistant materials of construction with stainless steel trim. Switching valves shall be designed such that if valve drive system stops in mid-stroke, the air flow through the dryer will not be interrupted.
- D. Provide dryer with flanged inlet air connection and outlet air connection.
- E. Provide all necessary pipe, valves and fittings for interconnecting the chambers and regeneration system. Asbestos gaskets will not be permitted. Piping shall be carbon steel.

## 2.18 CONTROLS AND INSTRUMENTS

- A. Provide dryer with a control panel mounted on the dryer skid.
  - 1. Provide control panel with the following indicating lights:
    - a. High humidity at dry outlet.
    - b. Switching failure for inlet valves.
    - c. Switching failure for purge exhaust valves.
    - d. Power on.
    - e. Left chamber drying.

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- f. Right chamber drying.
- 2. Provide control panel with one set of normally open auxiliary alarm contacts connected to the distributed control system which will close on any of the following conditions:
  - a. High humidity at dryer outlet.
  - b. Switching failure for inlet valves.
  - c. Switching failure for purge exhaust valves.
  - d. Loss of power to dryer.
- 3. Provide the control panel with the following gauges:
  - a. Visual color change outlet moisture indicator.
  - b. Inlet pressure.
  - c. Outlet pressure.
  - d. Right chamber pressure.
  - e. Left chamber pressure.
- B. Provide dryer with a purge flow indicator gauge mounted adjacent to the purge flow adjusting valve.
- C. All electrical enclosures shall be NEMA IV.
- D. Power supply to dryer control panel will be 120 volt, 60 hertz, single phase ac.

## 2.19 CLEANING AND PAINTING

- A. Shop clean all exterior ferrous according to SSPC-SP6.
- B. Apply manufacturer's standard coating system at 5.0 mils minimum dry film.
- C. Protect motors, electrical equipment, and machinery of all kinds against corrosion, moisture deterioration, mechanical injury, and accumulation of dirt or other foreign matter. Protect all bearings by factory grease packing or by lubricating oil.
- D. Protect exposed machined surfaces with suitable rust preventative compound on these surfaces.

## **PART 3 - EXECUTION**

(Not used.)

## **END OF SECTION**

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#### 230530 - PIPE SUPPORTS AND HANGERS PROCESS PIPING

## PART 1 - GENERAL

#### **1.1 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This specification covers supports and hangers for suspended pipelines.
- B. The contractor shall furnish and install all pipe hangers and supports listed in the contract documents and/or this specification.

## **1.3 STANDARDS AND CODES**

- A. Design, materials and labor shall conform to the Federal Occupational Safety and Health Standards and the applicable provisions of the following standards.
  - 1. American National Standards Institute (ANSI).
  - 2. American Society of Mechanical Engineers (ASME)
  - 3. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

#### 1.4 QUALITY ASSURANCE

A. All pipe hangers and supports shall conform to ASME B31.3 - Process Piping, and Documents MSS SP-58 and SP-69 of the Manufacturers Standardization Society of the Valve & Fittings Industry.

#### 1.5 SUBMITTALS

- A. The contractor shall submit to the engineer, prior to installation, the following information and data for approval:
  - 1. Manufacturer's Data Sheets on all catalogued items to be used.
  - 2. Drawings covering all specially designed hanger assemblies and fabrications.

#### **PART 2 - MATERIALS**

#### 2.1 GENERAL

- A. Type numbers listed below correspond to those in Federal Specification WW-H-171. All pipe supports and hangers shall be in conformance with this federal specification unless an exception is approved in writing by Energy Systems Group, LLC.
- B. Specific supports, hangers, types, sizes, and locations detailed and called out on the construction drawings shall govern over this specification.

#### 2.2 FLOOR ANCHORS

- A. Where possible, use cast-in-place anchors of heavy structural steel or cast iron.
- B. For installation in existing concrete, use expansion anchors and/or self drilling anchors.

## **2.3 BEAM ATTACHMENTS**

- A. This section applies where piping is supported from overhead building steel.
- B. Selection shall be based on recommended load limitations.
- C. For non-welding attachments, use Types 20, 21, 28 thru 31 as required by load.
- D. Where welding is required, refer to accompanying contract drawings for details.

#### 2.4 HANGER RODS

- A. Shall be hot rolled steel with cut coarse threads.
- B. Where rod sizes are listed in the catalogue for a type of fitting, that size shall govern.
- C. Where rod sizes are not listed, the rod size shall conform to the following table (based on suggested pipe support spacing in ANSI B31.1 Power Piping Code):

<u>Pipe size, in</u> .	Maximum Load lbs.	Rod size, in.
2 and smaller	610	3/8
2-1/2 to 3-1/2	1,130	1/2
4 and 5	1,810	5/8
6	2,710	3/4
8 to 12	3,770	7/8
14 and 16	4,960	1

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18 and 20	8,000	1-1/4
24	11,630	1-1/2

#### 2.5 STEEL PIPE AND O.D. TUBING

- A. General:
  - 1. Hangers and supports for tubing shall be specified for tubing in order to be of the proper diameter.
  - 2. Hangers and supports that are in direct contact with copper shall be copperplated or plastic-coated to prevent any electrolytic reaction.
- B. Ambient to  $120^{\circ}$  F:
  - 1. Hangers: Types 1, 3 thru 12
  - 2. Supports: Types 24, 26, 36 thru 39
- C. Hot Systems:
  - 1. Insulated  $120^{\circ}$  to  $450^{\circ}$  F No Thermal Movement:
    - a. Hangers: Types 1, 3 thru 12
    - b. Supports: Types 36 thru 39
  - 2. Insulated  $120^{\circ}$  to  $450^{\circ}$  F Thermal Movement:
    - a. Applies where thermal movement will cause the hanger rod to deviate more than  $5^{\circ}$  from the vertical, or where longitudinal expansion causes a movement of more than 1/2" in the piping supported from below.
    - b. Protection saddles (pipe): Type 40 (weld to pipe)
    - c. Protection shields (tubing): Type 41
    - d. Hangers (inside use only): Types 42 thru 44
    - e. Supports (inside use only): Types 45 thru 48
    - f. Pipe slide assembly (inside and outside use): carbon steel tee with stainless steel slide plate; carbon steel base with filled Teflon pad.

## 2.6 SPECIAL MATERIALS

- A. Trapeze Hangers:
  - 1. Substantial angle or channel iron construction with suspended adjustable steel threaded rods and nuts.
  - 2. Pipe supports as listed in paragraph 2.06 shall be installed as required on trapeze hangers.

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- B. Vertical Risers:
  - 1. As shown on accompanying contract drawings and/or documents.
  - 2. For a wide range of loads (50 to 50,000 pounds) where there are large thermal movements, and where support variability cannot exceed  $\pm 6\%$ , use Type 52 constant support hangers.

## **PART 3 - EXECUTION**

## 3.1 GENERAL

- A. The contractor shall furnish and install all structural supports, anchors, and hangers required for the suspension and placement of the piping required for this installation. Pipe hangers and supports shall be installed to allow for expansion and contraction, and placed close to fittings, valves, and heavy equipment. They shall be installed so that piping will be free from vibration, sagging or movement other than caused by heat expansion or contraction. Piping shall be pitched as specified in individual service specifications.
- B. Piping shall be supported directly from the structures and not from the supporting systems or equipment of other trades.
- C. Pipe may be supported by trapeze hangers and/or in tiers, but there shall be sufficient room for installation of fittings, insulation, etc., and for future rearrangement work or maintenance.
- D. There shall be no cutting, drilling or welding on the building steel except as shown on the contract drawings or as instructed by Energy Systems Group, LLC's representative.
- E. Maximum spans between hangers for straight horizontal runs of steel pipe shall be in compliance with ANSI B31.1, Manufacturer Standard Society (MSS) SP-58, SP-69, SP-77, SP-89, SP-90 and the contract documents.
- F. Additional hangers shall be provided where concentrated weights such as valves or heavy fittings occur, and where changes in direction of the piping system occur between hangers.
- G. Hanger rods shall be connected to beam clamps, concrete inserts or expansion anchors. "C" clamps shall not be allowed. Offset suspension by hangers is not permitted.
- H. Hanger rods shall be installed with a double nut arrangement both at the lower end where the hanger is attached, and at the top where it fastens to the clamp or insert.

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- I. Inserts shall be provided as specified elsewhere in this specification. When through-bolts are used, plates or large washers shall be provided under the heads.
- J. Vertical pipes shall be installed as shown on accompanying contract drawings.

## END OF SECTION

#### 231113 - HYDRONIC PIPING

#### 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.
- B. The following specifications included in the contract document also apply to this section.
  - 1. Section 230530, PIPE SUPPORTS & HANGERS
  - 2. Section 231123, GAS PIPING
- C. The detailed Piping Material Specifications listed in the index are considered part of this document.

#### **1.2 SUMMARY**

- A. This Specification covers all labor, materials, equipment, tools, and services as required for a complete installation of above and below ground piping and mechanical equipment.
- B. This Specification, together with the other related specifications referenced herein, Piping and Instrument Diagrams and construction drawings, establishes the requirements for fabrication, erection, inspection, cleaning and testing of the piping systems and their components.

#### **1.3 CODES AND STANDARDS**

- A. Design, materials, labor and workmanship described herein shall be in accordance with all applicable codes and standards including, but not limited to, the following listed codes and standards, including their latest editions and addenda, in effect as of the date specified in the Energy Systems Group, LLC contract. All material and workmanship shall also be in compliance with all applicable Federal, State and Local Codes and laws. Should there be any conflict between any code, standard, and/or specification, the more stringent shall govern.
  - 1. ANSI American National Standards Institute
  - 2. API American Petroleum Institute
  - 3. ASME American Society of Mechanical Engineers
  - 4. ASTM American Society for Testing and Materials
  - 5. AWS American Welding Society

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- 6. AWWA American Water Works Association
- 7. MSS Manufacturer Standardization Society of the Valve and Fitting Industry.
- 8. NFPA National Fire Protection Association
- 9 OSHA Occupational Safety and Health Administration

# 1.4 QUALITY ASSURANCE

- A. Contractors shall have not less than (5) five years experience as a Mechanical Contractor with specific experience in piping fabrication techniques, application and installation of the material types and sizes as referenced herein, and as shown on the engineering drawings and/or as referenced in the bid documents.
- B. The Contractor shall be responsible for the successful start up and operation all equipment and materials installed by the Contractor. Energy Systems Group, LLC shall perform testing on the equipment during start up and operation and the Contractor shall be responsible for correcting any deficiencies or noncompliance, caused by the Contractor's work, in the system at no cost to Energy Systems Group, LLC.
- C. Written inspection records and test reports shall be maintained, these shall include but not be limited to the following.
  - 1. Hydro or pressure test.
  - 2. Visual and x-ray weld inspection.
  - 3. Startup and or functional test.

# 1.5 SUBMITTALS

- A. All submittals shall be in accordance with Section 01330 SUBMITTAL PROCEDURES.
  - 1. All applicable welding procedures.
  - 2. A copy of welder qualification status.
  - 3. Any requests for deviation or substitutions from the materials and methods described herein.
  - 4. A copy of any or all inspection and test records when requested.
  - 5. A copy of all as built drawings.
  - 6. Fabrication drawings.
- B. The Contractor shall submit Manufacturer's delivery date for all the equipment and materials required for the installation.

C. Certified mill test reports for all piping shall be submitted by the Contractor to Energy Systems Group, LLC when piping is delivered at the job site.

## 1.6 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Handle materials in a manner that will not cause overstress, warp, twist or other damage.
- B. Take precautions to prevent damage to protective coatings on surfaces of materials.
- C. Store and protect materials at the site from damage, deterioration and corrosion. If necessary, store materials in weathertight enclosures.
- D. Packaged materials shall be stored in their original unbroken container.
- E. Remove accumulations of mud, dirt and other foreign substances from materials immediately prior to erection.
- F. In the event of damaged items or previously opened packaged materials, immediately repair and/or replace such items as is necessary, to Energy Systems Group, LLC approval, at no extra cost to Energy Systems Group, LLC.
- G. All piping items shall be segregated upon receipt and stored in an orderly manner. Materials shall be kept clean and elevated above grade or floor by timbers, structural steel or other suitable method. Unprotected piping, fittings and components shall be sloped to allow drainage. Materials stored outside shall be protected from damage due to weather conditions.
- H. Stainless steel components shall not be stored in contact with carbon steel, storage rack bends or other carbon steel items. All basic material groups shall be segregated according to material type (i.e. carbon steel, stainless steel, copper, etc.).

# PART 2 - PRODUCTS

## 2.1 GENERAL

A. All materials shall be in accordance with the Piping Material Specifications listed:

	<u>Addendum</u>	Section Title
231123	D	Glycol Chilled Water (CHWS, CHWR)

Copy of each specification is included in with this specification.

B. All material shall be new, unused, and free of defects and imperfections, and shall be supplied in strict accordance and with the applicable Piping Material Specifications.

## NOTE: NO SUBSTITUTIONS ARE PERMITTED WITHOUT WRITTEN CONSENT OF Energy Systems Group, LLC.

- C. All pipe, fittings and valves shall be supplied marked by the manufacturer in accordance with the marking sections of the standards to which reference is made in the Piping Material Specifications, or in accordance with the requirements of MSS SP-25: "Standard Marking System for Valves, Fittings, Flanges and Unions of the Manufacturers Standardization Society of the Valve and Fitting Industry."
- D. All material items shall be carefully inspected upon receipt at the jobsite. The Contractor shall examine all components for compliance with the applicable material class specification, ASTM identification and markings, purchase order compliance including shortages, and over shipments and any damaged or flawed items (i.e. scarred flange faces, bent pipe, damaged threads, beveled ends, etc.), and shall report his findings to Energy Systems Group, LLC, or his representative. Items failing to meet this criteria shall be rejected and held in a separated area for disposition. Disposition of rejected items shall be as agreed upon between the Contractor and Energy Systems Group, LLC or his representative. Items rejected shall be replaced by the Contractor at no cost to Energy Systems Group, LLC.
- E. Small diameter carbon steel piping which is normally banded in bundles and tagged with an identifying tag shall be color coded by the Contractor by painting a stripe the entire length of each bundle in accordance with the following color code requirements.

Material Designation	Color Code
ASTM A-53 Grade B	Blue
ASTM A-106 Grade B	Green

Any unidentified materials shall be removed from the jobsite at the Contractor's expense.

- F. All piping, as defined in ASME B31.9 Building Services Piping and as noted on P&ID's shall be provided with data reports, inspection and stamping as required by Section 1 of the ASME Boiler and Pressure Vessel Code.
- G. Pipe in sizes 24" and smaller shall conform dimensionally to ANSI B36.10 for carbon steel and ANSI B36.19 for stainless steel. Pipe wall thickness shall be as indicated in the Piping Material Specifications.
- H. All steel screwed and socket welding fittings shall conform to ANSI B16.11.

I. All carbon steel butt-welding fittings shall conform dimensionally to ANSI B16.9, with wall thickness at least equal to that of the pipe on the same service. Where the fitting is heavier than the pipe, ends of fittings shall be beveled to meet code requirements.

## PART 3 - EXECUTION

## **3.1 PREPARATION**

- A. The Contractor shall carefully review the engineering drawings of all disciplines, and check for obstructions and interferences. This shall be done during the bid period and prior to proceeding with installation to avoid unnecessary rework later. In addition, the Contractor shall become familiar with the drawings and make note of locations where walls, partitions, ceilings, structural members, etc., are called to be closed-in or to be furred. He shall coordinate this work with other contract trades to avoid interferences or delays in construction.
- B. Any questionable information in the specifications and/or on the plans, or conflicts with codes, shall be called to the attention of Energy Systems Group, LLC, for clarification before proceeding with fabrication or erection of the parts affected. If, in the opinion of the Contractor, any additional detail drawings are necessary, he shall prepare them at his own expense, together with all bills of material.
- C. If modifications to the arrangement of the piping systems are required to suit structural conditions, or to avoid interference with the work of other trades, the Contractor shall furnish all additional materials and labor as required to meet the installation conditions. The Contractor shall furnish all modification requests by "red-lining" the engineering drawings to indicate the necessary change. Energy Systems Group, LLC, shall secure approval and sign the requests prior to installation.

## **3.2 ARRANGEMENT AND ALIGNMENT**

- A. Arrange and align all piping in accordance with the drawings. Elevations as given must be held. Floor elevations where given are to high points of floor. Dimensions must be held as closely as possible. Field check all dimensions for accuracy before pipe is fabricated.
- B. Install all piping straight and as direct as possible, generally forming right angles with, or running parallel with, walls or adjacent piping. All piping shall be neatly spaced, with risers and drops running plumb and true.
- C. Run piping in wall chases, pipe shafts, hung ceilings, recesses, etc. when same are provided. Do not run service piping in floor slab fill unless specifically noted on drawings.

- D. The Contractor shall not scale the construction drawings. Piping and equipment are located in the drawings by dimensions to center lines of building columns, and/or to other pipes, to center line or bottom of pipe elevations, or, by the invert elevation for buried pipe. The Contractor shall check all dimensions in the field before final connections are fabricated.
- E. Drawings showing piping 1-1/2" and smaller are in general diagrammatic and the exact location of these lines shall be determined by the Contractor from field measurements taken by him. The actual arrangement of the small size piping, when erected, shall follow the general locations shown on the drawings as far as practicable. The installation made in this way shall be neat in appearance and convenient to operate, and shall provide for appropriate expansion and drainage.
- F. Coordinate installation of piping systems with other work and/or with existing facilities, to avoid blocking building openings, light fixtures, etc. Piping shall not interfere with access to valves or equipment and shall not obstruct passageways. In general, minimum headroom clearance shall be considered as 7'-0" clear under all piping, coverings, and appurtenances. Piping shall be installed with sufficient clearance for operation, inspection/ replacement of valves, etc.

# 3.3 GENERAL

- A. Install all piping systems for expansion and/or contraction under start-up, operating, shut-down, and steam-out conditions, without overstressing piping, valves or equipment. Pipe anchors, guides, hangers and supports shall be provided as required in accordance with pipe support drawings and the engineering specification labeled, "Pipe Supports and Hangers".
- B. Install anchors where shown on the plans. Furnish guides on each side of all expansion loops, off-sets, swing joints and expansion joints whether or not detailed on the plans.
- C. Piping which is furnished as part of packaged equipment shall conform to the requirements of this specification and the applicable Piping Material Specification.
- D. Special precaution shall be taken at all times during fabrication and erection to prevent entrance of any foreign matter into piping or equipment.
- E. Open end of pipes shall be plugged after fabrication. All openings in pipe or equipment left overnight or for future connection shall be covered to keep foreign particles out of the system. A plastic type plug or cap should be used for temporary protection. Rags or waste are not to be used because they will deposit lint in the openings.

- F. Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 1" larger than the outside diameter of uninsulated pipes or of the insulation for insulated services. When pipe is fitted with restraining rods, the sleeve shall be oversized to accommodate the rods. Holes for sleeves in existing buildings are to be neatly cut.
- G. Sleeve Construction:
  - 1. Interior Partitions: No. 22 gauge galvanized sheet steel with soldered joint.
  - 2. Interior Masonry Walls and Floors: Standard weight galvanized steel pipe, or stainless steel where shown on drawings.
  - 3. Exterior Walls: Standard weight galvanized steel pipe.
- H. Sleeve Caulking:
  - 1. Interior walls and floors: Fill the space between outside of pipe or insulation and the inside of the sleeve, or framed opening, with fiber glass, seal both ends with expanded foam.
  - 2. Exterior walls (above ground): Pack with oakum, seal with lead and watertight mastic or asphalt; or install a modular mechanical seal "Link-Seal" as manufactured by the Thunderline Corporation.
  - 3. Fire Rated walls and floors: Run pipe through a sleeve 1" larger than the outside diameter of the pipe or insulation (if insulated pipe is called for). The insulation shall be fire resistant. Fill space between the sleeve and the pipe completely with fiberglass wool and grout the ends.

When pipe penetration will be exposed to view an escutcheon plate shall also be furnished and installed.

- I. Provide escutcheons on both sides of wall, floor, ceiling, and partition penetrations for all pipes exposed to view in finished areas, whether or not insulated, unless otherwise shown on the drawings. For pipes passing through floors, escutcheons shall fit over the sleeves. Escutcheons plates shall be stainless steel or chrome plated and fabricated in one piece.
- J. Roof Caulking: Provide caulking, sealants, compressible fillers, flashings and/or rain covers as detailed on the architectural drawings. Coordinate work with roofing contractor.

# 3.4 INSTALLATION

A. Provide unions or flanges at all piping connections to coils, equipment, control valves, pressure reducing valves, steam traps, etc., at all locations as shown on the drawings, and generally as required to disconnect piping from equipment and apparatus. Arrange connections so that the equipment served may be removed

without disturbing the piping. Where valves serve to isolate equipment or specialties, the unions or flanges shall be located between valves and equipment or specialties. Unions shall generally be used for pipe sizes 2" and smaller, and flanges for pipe sizes 2-1/2" and larger.

B. Unless otherwise shown on the plans, install all piping to coils, pumps and other equipment including valves and strainers therein, at line size. If a reduction is required at a pump or control valve, the reducer shall be installed abutting the inlet and/or outlet of the pump or valve. If pump suction strainers are specified, provide pipe reduction at strainer outlet connection to pump inlet.

Piping at pump and driver nozzles shall be arranged to permit removal of pump or driver without removing block valves.

- C. Piping shall not be covered or closed in until completion of the piping cleaning, testing and until the installation is approved by Energy Systems Group, LLC. Piping that has been covered or concealed without cleaning, testing and approval, shall be exposed at the contractor's expense.
- D. Flanges:
  - 1. Except for removable sections of pipe and for piping requiring dismantling for cleaning, use of companion flanges in piping shall be limited to connections at flanged equipment. Field joints may be flanged construction where expedient and economical to avoid field welding of joint requiring heat treatment and examination.
  - 2. The location of flanged joints are shown on piping drawings. Bolt holes of flanges shall straddle the center lines of pipe unless otherwise shown and noted on drawings. Each piping material specification describes the type of flanges to be used and gives the rating, material, facing, etc. When a different type of flange is used, its location and description is shown on the drawings.
  - 3. Blinds shall be provided as indicated on piping drawings and Piping and Instrument Diagrams. Material shall be the same as the piping in the line where it is used. Blinds shall be accessible from grade or platforms.
  - 4. All orifice flanges shall be welding neck type, ANSI Class 300 minimum rating, and 2" minimum pipe size. Orifice plates shall be 1/8" thick for lines 12" and smaller, and 1/4" for lines 14" and larger, unless otherwise noted. The preferred installation of orifice flanges is in a horizontal line.
- E. Piping:
  - 1. All assembled piping shall be worked in place without springing or forcing, except as specified on the drawings, to properly clear all openings and equipment. All piping shall be installed to permit free expansion and

contraction without damage to joints, hangers, or to insulation where it is applied.

- 2. All piping shall be erected and supported in a manner that will not put undue strain on pumps, tanks, or equipment. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.
- 3. Install piping with minimum clearance of at least one inch between extreme projections of piping, flanges, fittings, valves, etc., to allow for insulation, pipe expansion and the like.
- 4. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings or welds will not be permitted. After cutting pipe, ends shall be reamed and cleaned to eliminate foreign matter and burrs.
- 5. Long radius elbows shall be used wherever possible.
- 6. Reductions in line size shall be made with butt-welding reducers, swage nipples, screwed or socket weld reducers.

DO NOT USE BUSHINGS.

- 7. Use eccentric reducing fittings or eccentric reducing couplings where required to prevent pocketing of liquid or noncondensibles.
- 8. Eccentric reducers with the straight side on top shall be installed, when required, on suction side of pumps. Eccentric reducers with the straight side on the bottom shall be installed on pipe racks.
- 9. Make all branch connections with tees, except that on steel piping, forged steel "Weldolets," "Sockolets" or "Threadolets" as manufactured by Bonney Forge, or approved equal, may be used when the branch pipe is smaller than one-half the size of the main pipe (nominal sizes).
- 10. Where a line with lower rating connects to pipe or equipment with a higher rating, it shall take the higher rating to and including the first block valve, block and check valve, or to and including the second valve when double block valves are used.
- F. Strainers:
  - 1. Permanent strainers shall be provided prior where indicated on Piping and Instrument Diagrams, and shall be constructed of the same material described in the Piping Material Specifications.
- G. Valves:
  - 1. The valve type: gate, globe, check, butterfly, ball, etc., shall be as indicated on Piping and Instrument Diagrams. Valve material and end connections shall be provided as specified in the appropriate Piping Material Specifications. If conflicts exists between P. & I.D. and technical specifications, the technical specification shall govern.

- 2. Shutoff valves on both sides of a control valve and the bypass valve shall take the same specification as the line with the higher rating.
- 3. Valves requiring special trim or other features not in agreement with the assigned Piping Material Specification are noted on the Piping and Instrument Diagrams.
- 4. Where a vent line, drain line, etc. connects to a process line that has special trim valves, all valves in the connecting line shall have the special trim.
- 5. All threaded lug type butterfly valves shall be installed using two sets of cap screws.
- 6. Check valves must be installed horizontally, or in a vertical line with upward flow only.
- 7. Globe valves shall be installed with the pressure under the disc.
- 8. All sanitary piping valves shall be free draining in the installed position.
- 9. All control valves shall be easily accessible from grade and conveniently located for operation.
- 10. Relief valves shall be in an upright vertical position. When discharging to atmosphere, provide a 3/8" diameter weephole at low point unless drip pan elbows are used and chamfer outlet pipe end at 30° angle to the direction of flow.
- H. Instruments:
  - 1. Instrument connections on piping and equipment such as local mounted pressure and temperature instruments, gage glass and level controls, shall be accessible from grade or ladders.
  - 2. Instruments (i.e. pressure gauges, thermometers, orifice plates, etc.) are shown on the drawings in their approximate locations. Exact location shall consider visibility and any special installation requirements, and shall be as approved by Energy Systems Group, LLC,. Any relocation required because Contractor failed to obtain approval shall be done at Contractor's expense.
  - 3. Furnish and install 1/2 inch size, 3,000 lb., forged steel weldolets, threadolets, elbowlets or weld couplets with nipples and root valves for all the pressure measuring instruments to be mounted in the piping systems, as shown on the Piping and Instrument Diagrams. Nipples shall be long enough to clear the pipe insulation. Fittings, nipples and valves shall comply with the Piping Material Specification of each piping system.
  - 4. Furnish and install 3/4 inch size 3,000 lb., forged steel weldolets, threadolets, threaded elbowlets or threaded weld couplets for the thermowells for all the temperature measuring instruments to be mounted in the piping systems, as shown on the Piping and Instrument Diagrams.
  - 5. The length of the thermowells shall be at least half the diameter of the pipe in which they are to be inserted up to a maximum of 6 inch in length. The thermowells shall be furnished with lagging extensions to clear the insulation in the piping systems. Thermowells for all services shall be made of stainless steel.

- I. Vents and Drains:
  - 1. Vents and drains shall be provided for liquid piping only and equipment as indicated on the Piping and Instruments Diagrams and on the physical drawings. Vents and drains shall also be provided, in addition to those shown on the drawings, when the arrangement of the piping results in high and low points that cannot be vented or drained through connections shown.
  - 2. Each drain point shall have a valve and a capped nipple. Unless otherwise shown on the drawings, the size of the drains shall be:

1/2" for headers 2" and smaller 3/4" for 2-1/2" thru 4" 1-1/2" for 6" thru 16" 2" for 18" and larger.

- 3. All drains shall be run to the nearest edge of the concrete slab or utilize buckets.
- 4. Manual vents shall have a 1/2" valve for headers 16" and smaller, and a 1" valve for 18" and larger, and shall be arranged so that blow-off water can be caught in a bucket. Automatic air vents, where used, shall be installed with 1/4" tubing to a suitable location.
- 5. Pump casing vents and drains shall be provided as shown on Piping and Instrument Diagrams.
- 6. Sample connections shall be 3/4" size and be made either on top or side of main line, never on the bottom.

Sample lines shall be as short as possible.

# **3.5 FABRICATION**

- A. Fabrication of all piping systems shall be in accordance with ASME B31.9 Building Services Piping.
- B. All welding shall be accomplished using welding procedure specifications and welders/welding operators which have been qualified in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- C. Copies of the applicable welding procedure specifications, including the procedure qualification records (PQR), along with the welder/welding operator qualification test records shall be submitted to Energy Systems Group, LLC for approval prior to performing any work.

- D. All welding performed by the Contractor or fabricator shall be visually inspected to assure compliance to the requirements of the applicable code or standard, (e.g., ASME Section I, or ASME B31.9).
- E. Other nondestructive examinations (NDE), such as radiographic, magnetic particle or liquid penetrant examination, shall be performed as required by the applicable code, or engineering design specification.
- F. Energy Systems Group, LLC reserves the right to inspect by NDE any and all work performed by the Contractor/Fabricator at any time during the manufacturing or erection process. If, as a result of this inspection, a certain welder's work is frequently rejected, Energy Systems Group, LLC will require that the welder be removed from this work and that all work performed by that welder be inspected until Energy Systems Group, LLC is satisfied that the quality of the welder's work meets the requirements of the applicable code, standard, or engineering design specification.
- G. Any welds found defective as a result of Energy Systems Group, LLC NDE construction inspections, shall be replaced at no cost to Energy Systems Group, LLC. The contractor shall bear the cost of retesting the repaired of replaced weld.
- H. Welding on piping systems shall be performed using the Shielded Metal Arc Welding (SMAW) process and/or the Gas Tungsten Arc Welding (GTAW) process.

## **3.6 BASE MATERIALS: CARBON STEEL**

A. For carbon steel welding the base materials shall be restricted to carbon steels, wrought or cast forms, which have a minimum specified tensile strength of 70 KSI or less, and which are found in the following codes and tables:

Codes Tables

ANSI B31.1	Appendix A Table A-I Carbon Steel (P-1 Material)
ASME Section I	PG-23.1 Carbon Steel (P-1 Material)
ASME Section VIII	UCS-23 Carbon Steel (P-1 Material)

## **3.7 FABRICATION - FLANGED JOINTS**

- A. Flange dimensions and drilling are to conform to ANSI Standards for the pressure classes involved.
- B. All bolt holes shall straddle normal horizontal and vertical centerlines of flanges unless noted otherwise on the drawings. All bolt holes are to be spot faced.
- C. Steel flanges which are to be bolted to flat faced flanges on valves or equipment shall be flat faced and furnished with full face gaskets.

- D. All flange facings shall be protected from damage. Any flange facings marred or otherwise damaged shall be refaced.
- E. All flange facings shall be in alignment before bolting is begun. All bolts in flanged joints shall be coated with antiseize thread compound and uniformly tightened. Care shall be taken to obtain uniform pressure on all gaskets and avoid overstressing of bolts or dishing of flanges.
- F. Flanges in piping runs shall not be out of square more than 3/64 inch per foot of outside diameter of flange. Angular tolerances shall be plus or minus 1/2 degree.
- G. The materials of bolts and nuts shall be as specified in the Piping Material Specification for each particular system.
- H. On distilled water, deionized water or other services where sanitation is extremely important, the inside diameter of gaskets must match the inside diameter of flanges, to minimize pockets.

## **3.8 FABRICATION - SCREWED JOINTS**

- A. All pipe threads shall be concentric with the outside of the pipe and conform to ANSI B2.1. The ends shall be reamed after cutting to remove all fines and burrs.
- B. Threading on hydraulic piping shall be in accordance with JIC Standards.
- C. For pipe materials (such as carbon steel to carbon steel, brass to brass, etc.) teflon tape, as specified in the piping material specification, shall be used on make end only, except when seal welding or brazing, etc., is specified.
- D. Seal welding of screwed joints shall not be used unless so specified on the drawings. Where welding is specified, pipe tape shall not be used in the joint and the weld should cover all exposed threads.
- E. On all screwed connections, and particularly at screwed valves, care shall be exercised to guard against overly long threading which would allow the pipe to be screwed into the valve so deeply that seating surfaces could be distorted.
- F. Screwed connections at instrument shall not be seal welded.
- G. Orifice flange taps shall be seal welded in all socket weld piping classes.
- H. Remove any or all cutting or threading oils prior to assembly.

<u>NOTE</u>: THE PIPING SYSTEMS MATERIAL SPECIFICATION SHEETS LISTED IN THE PROJECT INDEX, AND FOLLOWING HEREAFTER, ARE CONSIDERED PART OF THIS SPECIFICATION.

## **END OF SECTION**

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## 231123 - GAS PIPING

## PART 1 - GENERAL

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The following specification included in the contract document also apply to this section.
  - 1. Section 230530, PIPE SUPPORTS & HANGERS
  - 2. Section 231123, HYDRONIC PIPING
- C. The detailed Piping Material Specifications listed in the index are considered part of this document.

#### 1.2 SUMMARY

- A. This Specification covers all labor, materials, equipment, tools, and services as required for a complete installation of above and below ground piping and mechanical equipment.
- B. This Specification, together with the other related specifications referenced herein, Piping and Instrument Diagrams and construction drawings, establishes the requirements for fabrication, erection, inspection, cleaning and testing of the piping systems and their components.

#### **1.3 CODES AND STANDARDS**

- A. Design, materials, labor and workmanship described herein shall be in accordance with all applicable codes and standards including, but not limited to, the following listed codes and standards, including their latest editions and addenda, in effect as of the date specified in Energy Systems Group, LLC's contract. All material and workmanship shall also be in compliance with all applicable Federal, State and Local Codes and laws. Should there be any conflict between any code, standard, and/or specification, the more stringent shall govern.
  - 1. ANSI American National Standards Institute
  - 2. API American Petroleum Institute
  - 3. ASME American Society of Mechanical Engineers
  - 4. ASTM American Society for Testing and Materials
  - 5. AWS American Welding Society

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- 6. AWWA American Water Works Association
- 7. MSS Manufacturer Standardization Society of the Valve and Fitting Industry.
- 8. NFPA National Fire Protection Association
- 9 OSHA Occupational Safety and Health Administration

# 1.4 QUALITY ASSURANCE

- A. Contractors shall have not less than (5) five years experience as a Mechanical Contractor with specific experience in piping fabrication techniques, application and installation of the material types and sizes as referenced herein, and as shown on the engineering drawings and/or as referenced in the bid documents.
- B. The Contractor shall be responsible for the successful start up and operation all equipment and materials installed by the Contractor. Energy Systems Group, LLC shall perform testing on the equipment during start up and operation and the Contractor shall be responsible for correcting any deficiencies or noncompliance, caused by the Contractor's work, in the system at no cost to Energy Systems Group, LLC.
- C. Written inspection records and test reports shall be maintained, these shall include but not be limited to the following.
  - 1. Hydro or pressure test.
  - 2. Visual and x-ray weld inspection.
  - 3. Startup and or functional test.

# 1.5 SUBMITTALS

- A. All submittals shall be in accordance with Section 01330 SUBMITTAL PROCEDURES.
  - 1. All applicable welding procedures.
  - 2. A copy of welder qualification status.
  - 3. Any requests for deviation or substitutions from the materials and methods described herein.
  - 4. A copy of any or all inspection and test records.
  - 5. A copy of all as built drawings.
  - 6. Fabrication drawings.
- B. The Contractor shall submit Manufacturer's delivery date for all the equipment and materials required for the installation.

- C. Certified mill test reports for all piping shall be submitted by the Contractor to the Site Engineer when piping is delivered at the job site.
- D. Closeout Submittals Operation and Maintenance Manuals.

# 1.6 **PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Handle materials in a manner that will not cause overstress, warp, twist or other damage.
- B. Take precautions to prevent damage to protective coatings on surfaces of materials.
- C. Store and protect materials at the site from damage, deterioration and corrosion. If necessary, store materials in weathertight enclosures.
- D. Packaged materials shall be stored in their original unbroken container.
- E. Remove accumulations of mud, dirt and other foreign substances from materials immediately prior to erection.
- F. In the event of damaged items or previously opened packaged materials, immediately repair and/or replace such items as is necessary, to Energy Systems Group, LLC approval, at no extra cost to Energy Systems Group, LLC.
- G. All piping items shall be segregated upon receipt and stored in an orderly manner. Materials shall be kept clean and elevated above grade or floor by timbers, structural steel or other suitable method. Unprotected piping, fittings and components shall be sloped to allow drainage. Materials stored outside shall be protected from damage due to weather conditions.
- H. Stainless steel components shall not be stored in contact with carbon steel, storage rack bends or other carbon steel items. All basic material groups shall be segregated according to material type (i.e. carbon steel, stainless steel, copper, etc.).

# **1.7 PROJECT CONDITIONS**

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Energy Systems Group, LLC or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

- 1. Notify Energy Systems Group, LLC no fewer than two days in advance of proposed interruption of natural-gas service.
- 2. Do not proceed with interruption of natural-gas service without Energy Systems Group, LLC's written permission.
- C. Coordinate sizes and locations of concrete bases with actual equipment provided.

# PART 2 - PRODUCTS

# 2.1 GENERAL

A. All materials shall be in accordance with the Piping Material Specifications listed:

	Addendum	Section Title
231123	А	Landfill Waste Gas- (0-150 PSIG) Above Grade
231123	В	Landfill Waste Gas- (151-400 PSIG) Above Grade
231123	С	Landfill Waste Gas- (401-1000 PSIG) Above Grade
231123	E	Plant Air (CA) Instrument Air (IAS)
231123	F	Process Condensate

Copy of each specification is included in with this specification.

B. All material shall be new, unused, and free of defects and imperfections, and shall be supplied in strict accordance with the applicable Piping Material Specifications.

# NOTE: NO SUBSTITUTIONS ARE PERMITTED WITHOUT WRITTEN CONSENT OF Energy Systems Group, LLC.

- C. All pipe, fittings and valves shall be supplied marked by the manufacturer in accordance with the marking sections of the standards to which reference is made in the Piping Material Specifications, or in accordance with the requirements of MSS SP-25: "Standard Marking System for Valves, Fittings, Flanges and Unions of the Manufacturers Standardization Society of the Valve and Fitting Industry."
- D. All material items shall be carefully inspected upon receipt at the jobsite. The Contractor shall examine all components for compliance with the applicable material class specification, ASTM identification and markings, purchase order compliance including shortages, and over shipments and any damaged or flawed items (i.e. scarred flange faces, bent pipe, damaged threads, beveled ends, etc.), and shall report

his findings to Energy Systems Group, LLC or his representative. Items failing to meet this criteria shall be rejected and held in a separated area for disposition. Disposition of rejected items shall be as agreed upon between the Contractor and Energy Systems Group, LLC or his representative. Items rejected shall be replaced by the Contractor at no cost to Energy Systems Group, LLC.

E. Small diameter carbon steel piping which is normally banded in bundles and tagged with an identifying tag shall be color coded by the Contractor by painting a stripe the entire length of each bundle in accordance with the following color code requirements.

Material Designation	Color Code
ASTM A-53 Grade B	Blue
ASTM A-106 Grade B	Green

Any unidentified materials shall be removed from the jobsite at the Contractor's expense.

- F. All piping, as defined in Process Piping Code ANSI B31.3 and as noted on P&ID's shall be provided with data reports, inspection and stamping as required by Section 1 of the ASME Boiler and Pressure Vessel Code.
- G. Pipe in sizes 24" and smaller shall conform dimensionally to ANSI B36.10 for carbon steel and ANSI B36.19 for stainless steel. Pipe wall thickness shall be as indicated in the Piping Material Specifications.
- H. All steel screwed and socket welding fittings shall conform to ANSI B16.11.
- I. All carbon steel butt-welding fittings shall conform dimensionally to ANSI B16.9, with wall thickness at least equal to that of the pipe on the same service. Where the fitting is heavier than the pipe, ends of fittings shall be beveled to meet code requirements.

## **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

A. The Contractor shall carefully review the engineering drawings of all disciplines, and check for obstructions and interferences. This shall be done during the bid period and prior to proceeding with installation to avoid unnecessary rework later. In addition, the Contractor shall become familiar with the drawings and make note of locations where walls, partitions, ceilings, structural members, etc., are called to be closed-in or to be furred. He shall coordinate this work with other contract trades to avoid interferences or delays in construction.

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- B. Any questionable information in the specifications and/or on the plans, or conflicts with codes, shall be called to the attention of Energy Systems Group, LLC for clarification before proceeding with fabrication or erection of the parts affected. If, in the opinion of the Contractor, any additional detail drawings are necessary, he shall prepare them at his own expense, together with all bills of material.
- C. If modifications to the arrangement of the piping systems are required to suit structural conditions, or to avoid interference with the work of other trades, the Contractor shall furnish all additional materials and labor as required to meet the installation conditions. The Contractor shall furnish all modification requests by "red-lining" the engineering drawings to indicate the necessary change. Energy Systems Group, LLC shall secure approval and sign the requests prior to installation.

#### **3.2 ARRANGEMENT AND ALIGNMENT**

- A. Arrange and align all piping in accordance with the drawings. Elevations as given must be held. Floor elevations where given are to high points of floor. Dimensions must be held as closely as possible. Field check all dimensions for accuracy before pipe is fabricated.
- B. Install all piping straight and as direct as possible, generally forming right angles with, or running parallel with, walls or adjacent piping. All piping shall be neatly spaced, with risers and drops running plumb and true.
- C.
- D. The Contractor shall not scale the construction drawings. Piping and equipment are located in the drawings by dimensions to center lines of building columns, and/or to other pipes, to center line or bottom of pipe elevations, or, by the invert elevation for buried pipe. The Contractor shall check all dimensions in the field before final connections are fabricated.
- E. Drawings showing piping 1-1/2" and smaller are in general diagrammatic and the exact location of these lines shall be determined by the Contractor from field measurements taken by him. The actual arrangement of the small size piping, when erected, shall follow the general locations shown on the drawings as far as practicable. The installation made in this way shall be neat in appearance and convenient to operate, and shall provide for appropriate expansion and drainage.
- F. Coordinate installation of piping systems with other work and/or with existing facilities, to avoid blocking building openings, light fixtures, etc. Piping shall not interfere with access to valves or equipment and shall not obstruct passageways. In general, minimum headroom clearance shall be considered as 7'-0" clear under all

piping, coverings, and appurtenances. Piping shall be installed with sufficient clearance for operation, inspection/ replacement of valves, etc.

#### **3.3 GENERAL**

- A. Install all piping systems for expansion and/or contraction under start-up, operating, shut-down, and steam-out conditions, without overstressing piping, valves or equipment. Pipe anchors, guides, hangers and supports shall be provided as required in accordance with pipe support drawings and the engineering specification labeled, "Pipe Supports and Hangers".
- B. Install anchors where shown on the plans. Furnish guides on each side of all expansion loops, off-sets, swing joints and expansion joints whether or not detailed on the plans.
- C. Piping which is furnished as part of packaged equipment shall conform to the requirements of this specification and the applicable Piping Material Specification.
- D. Special precaution shall be taken at all times during fabrication and erection to prevent entrance of any foreign matter into piping or equipment.
- E. Open end of pipes shall be plugged after fabrication. All openings in pipe or equipment left overnight or for future connection shall be covered to keep foreign particles out of the system. A plastic type plug or cap should be used for temporary protection. Rags or waste are not to be used because they will deposit lint in the openings.
- F. Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 1" larger than the outside diameter of uninsulated pipes or of the insulation for insulated services. When pipe is fitted with restraining rods, the sleeve shall be oversized to accommodate the rods. Holes for sleeves in existing buildings are to be neatly cut.
- G. Sleeve Construction:
  - 1. Interior Partitions: No. 22 gauge galvanized sheet steel with soldered joint.
  - 2. Interior Masonry Walls and Floors: Standard weight galvanized steel pipe, or stainless steel where shown on drawings.
  - 3. Exterior Walls: Standard weight galvanized steel pipe.
- H. Sleeve Caulking:
  - 1. Interior walls and floors: Fill the space between outside of pipe or insulation and the inside of the sleeve, or framed opening, with fiber glass, seal both ends with expanded foam.

- 2. Exterior walls (above ground): Pack with oakum, seal with lead and watertight mastic or asphalt; or install a modular mechanical seal "Link-Seal" as manufactured by the Thunderline Corporation.
- 3. Fire Rated walls and floors: Run pipe through a sleeve 1" larger than the outside diameter of the pipe or insulation (if insulated pipe is called for). The insulation shall be fire resistant. Fill space between the sleeve and the pipe completely with fiberglass wool and grout the ends.

When pipe penetration will be exposed to view an escutcheon plate shall also be furnished and installed.

- I. Provide escutcheons on both sides of wall, floor, ceiling, and partition penetrations for all pipes exposed to view in finished areas, whether or not insulated, unless otherwise shown on the drawings. For pipes passing through floors, escutcheons shall fit over the sleeves. Escutcheons plates shall be stainless steel or chrome plated and fabricated in one piece.
- J. Roof Caulking: Provide caulking, sealants, compressible fillers, flashings and/or rain covers as detailed on the architectural drawings. Coordinate work with roofing contractor.

### 3.4 INSTALLATION - ABOVEGROUND PIPING

- A. Provide unions or flanges at all piping connections to coils, equipment, control valves, pressure reducing valves, steam traps, etc., at all locations as shown on the drawings, and generally as required to disconnect piping from equipment and apparatus. Arrange connections so that the equipment served may be removed without disturbing the piping. Where valves serve to isolate equipment or specialties, the unions or flanges shall be located between valves and equipment or specialties. Unions shall generally be used for pipe sizes 2" and smaller, and flanges for pipe sizes 2-1/2" and larger.
- B. Unless otherwise shown on the plans, install all piping to coils, pumps and other equipment including valves and strainers therein, at line size. If a reduction is required at a pump or control valve, the reducer shall be installed abutting the inlet and/or outlet of the pump or valve. If pump suction strainers are specified, provide pipe reduction at strainer outlet connection to pump inlet.

Piping at pump and driver nozzles shall be arranged to permit removal of pump or driver without removing block valves.

C. Piping shall not be covered or closed in until completion of the piping cleaning, testing and until the installation is approved by Energy Systems Group, LLC Piping that has been covered or concealed without cleaning, testing and approval, shall be exposed at the contractor's expense.

### D. Flanges:

- 1. Except for removable sections of pipe and for piping requiring dismantling for cleaning, use of companion flanges in piping shall be limited to connections at flanged equipment. Field joints may be flanged construction where expedient and economical to avoid field welding of joint requiring heat treatment and examination.
- 2. The location of flanged joints are shown on piping drawings. Bolt holes of flanges shall straddle the center lines of pipe unless otherwise shown and noted on drawings. Each piping material specification describes the type of flanges to be used and gives the rating, material, facing, etc. When a different type of flange is used, its location and description is shown on the drawings.
- 3. Blinds shall be provided as indicated on piping drawings and Piping and Instrument Diagrams. Material shall be the same as the piping in the line where it is used. Blinds shall be accessible from grade or platforms.
- 4. All orifice flanges shall be welding neck type, ANSI Class 300 minimum rating, and 2" minimum pipe size. Orifice plates shall be 1/8" thick for lines 12" and smaller, and 1/4" for lines 14" and larger, unless otherwise noted. The preferred installation of orifice flanges is in a horizontal line.

## E. Piping:

- 1. All assembled piping shall be worked in place without springing or forcing, except as specified on the drawings, to properly clear all openings and equipment. All piping shall be installed to permit free expansion and contraction without damage to joints, hangers, or to insulation where it is applied.
- 2. All piping shall be erected and supported in a manner that will not put undue strain on pumps, tanks, or equipment. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.
- 3. Install piping with minimum clearance of at least one inch between extreme projections of piping, flanges, fittings, valves, etc., to allow for insulation, pipe expansion and the like.
- 4. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings or welds will not be permitted. After cutting pipe, ends shall be reamed and cleaned to eliminate foreign matter and burrs.
- 5. Long radius elbows shall be used wherever possible.
- 6. Reductions in line size shall be made with butt-welding reducers, swage nipples, screwed or socket weld reducers.

DO NOT USE BUSHINGS.

7. Use eccentric reducing fittings or eccentric reducing couplings where required to prevent pocketing of liquid or noncondensibles.

- 8. Eccentric reducers with the straight side on top shall be installed, when required, on suction side of pumps. Eccentric reducers with the straight side on the bottom shall be installed on pipe racks.
- 9. Make all branch connections with tees, except that on steel piping, forged steel "Weldolets," "Sockolets" or "Threadolets" as manufactured by Bonney Forge may be used when the branch pipe is smaller than one-half the size of the main pipe (nominal sizes).
- 10. Where a line with lower rating connects to pipe or equipment with a higher rating, it shall take the higher rating to and including the first block valve, block and check valve, or to and including the second valve when double block valves are used.
- F. Strainers:
  - 1. Permanent strainers shall be provided prior to all control valves and where indicated on Piping and Instrument Diagrams, and shall be constructed of the same material described in the Piping Material Specifications.
  - 2. All pumps and compressors not equipped with a permanent suction strainer shall have a temporary strainer installed between the suction valve and the equipment before start-up of the unit. The temporary strainer shall be as specified on the Piping Material Specifications, or per the compressor vendor's recommendation.
- G. Valves:
  - 1. The valve type: gate, globe, check, butterfly, ball, etc., shall be as indicated on Piping and Instrument Diagrams. Valve material and end connections shall be provided as specified in the appropriate Piping Material Specifications. If conflicts exists between P. & I.D. and technical specifications, the technical specification shall govern.
  - 2. Shutoff valves on both sides of a control valve and the bypass valve shall take the same specification as the line with the higher rating.
  - 3. Valves requiring special trim or other features not in agreement with the assigned Piping Material Specification are noted on the Piping and Instrument Diagrams.
  - 4. Where a vent line, drain line, etc. connects to a process line that has special trim valves, all valves in the connecting line shall have the special trim.
  - 5. All threaded lug type butterfly valves shall be installed using two sets of cap screws.
  - 6. Check valves must be installed horizontally, or in a vertical line with upward flow only.
  - 7. Globe valves shall be installed with the pressure under the disc.
  - 8. All sanitary piping valves shall be free draining in the installed position.
  - 9. All control valves shall be easily accessible from grade or permanent platforms and conveniently located for operation.

- 10. Relief valves shall be in an upright vertical position. When discharging to atmosphere, provide a 3/8" diameter weephole at low point unless drip pan elbows are used and chamfer outlet pipe end at 30° angle to the direction of flow.
- H. Instruments:
  - 1. Instrument connections on piping and equipment such as local mounted pressure and temperature instruments, gage glass and level controls, shall be accessible from grade, platforms or ladders.
  - 2. Instruments (i.e. pressure gauges, thermometers, orifice plates, etc.) are shown on the drawings in their approximate locations. Exact location shall consider visibility and any special installation requirements, and shall be as approved by Energy Systems Group, LLC. Any relocation required because Contractor failed to obtain approval shall be done at Contractor's expense.
  - 3. Furnish and install 1/2 inch size, 3,000 lb., forged steel weldolets, threadolets, elbowlets or weld couplets with nipples and root valves for all the pressure measuring instruments to be mounted in the piping systems, as shown on the Piping and Instrument Diagrams. Nipples shall be long enough to clear the pipe insulation. Fittings, nipples and valves shall comply with the Piping Material Specification of each piping system.
  - 4. Furnish and install 3/4 inch size 3,000 lb., forged steel weldolets, threadolets, threaded elbowlets or threaded weld couplets for the thermowells for all the temperature measuring instruments to be mounted in the piping systems, as shown on the Piping and Instrument Diagrams.
  - 5. The length of the thermowells shall be at least half the diameter of the pipe in which they are to be inserted up to a maximum of 6 inch in length. The thermowells shall be furnished with lagging extensions to clear the insulation in the piping systems. Thermowells for all services shall be made of stainless steel.
- I. Vents and Drains:
  - 1. Vents and drains shall be provided for the piping and equipment as indicated on the Piping and Instruments Diagrams and on the physical drawings. Vents and drains shall also be provided, in addition to those shown on the drawings, when the arrangement of the piping results in high and low points that cannot be vented or drained through connections shown.
  - 2. Each drain point shall have a valve and a capped nipple. Unless otherwise shown on the drawings, the size of the drains shall be:

1/2" for headers 2" and smaller 3/4" for 2-1/2" thru 4" 1-1/2" for 6" thru 16" 2" for 18" and larger.

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- 3.
- 4. Manual vents shall have a 1/2" valve for headers 16" and smaller, and a 1" valve for 18" and larger, and shall be piped arranged so that blow-off water can be caught in a bucket. Automatic air vents, where used, shall be installed with 1/4" tubing to a suitable location.
- 5. Pump casing vents and drains shall be provided as shown on Piping and Instrument Diagrams.
- 6. Sample connections shall be 3/4" size and be made either on top or side of main line, never on the bottom.

Sample lines shall be as short as possible.

## 3.5 FABRICATION

- A. Fabrication of all piping systems shall be in accordance with the Process Piping Code ANSI B31.3.
- B. All welding shall be accomplished using welding procedure specifications and welders/welding operators which have been qualified in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- C. Copies of the applicable welding procedure specifications, including the procedure qualification records (PQR), along with the welder/welding operator qualification test records shall be submitted to Energy Systems Group, LLC for approval prior to performing any work.
- D. All welding performed by the Contractor or fabricator shall be visually inspected to assure compliance to the requirements of the applicable code or standard, (e.g., ASME Section I, or ANSI B31.3).
- E. Other nondestructive examinations (NDE), such as radiographic, magnetic particle or liquid penetrant examination, shall be performed as required by the applicable code, or engineering design specification.
- F. Energy Systems Group, LLC reserves the right to inspect by NDE any and all work performed by the Contractor/Fabricator at any time during the manufacturing or erection process. If, as a result of this inspection, a certain welder's work is frequently rejected, Energy Systems Group, LLC will require that the welder be removed from this work and that all work performed by that welder be inspected until Energy Systems Group, LLC is satisfied that the quality of the welder's work meets the requirements of the applicable code, standard, or engineering design specification.

- G. Any welds found defective as a result of Energy Systems Group, LLCNDE construction inspections, shall be replaced at no cost to Energy Systems Group, LLC. The contractor shall bear the cost of retesting the repaired of replaced weld.
- H. Welding on piping systems shall be performed using the Shielded Metal Arc Welding (SMAW) process and/or the Gas Tungsten Arc Welding (GTAW) process.
- I. Contractor shall spot x-ray 5% of all steam, gas, and pipe welds for ASME B31.3 section 341.5.1.

#### **3.6 BASE MATERIALS: CARBON STEEL**

A. For carbon steel welding the base materials shall be restricted to carbon steels, wrought or cast forms, which have a minimum specified tensile strength of 70 KSI or less, and which are found in the following codes and tables:

Codes	<u>Tables</u>
ANSI B31.3	Appendix A Table A-I Carbon Steel (P-1 Material)
ASME Section I	PG-23.1 Carbon Steel (P-1 Material)
ASME Section VIII	UCS-23 Carbon Steel (P-1 Material)

#### 3.7 BASE MATERIALS: STAINLESS STEEL

A. For stainless steel welding the base materials shall be restricted to stainless steels, wrought or cast forms, which have a minimum specified tensile strength of 70 KSI or less, and which are found in the following codes and tables:

Tables

Codes

ASME B31.3 Appendix A Table A-1 Stainless Steel

- B. Filler Materials:
  - 1. All covered electrodes, bare wire and rods, flux, and consumable inserts, shall conform to the SFA requirements of ASME Section II, Part C, ASME Section IX Weld Metal Analysis Number A-8.
  - 2. Tungsten electrodes used for the GTAW process shall conform to the requirements of AWS 5.4-69.
  - 3. Backing rings and consumable inserts are not to be used without specific approval by Energy Systems Group, LLC.

- C. Preparation of Base Metal:
  - 1. The joint edges shall be prepared by machining, grinding, shearing, plasma arc, or carbon arc air gouging. Regardless of which method of joint preparation is used, the welding groove shall be smooth, sound metal free of slag, scale and oxides. Only brushes containing stainless steel bristles shall be used on Stainless Steel material.
  - 2. The joint preparation and adjacent base metal surfaces for one inch adjacent to each edge of the joint preparation shall be free of grease, rust, scale, dirt, paint, lacquer, or other material detrimental to the weld. Cleaning may be accomplished by wire brushing, abrasive blasting, grinding with rubber or resin bonded alumina or silicon carbide grinding wheels, or carbide tools, or by an approved solvent cleaner.
  - 3. For butt weld fittings, the angle of bevel will be acceptable provided it is in accordance with ANSI B16.25, or if it is not less than 30° nor more than 40° measured from a square cut across the pipe.
- D. Fit-up and Tack Welding:
  - 3. Fit-up shall be accomplished using clamps, alignment lugs, tack welds or other appropriate means to properly align the joint for welding. Whenever possible, mechanical means for alignment should be used. If alignment, lugs and/or temporary attachments are used, the material must be of stainless steel.
  - 4. The inside surfaces of piping components to be joined by butt welding shall be aligned so that the misalignment at any point on the inside circumference does not exceed 1/16 inch or 1/4 of the nominal thickness of the component with the thinnest wall, whichever is smaller.
  - 5. If required, to meet fit-up tolerances, material surfaces may be built up by buttering with weld metal in accordance with an approved procedure.
  - 6. Tack and temporary attachment welds shall be made by a qualified welder or shall be removed.
  - 7. Tack welds which are not removed shall be made with an electrode which is the same as the electrode to be used for the first pass.
  - 8. Tack welds must be thoroughly cleaned, ground smooth, carefully examined for cracks, and all cracks removed before additional metal may be deposited.
  - 9. No metal shall be tack-welded inside the pipe for alignment purposes.
  - 10. Tack welds shall be kept to a minimum number and size. When tack welds in open butt single bevel pipe joints are to be incorporated into the production weld, their ends shall be feathered.
- E. At least one pass per 1/8" of wall thickness shall be made. Downward welding will not be permitted. The finished weld shall be uniform, with the toe or edge of the weld merging smoothly into the base metal. Butt welds shall have slight reinforcement built up gradually from toe or edge toward the center of the weld.

Fillet welds may be slightly concave on the finished surface. No undercutting or overlapping is permitted.

- F. All welds shall be full penetration, homogeneous with no voids.
- G. In all cases, the welding procedure used shall be one which will produce a weld having an inside surface which is smooth and free from cracks, crevices, or "icicles."
- H. All slag or flux remaining on any bead of welding shall be removed before laying down the next successive bead. The finished pass shall be cleaned thoroughly of all flux by first wire brushing, then lightly chipping, and then wire brushing the weld for final cleaning.
- I. Heating of pipe and fittings for straightening will not be permitted without prior approval of Energy Systems Group, LLC's representative.
- J. Minimum preheat and interpass temperature shall comply with the applicable piping design code (i.e., ASME B31.3) latest edition.
- K. Welding Repairs:
  - 1. Cracks or blow holes or any other weld defects shall be removed by grinding, carbon arc air gouging, or thermal cutting and the prepared cavity shall be so that the angle permits easy electrode manipulation. Care shall be exercised to remove the minimum amount of material necessary to eliminate the defect. Peening to cover defects shall not be allowed.
  - 2. A weld technique sheet per this procedure shall be used in making weld repairs. The contour and dimensions of the repair cavity may differ from the original joint.
- L. For stainless steel welding each welder shall identify his production welds by stamping his regularly assigned identification number on the pipe adjacent to the weld on all stainless steel material. Stamps shall be low stress type with a round or "U" shaped cross section.

#### **3.8 FABRICATION - FLANGED JOINTS**

- A. Flange dimensions and drilling are to conform to ANSI Standards for the pressure classes involved.
- B. All bolt holes shall straddle normal horizontal and vertical centerlines of flanges unless noted otherwise on the drawings. All bolt holes are to be spot faced.
- C. Steel flanges which are to be bolted to flat faced flanges on valves or equipment shall be flat faced and furnished with full face gaskets.

- D. All flange facings shall be protected from damage. Any flange facings marred or otherwise damaged shall be refaced.
- E. All flange facings shall be in alignment before bolting is begun. All bolts in flanged joints shall be coated with antiseize thread compound and uniformly tightened. Care shall be taken to obtain uniform pressure on all gaskets and avoid overstressing of bolts or dishing of flanges.
- F. Flanges in piping runs shall not be out of square more than 3/64 inch per foot of outside diameter of flange. Angular tolerances shall be plus or minus 1/2 degree.
- G. The materials of bolts and nuts shall be as specified in the Piping Material Specification for each particular system.
- H. On distilled water, deionized water or other services where sanitation is extremely important, the inside diameter of gaskets must match the inside diameter of flanges, to minimize pockets.

#### **3.9 FABRICATION - SCREWED JOINTS**

- A. All pipe threads shall be concentric with the outside of the pipe and conform to ANSI B2.1. The ends shall be reamed after cutting to remove all fines and burrs.
- B. Threading on hydraulic piping shall be in accordance with JIC Standards.
- C. For pipe materials (such as carbon steel to carbon steel, brass to brass, etc.) teflon tape, as specified in the piping material specification, shall be used on make end only, except when seal welding or brazing, etc., is specified.
- D. Seal welding of screwed joints shall not be used unless so specified on the drawings. Where welding is specified, pipe tape shall not be used in the joint and the weld should cover all exposed threads.
- E. On all screwed connections, and particularly at screwed valves, care shall be exercised to guard against overly long threading which would allow the pipe to be screwed into the valve so deeply that seating surfaces could be distorted.
- F. Screwed connections at instrument shall not be seal welded.
- G. Orifice flange taps shall be seal welded in all socket weld piping classes.
- H. Remove any or all cutting or threading oils prior to assembly.

#### 3.10 PAINTING

- A. Paint exposed, carbon steel piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating. Do not paint stainless steel piping.
  - 1. Alkyd System: MPI EXT 5.1D.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    - c. Topcoat: Exterior alkyd enamel gloss.
    - d. Color: Energy Systems Group, LLC specified.
- B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

<u>NOTE</u>: THE PIPING SYSTEMS MATERIAL SPECIFICATION SHEETS LISTED IN THE PROJECT INDEX, AND FOLLOWING HEREAFTER, ARE CONSIDERED PART OF THIS SPECIFICATION.

# 231123 (ADDENDUM – A) - LANDFILL WASTE GAS- ABOVE GRADE (LFG)

SERVICE:	LANDFILL GAS
MATERIAL:	CARBON STEEL
PRESSURE:	RANGE 0 THRU 150 PSIG
TEMPERATURE:	RANGE -20°F THRU 150°F

ITEM	SIZE	DESCRIPTION
PIPE	1/2" thru 2" 2-1/2" thru 12"	Carbon steel Schedule 80 ASTM A-106 Grade B seamless ANSI B36.10 Carbon steel standard weight ASTM A-53 Grade B seamless beveled ends ANSI B36.10
TYPE OF	1/2" thru 2"	Socket weld
JOINT	2-1/2" thru 12"	Butt welded or flanged as applicable
FITTINGS	1/2" thru 2"	Forged carbon steel ASTM A105 3000# ANSI B16.11 socket weld ends
	2-1/2" thru 12"	Carbon steel ASTM A-234 WPB standard weight ANSI B16.9
NIPPLES	1/2" thru 2"	Carbon steel ASTM A-106 Grade B Schedule 80 threaded both ends
UNIONS	1/2" thru 2"	Forged carbon steel ASTM A105 3000# ANSI B16.11 integral seat socket weld ends
FLANGES	1/2" thru 2" 2-1/2" thru 12"	Socket weld schedule 80 bore forged steel ANSI 150# class ASTM A-105 raised face ANSI B16.5 Weld neck forged steel ANSI 150# class ASTM A-105 standard bore raised face ANSI B16.5 <u>Exception</u> : Use flat face flanges when mating with flat faced flanges on valves or equipment
GASKETS	1/2" thru 12"	1/16" thick ANSI 150# ring type compressed synthetic fiber with SBR binder (Use FF gaskets with FF flanges)
THREAD SEALANT		Teflon ribbon 1/2" wide x 4 mils thick
BOLTS		Machine Bolts - Carbon Steel ASTM A-307 Grade B; Thread ANSI B1.1 Class 2A Heavy Hex Nuts – Carbon Steel ASTM A-563 Grade A; Thread ANSI B1.1 Class 2B <u>Exception</u> : Use cadmium plated bolts and nuts for outdoor installations
ITEM	SIZE	DESCRIPTION

BALL VALVES	1/2" thru 3"	Ball valve 600 WOG rating UL listed Body: Forged steel ASTM A105 Trim: Hard chrome plated bronze ball and stem Seats & Seals: RTFE (Reinforced Teflon) Ends: Socket weld Features: Blow-out proof stem
BUTTERFLY VALVES	3" thru 12"	Blow-out proof stem 150 PSIG rating at 366°F Butterfly valve ANSI 150# class (High Performance) Body: Carbon steel ASTM A-216 WCB Threaded lug pattern Disc: Stainless steel Type 316 Stem: 17-4 PH SS Seat: Reinforced Teflon (RTFE) or PFA/Viton or Buna-N Seals: Teflon/reinforced Teflon Features: Manual locking lever Manual worm gear-operator for 6" and larger valves Bi-directional dead end service
CHECK VALVES	1/2" thru 2"	Check valve 200# class swing type Body: Cast carbon steel ASTM A216 WCB Trim: Steel Ends: Flanged ends 150# class Features: Swing type Screwed cap Horizontal or vertical installation (however, the pressure must be under the disc) Renewable disc Integral seats
ITEM	SIZE	DESCRIPTION

CHECK VALVES	2-1/2" thru 12"	Check valve ANSI 150# class wafer type Body: Cast carbon steel ASTM A-216 WCB Trim: Carbon steel Seats: Buna-N Features: Wafer type Dual disc non-slam 316 SS spring and hinge pin
CHECK VALVES	1/2" thru 2"	Check valve 300# class swing type Body: Cast carbon steel ASTM A216 WCB Trim: Steel Ends: Flanged ends 300# class Features: Swing type Screwed cap Horizontal or vertical installation (however, the pressure must be under the disc) Renewable disc Integral seats

## 231123 (ADDENDUM – B) - LANDFILL WASTE GAS - ABOVE GRADE (LFG)

SERVICE:	LANDFILL GAS
MATERIAL:	CARBON STEEL
PRESSURE:	RANGE 151 THRU 400 PSIG
TEMPERATURE:	RANGE -20°F THRU 400°F

ITEM	SIZE	DESCRIPTION
PIPE	1/2" thru 2"	Carbon steel Schedule 80 ASTM A-106 Grade B seamless ANSI B36.10
	2-1/2" thru 12"	Carbon steel standard weight ASTM A-53 Grade B seamless beveled ends ANSI B36.10
TYPE OF	1/2" thru 2"	Socket weld
JOINT	2-1/2" thru 12"	Butt welded or flanged as applicable
FITTINGS	1/2" thru 2"	Forged carbon steel ASTM A105 3000# ANSI B16.11 socket weld ends
	2-1/2" thru 12"	Carbon steel ASTM A-234 WPB standard weight ANSI B16.9
NIPPLES	1/2" thru 2"	Carbon steel ASTM A-106 Grade B Schedule 80 threaded both ends
UNIONS	1/2" thru 2"	Forged carbon steel ASTM A105 3000# ANSI B16.11 integral seat socket weld ends
FLANGES	1/2" thru 2" 2-1/2" thru 12"	Socket weld schedule 80 bore forged steel ANSI 300# class ASTM A-105 raised face ANSI B16.5 Weld neck forged steel ANSI 300# class ASTM A-105 standard bore raised face ANSI B16.5 <u>Exception</u> : Use flat face flanges when mating with flat faced flanges on valves or equipment
GASKETS	1/2" thru 12"	1/16" thick ANSI 300# ring type compressed synthetic fiber with SBR binder (Use FF gaskets with FF flanges)
THREAD SEALANT		Teflon ribbon 1/2" wide x 4 mils thick
BOLTS		Machine Bolts - Carbon Steel ASTM A-307 Grade B; Thread ANSI B1.1 Class 2A Heavy Hex Nuts – Carbon Steel ASTM A-563 Grade A; Thread ANSI B1.1 Class 2B
ITEM	SIZE	DESCRIPTION

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BALL VALVES	1/2" thru 3"	Ball valve 600 WOG rating UL listed Body: Forged steel ASTM A105 Trim: Hard chrome plated bronze ball and stem Seats & Seals: RTFE (Reinforced Teflon) Ends: Socket weld Features:
		Blow-out proof stem 150 PSIG rating at 366°F
BUTTERFLY VALVES	3" thru 12"	Butterfly valve ANSI 300# class (High Performance) Body: Carbon steel ASTM A-216 WCB Threaded lug pattern Disc: Stainless steel Type 316 Stem: 17-4 PH SS Seat: Reinforced Teflon (RTFE) or PFA/Viton or Buna-N Seals: Teflon/reinforced Teflon Features: Manual locking lever Manual locking lever Manual worm gear-operator for 6" and larger valves Bi-directional dead end service
CHECK VALVES	1/2" thru 2"	Check valve 300# class swing type Body: Cast carbon steel ASTM A216 WCB Trim: Steel Ends: Flanged ends 300# class Features: Swing type Screwed cap Horizontal or vertical installation (however, the pressure must be under the disc) Renewable disc Integral seats
ITEM	SIZE	DESCRIPTION

CHECK VALVES	2-1/2" thru 12"	Check valve ANSI 300# class wafer type Body: Cast carbon steel ASTM A-216 WCB Trim: Carbon steel Seats: Buna-N Features: Wafer type Dual disc non-slam 316 SS spring and hinge pin
STRAINERS	<sup>1</sup> ⁄4" thru 2"	Cast carbon steel "Y" pattern socket weld end connections Self cleaning strainer ASTM A-216 WCB 0.033 or 0.045 perforated stainless steel screen (Alternate: Monel)
STRAINERS	2-1/2" thru 12"	Cast Steel 300# ANSI flanged "Y" pattern Self-cleaning strainer ASTM A-216 WCB 0.045 perforated stainless steel screen (Alternate: Monel)
TEMPORARY STRAINERS	2 ½" thru 12"	Stainless steel conical strainer with 1/8" perforations 14 gage Flange ANSI 300# class

## 231123 (ADDENDUM – C) - LANDFILL WASTE GAS - ABOVE GRADE (LFG)

SERVICE:	LANDFILL GAS
MATERIAL:	CARBON STEEL
PRESSURE:	RANGE 401 THRU 1000 PSIG
TEMPERATURE:	RANGE -20°F THRU 600°F

ITEM	SIZE	DESCRIPTION
PIPE	1/2" thru 2"	Carbon steel Schedule 80 ASTM A-106 Grade B seamless ANSI B36.10
	2-1/2" thru 6"	Carbon steel standard weight ASTM A-53 Grade B seamless beveled ends ANSI B36.10
TYPE OF	1/2" thru 2"	Socket weld
JOINT	2-1/2" thru 6"	Butt welded or flanged as applicable
FITTINGS	1/2" thru 2"	Forged carbon steel ASTM A105 3000# ANSI B16.11 socket weld ends
	2-1/2" thru 6"	Carbon steel ASTM A-234 WPB standard weight ANSI B16.9
NIPPLES	1/2" thru 2"	Carbon steel ASTM A-106 Grade B Schedule 80 threaded both ends
UNIONS	1/2" thru 2"	Forged carbon steel ASTM A105 3000# ANSI B16.11 integral seat socket weld ends
FLANGES	1/2" thru 2" 2-1/2" thru 6"	Socket weld schedule 80 bore forged steel ANSI 600# class ASTM A-105 raised face ANSI B16.5 Weld neck forged steel ANSI 600# class ASTM A-105 standard bore raised face ANSI B16.5
GASKETS	1/2" thru 6"	1/16" thick ANSI 600# ring type compressed synthetic fiber with SBR binder (Use FF gaskets with FF flanges)
THREAD SEALANT		Teflon ribbon 1/2" wide x 4 mils thick
BOLTS		Machine Bolts - Carbon Steel ASTM A-307 Grade B; Thread ANSI B1.1 Class 2A Heavy Hex Nuts – Carbon Steel ASTM A-563 Grade A; Thread ANSI B1.1 Class 2B
ITEM	SIZE	DESCRIPTION

Advanced Engineering Consultants Landfill Waste Gas-Above Grade (LFG) 231123 (Addendum C)-1 (rev 07072023)

		Ball valve 600 WOG rating UL listed
BALL VALVES	1/2" thru 3"	Body: Forged steel ASTM A105 Trim: Hard chrome plated bronze ball and stem Seats & Seals: RTFE (Reinforced Teflon) Ends: Socket weld Features: Blow-out proof stem 600 PSIG rating at 366°F
PLUG VALVES	1/2" thru 2"	<ul> <li>Plug valve Class 600 lubricated or non-lubricated</li> <li>Body: Cast carbon steel ASTM A216 WCB</li> <li>Plug: Cast iron ASTM A-126 Class B     <ul> <li>Stainless Steel Plug for non-lubricating</li> </ul> </li> <li>Ends: Flanged ends Class 600</li> <li>Features:     <ul> <li>Regular pattern</li> <li>Lubricated plug or non-lubricated</li> <li>Wrench operated</li> </ul> </li> </ul>
PLUG VALVES	3" thru 6"	Plug valve Class 600 lubricated or non-lubricated Body: Cast carbon steel ASTM A-216WCB Plug: Cast iron ASTM A-126 Grade B Ends: Buttweld ANSI B16.10/B16.25 Flanged ends Class 600 Features: Regular pattern Lubricated plug or non-lubricated Wrench operated
ITEM	SIZE	DESCRIPTION

BUTTERFLY VALVES	3" thru 6"	Butterfly valve ANSI Class 600 (High Performance) Body: Carbon steel ASTM A-216 WCB Threaded lug pattern Disc: Stainless steel Type 316 Stem: 17-4 PH SS Seat: Reinforced Teflon (RTFE) or PFA/Viton or Buna-N Seals: Teflon/reinforced Teflon Features: Manual locking lever Manual worm gear-operator for 6" valves Bi-directional dead end service
CHECK VALVES	1/2" thru 2"	Check valve Class 600 swing type Body: Cast carbon steel ASTM A216 WCB Trim: Steel Ends: Flanged ends Class 600 Features: Swing type Screwed cap Horizontal or vertical installation (however, the pressure must be under the disc) Renewable disc Integral seats
CHECK VALVES	2-1/2" thru 6"	Check valve ANSI Class 600 wafer type Body: Cast carbon steel ASTM A-216 WCB Trim: Carbon steel Seats: Buna-N Features: Wafer type Dual disc non-slam 316 SS spring and hinge pin
ITEM	SIZE	DESCRIPTION

STRAINERS	<sup>1</sup> ⁄4" thru 2"	Cast carbon steel "Y" pattern socket weld end connections Self cleaning strainer ASTM A-216 WCB 0.033 or 0.045 perforated stainless steel screen (Alternate: Monel)
STRAINERS	2-1/2" thru 6"	Cast Steel 600# ANSI flanged "Y" pattern Self-cleaning strainer ASTM A-216 WCB 0.045 perforated stainless steel screen (Alternate: Monel)
TEMPORARY STRAINERS	2 ½" thru 6"	Stainless steel conical strainer with 1/8" perforations 14 gage Flange ANSI 600# class

# 231123 (ADDENDUM D) - GLYCOL CHILLED WATER (CHWS/CHWR)

CHILLED WATER (CHWS, CHWR)
CARBON STEEL
RANGE 0 THRU 150 PSIG
RANGE 0°F THRU 150°F

ITEM	SIZE	DESCRIPTION
PIPE	1/2" thru 2" 2-1/2" thru 12"	Carbon steel standard weight ASTM A-53 Grade B seamless threaded & coupled ANSI B36.10 Carbon steel standard weight ASTM A-53 grade B seamless beveled ends ANSI B36.10
TYPE OF	1/2" thru 2"	Screwed NPT
JOINT	2-1/2" thru 12"	Butt welded or flanged as applicable
FITTINGS	1/2" thru 2" 2-1/2" thru 12"	Malleable iron ASTM A-197 150# ANSI B16.3 screwed ends black Carbon steel ASTM A-234 WPB standard weight ANSI B16.9
NIPPLES	1/2" thru 2"	Carbon steel ASTM A-106 Grade B Schedule 80 threaded both ends
UNIONS	1/2" thru 2"	Malleable iron 300# class ASTM A-197 bronze to iron seats
FLANGES	1/2" thru 2" 2-1/2" thru 12"	Screwed forged steel ANSI 150# class ASTM A-105 raised face ANSI B16.5 Weld neck forged steel ANSI 150# class ASTM A-105 standard bore raised face ANSI B16.5 <u>Exception</u> : Use flat face flanges when mating with flat faced flanges on valves or equipment
GASKETS	1/2" thru 2"	1/16" thick ANSI 150# ring type compressed synthetic fiber with SBR binder (Use FF gaskets with FF flanges)
THREAD SEALANT		Teflon ribbon 1/2" wide x 4 mils thick
BOLTS		Machine Bolts - Carbon Steel ASTM A-307 Grade B; thread ANSI B1.1 Class 2A Heavy Hex Nuts - Carbon Steel ASTM A-563 Grade A; thread ANSI B1.1 Class 2B <u>Exception</u> : Use cadmium plated bolts and nuts for outdoor installations

ITEM	SIZE	DESCRIPTION
BALL VALVES	1/2" thru 3"	Ball Valve 600# WOG rating Body: Bronze ASTM B-61 Trim: Hard chrome plated bronze ball and stem Seats & Seals: RTFE (Reinforced Teflon) Ends: Screwed NPT Features: Blow-out proof stem 2-1/4" stem extension (insulated systems) 150 PSIG rating at 366°F
BUTTERFLY VALVES	4" thru 12"	Butterfly valve ANSI 150# class (High Performance) Body: Carbon steel ASTM A-216 WCB Threaded lug pattern Disc: Stainless steel Type 316 Stem: 17-4 PH SS Seat: Reinforced Teflon (RTFE) or PFA/Viton Seals: Teflon/reinforced Teflon Features: Manual locking lever Manual worm gear-operator for 6" and larger valves Bi-directional dead end service
CHECK VALVES	1/4" thru 2"	Check valve 150# class swing type Body: Bronze ASTM B-62 Trim: Bronze Ends: Screwed NPT Features: Renewable disc Integral seats Horizontal or vertical installation

ITEM	SIZE	DESCRIPTION
CHECK VALVES	2-1/2" thru 12"	Check valve 125# class Globe type Body: Cast iron ASTM A-126 Class B Trim: 304 Stainless steel Seat: 304 Stainless steel Ends: Flanged F.F. ANSI B16.1 Features: Disc type Spring loaded non-slam center guided 304 SS spring

GATE VALVES	1/2" thru 2"	Gate valve 150# class 300# (-20 to 150°F) WOG rating Body: Bronze B-62 Trim: Bronze B-62 Ends: Screwed NPT Features: Union bonnet Rising stem Solid wedge disc TFE impregnated Non-asbestos packing
ITEM	SIZE	DESCRIPTION
GATE VALVES	2-1/2" thru 12"	Gate valve ANSI 125# class 200#(-20 to 150°F) WOG rating Body: IBBM cast iron ASTM A-126 Trim: Bronze seat and stem Ends: Flanged FF ANSI B16.1 Features: OS&Y Bolted bonnet Rising stem Solid wedge disc
GLOBE VALVES	1/2" thru 2"	Globe Valve 150# Class Body: Bronze ASTM B-62 Trim: Bronze ASTM B-62 Ends: Screwed NPT

		Features: Union bonnet Rising stem Renewable solid virgin TFE (Teflon) disc
STRAINERS	1/4" thru 2"	Strainer Bronze ASTM B-62 (Alternate B-61) "Y" pattern Threaded end connections Self-cleaning Rating: 400# WOG @ 150°F 0.033 perforated SS screen (Alternate: Monel)
ITEM	SIZE	DESCRIPTION
STRAINERS	2-1/2" thru 12"	Strainer Cast Iron ASTM A-278 Class 30 "Y" pattern 125#, flanged ends Self-cleaning Rating: 400# WOG @ 150°F 0.045 perforated SS screen (Alternate: Monel)
TEMPORARY STRAINERS	2-1/2" thru 12"	Strainer Stainless Steel Conical Strainer ANSI 150#, flanged ends 1/8" perforated 14 gauge screen

Advanced Engineering Consultants Glycol Cooling Water (CWSCWR) 231123 (Addendum D)-6 (rev 07072023)

## 231123 (ADDENDUM E) – PLANT AIR (CA) INSTRUMENT AIR (IAS)

SERVICE:PLANT AIR (CA) INSTRUMENT AIR (IAS)MATERIAL:CARBON STEELPRESSURE:RANGE 0 THRU 150 PSIGTEMPERATURE:RANGE 38°F THRU 120°F

ITEM	SIZE	DESCRIPTION
PIPE (See note #1 at	1/2" thru 2"	Carbon steel standard weight ASTM A-53 Grade B seamless threaded & coupled ANSI B36.10
end of spec.)	2-1/2" thru 4"	Carbon steel standard weight ASTM A-53 Grade B seamless beveled ends ANSI B36.10.
TYPE OF JOINT	1/2" thru 2"	Screwed NPT
FITTINGS	1/2" thru 2"	Malleable iron ASTM A-197 150# ANSI B16.3 screwed ends black
	2-1/2" thru 4"	Carbon steel ASTM A-234 WPB standard weight ANSI B16.9
NIPPLES	1/2" thru 2"	Carbon steel ASTM A-106 Grade B Schedule 80 threaded both ends
UNIONS	1/2" thru 2"	Malleable iron 300# class ASTM A-197 bronze to iron seats
FLANGES	1/2" thru 2"	Screwed forged steel ANSI 150# class ASTM A-105 raised face ANSI B16.5
	2-1/2" thru 4"	Weld neck forged steel ANSI 150# class ASTM A-105 standard bore raised face ANSI B16.5 <u>Exception</u> : Use flat face flanges when mating with flat faced flanges on valves or equipment
GASKETS	1/2" thru 4"	1/16" thick ANSI 150# ring type compressed synthetic fiber with SBR binder (Use FF gaskets with FF flanges)

Advanced Engineering Consultants Plant Air (CA) – Instrument Air (IAS) 231123 (Addendum E)-1 (rev 07072023)

ITEM	SIZE	DESCRIPTION
THREAD SEALANT		Teflon ribbon 1/2" wide x 4 mils thick
BOLTS		Machine Bolts – Carbon Steel ASTM A-307 Grade B; Thread ANSI B1.1 Class 2A Heavy Hex Nuts – Carbon Steel ASTM A-563 Grade A; Thread ANSI B1.1 Class 2B
BALL VALVES	1/2" thru 4"	Ball Valve 600# WOG rating Body: Bronze ASTM B-61 Trim: Hard chrome plated bronze ball and stem Seats & Seals: RTFE (Reinforced Teflon) Ends: Screwed NPTFeatures:Blow-out proof stem 2-1/4" stem extension (when required) 150 PSIG rating at 366°F
CHECK VALVES	1/4" thru 2"	Check valve 125# class swing type Body: Bronze ASTM B-62 Trim: Bronze Ends: Screwed NPT Features: Swing type screwed cap Horizontal or vertical installation 200 PSIG rating at 150°F
CHECK VALVES	2-1/2" thru 4"	<ul> <li>Check valve 125# class wafer type Body: Cast iron ASTM A-126 Class B Trim: Disc - Bronze or Aluminum Bronze Seat: Buna-N</li> <li>Features: Wafer type Dual disc non-slam 316 SS spring and hinge pin</li> </ul>
ITEM	SIZE	DESCRIPTION

GATE VALVES	1/2" thru 2"	Gate valve 150# class 300# (-20 to 150°F) WOG rating Body: Bronze B-62 Trim: Bronze B-62 Ends: Screwed NPT Features: Union bonnet
		Rising stem Solid wedge disc TFE impregnated Non-asbestos packing
GATE VALVES	2-1/2" thru 4"	Gate valve ANSI 125# class 200#(-20 to 150°F) WOG rating Body: IBBM cast iron ASTM A-126 Trim: Bronze seat and stem Ends: Flanged FF ANSI B16.1 Features: OS&Y Bolted bonnet Rising stem Solid wedge disc
GLOBE VALVES	1/2" thru 4"	Globe Valve 150# Class Body: Bronze ASTM B-62 Trim: Bronze ASTM B-62 Ends: Screwed NPT Features: Union bonnet Rising stem Renewable solid virgin TFE (Teflon) disc

ITEM	SIZE	DESCRIPTION
STRAINERS	1/4" thru 2"	Strainer Bronze ASTM B-62 (Alternate B-61) "Y" pattern Threaded end connections Self-cleaning Rating: 400# WOG @ 150°F 300# Steam @ 350°F 0.033 perforated SS screen (Alternate: Monel)
STRAINERS	2-1/2" thru 4"	Strainer Cast Iron ASTM A-278 Class 30 "Y" pattern 125#, flanged ends Self-cleaning Rating: Up to 12": 200# WOG @ 150°F Over 12": 150# WOG @ 150°F 0.045 perforated SS screen (Alternate: Monel)

\*Notes:

1. All compressed air piping being routed below ground shall be copper and/or HDPE. Provide electric union at change of pipe material of iron pipe to copper pipe.

# 231123 (ADDENDUM F)-LANDFILL GAS (WET) AND PROCESS CONDENSATE (COND)

SERVICE:LANDFILL GAS (WET) AND PROCESS CONDENSATEMATERIAL:STAINLESS STEEL TYPE 304L SCHEDULE 40S/10S (Purge Welded)PRESSURE:RANGE 0 THRU 300 PSIGTEMPERATURE:RANGE 32°F THRU 180°F

ITEM	SIZE	DESCRIPTION
PIPE	1/2" thru 2"	Stainless steel Schedule 40S ASTM A-34 Grade TP316L ANSI B36.19 (Trent Tube, Damascus, AST)
	2 ½ thru 10"	Stainless steel Schedule 10S ASTM A-34 Grade TP316L ANSI B36.19 (Trent Tube, Damascus, AST)
TYPE OF	1/2" thru 2"	Socket Welded
JOINT	2 1/2" thru 10"	Butt welded (inert gas purge)
FITTINGS	1/2" thru 2"	Stainless steel ASTM A-182 F316 3000# class
	2 1/2" thru 10"	Stainless steel Schedule 10S butt weld square ends up to 4" nominal pipe diameter, standard outside bevel for 6" and larger Elbows, reducers, caps, tees and reducing tees ASTM A-403 WP316L ANSI B16.9
STUB ENDS	1/2" thru 10"	Stainless steel schedule 10S ASTM A-403 WP316L Type "A" ANSI B16.9 short pattern
FLANGES (CS)	1/2" thru 10"	Forged steel lap joint back-up for Type "A" stub ends ANSI 300# class ASTM A-105 ANSI B16.5
FLANGES (SS)	1/2" thru 10"	Forged stainless steel lap joint back-up for Type "A" stub ends ANSI 300# class ASTM A-182-F304/L ANSI B16.5
FLANGES (Alternate)	1/2" thru 10"	Forged stainless steel Slip-on ANSI 300# class ASTM A-182-F316/L Raised face ANSI B16.5
GASKETS	1/2" thru 10"	1/16 " thick Teflon, ANSI 300# ring type with full ID to match Schedule 10S pipe
BOLTS (CS)		Machine Bolts – Carbon Steel, Cadmium Plated ASTM A-307 Grade B; Thread ANSI B1.1 Class 2A Heavy Hex Nuts – Carbon Steel, Cadmium Plated A-563 Grade A; Thread ANSI B1.1 Class 2B
BOLTS (SS)		Hex head cap screws - 316 stainless steel ASTM F-593, Alloy GP 2, CW, S1, S4, and S5; Thread ANSI B1.3, system Hex nuts - 316 stainless steel ASTM F-594, Alloy GP 2, CW, S1, S4, and S5; Thread ANSI B1.3, system 21
ITEM	SIZE	DESCRIPTION
BALL	1/4" thru 2"	

VALVES		Ball valves ANSI 300# class
		Body: Stainless steel Type 316 Trim: Stainless steel Type 316 Seats & Seals: TFE Ends: Socket Weld Schedule 10 Features: Blow-out proof stem With SS handle & nut
BUTTERFLY VALVES	3" thru 10"	Butterfly valve ANSI 300# class (High Performance) Body: Stainless steel ASTM A-351 CF8M Threaded lug pattern Disc: Stainless steel Type 316 Stem: 17-4 PH SS Seat: Reinforced Teflon (RTFE) or PFA/Viton Seals: Teflon/reinforced Teflon Features: Manual locking lever Manual locking lever Manual worm gear operator for 3" & 4" Bi-directional dead end service
CHECK VALVES	1/2" thru 10"	Check valves ANSI 300# class Body: Stainless steel 316 Trim: Teflon seats and seals Ends: Flanged 300# class Features: Swing type bolted cap Horizontal or vertical installation
ITEM	SIZE	DESCRIPTION
STRAINERS	1/2" thru 2"	

		Strainer Stainless Steel ASTM A182 Type 316L "Y" Pattern Ends: Socket weld Self cleaning
STRAINERS	2 1/2" thru 10"	Strainer Stainless Steel ASTM A351-CF8M "Y" Pattern 300# Flanged ends

Advanced Engineering Consultants Process Condensate (COND) 231123 (Addendum F)-3 (rev 07072023)

#### 260000 - ELECTRICAL EQUIPMENT PROVIDED BY THE OWNER:

The following equipment will be provided by Energy Systems Group, LLC, either directly or through one of his vendors. The electrical contractor will receive this equipment at the job site and install the equipment accordingly.

- 1. Electrical Building including HVAC, lights, receptacles, furnished by the subcontractor.
- 2. LV Switchboard (3000A) SWBD-01
- 3. Panelboard RP-1
- 4. Panelboard URP-1
- 5. Control Panel for BOP
- 6. Control Panel for ARI Equipment
- 7. Uninterruptible Power Supply (UPS) System 15 kVA, 208 volts, 3 phase
- 8. Dry-Type Transformer, 45 kVA, 480V-208/120V
- 9. One 2HP Full-Voltage Non-Reversing (FVNR) Starter for the Thermal Oxidizer
- 10. Motor Starter Panels for ARI-Provided Equipment
  - a. Two 20HP Variable Frequency Drives (VFD) for PD Blowers
  - b. Three 50HP Reduced-Voltage Soft Starters (RVSS) for Vacuum Pumps
- 11. Motor Starter Panels for Vilter-Provided Equipment:
  - a. One 600HP VFD Panel for Feed Gas Compressor
  - b. One 250HP RVSS Panel for Vacuum Gas Compressor
  - c. One 250HP RVSS Panel for Recycle Gas Compressor
  - d. One 350HP VFD Panel for Sales Gas Compressor
  - e. One 15HP VFD Panel
  - f. Two 7.5HP VFD Panels
  - g. Three 5HP VFD Panels
  - h. Two 3HP VFD Panels
#### 260001 - GENERAL ELECTRICAL PROVISIONS

#### PART 1 - GENERAL

#### 1.1 **REFERENCES**

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z535.1

(2009) Safety Color Code

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M

(2005) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2

(2012) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2017) National Electrical Code

## **1.2 SUBMITTALS**

A. Not Used

## **1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS**

- A. It is the intent of these specifications and the contract drawings to provide a complete and workable facility.
- B. Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets, and conduit as required by vertical and horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Owner.

- C. Except where shown in dimensional detail, the locations of switches, receptacles, lights, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed to eliminate interference with ducts, piping, and equipment. Exact locations shall be determined in the field. Door swings shall be verified to ensure that light switches are properly located.
- D. Equipment sizes indicated are minimum. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and shall install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed. Wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

# 1.4 CODES AND STANDARDS

A. Equipment design, fabrication, testing, performance, and installation shall, unless shown or specified otherwise, comply with the applicable requirements of NFPA 70 and IEEE C2 to the extent indicated by the references.

## 1.5 COORDINATION

A. Installation of the electrical work shall be coordinated with the work of other trades.

## **1.6 APPROVAL REQUIREMENTS**

- A. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), the label of, or listing with re-examination, in UL Elec Const Dir will be acceptable as sufficient evidence that the items conform to the requirements.
- B. Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

## **1.7 PREVENTION OF CORROSION**

A. Metallic materials shall be protected against corrosion. Equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Division 09 Painting. Aluminum shall not be used in contact with earth or concrete. Dissimilar metals in intimate contact shall be protected by approved fittings, barrier material, and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations and cadmium-plated in conformance with FS A-A-59214 for interior locations.

## **1.8 HAZARDOUS AREA**

- A. Electrical work within any hazardous location shall meet the applicable requirements of NFPA 70, Chapter 5, Articles 500 through 517. The following definitions apply:
  - 1. Explosionproof: A receptacle, fixture, device, or equipment enclosure that is designed to withstand explosion of a specified liquid, gas, vapor, or dust within the enclosure and to prevent the ignition of a specified gas, vapor, or dust surrounding the enclosure by sparks, flashes, or explosions of the specified liquid, gas, vapor, or dust that may occur within the enclosure. Enclosure shall be capable of operating at an external temperature that will not ignite a surrounding flammable atmosphere.
  - 2. Hazardous location: An area where ignitable vapors or dust may cause a fire or explosion created by energy emitted from lighting or other electrical equipment or by electrostatic generation.
  - 3. NFPA 70, Article 500-2 lists chemical atmospheres by groups A, B, C, and D. In addition, although not defined as a hazardous material by the NEC, oxygen concentrations (liquid and gaseous) are considered to provide a hazard because of the increased flammability of materials exposed to oxygen. Therefore, oxygen concentrations shall be classified under Group D.

# PART 2 - PRODUCTS

## 2.1 IDENTIFICATION PLATES

A. Identification plates shall be 2-layer black-white, engraved to show black letters on a white background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller shall be 1/16-inch thick with engraved lettering 1/8-inch high. Identification plates larger than 1-1/2 inches high shall be 1/8-inch thick with engraved lettering not less than 3/16-inch high. Identification plates having edges of 1-1/2 inches high and larger shall be beveled.

## 2.2 WARNING SIGNS

A. Each item of electrical equipment operating at 480 volts and above shall be provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards.

B. Any equipment with externally powered wiring shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

#### 2.3 DANGER - EXTERNAL VOLTAGE SOURCE

A. Safety color coding for identification of warning signs shall conform to ANSI Z535.1.

#### **2.4 ANCHOR BOLTS**

A. Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

#### 2.5 SEISMIC ANCHORAGE

- A. Electrical equipment, except communications equipment, shall be anchored to withstand a lateral force of 0.3 times the weight of the equipment.
- B. Communications equipment shall be anchored to withstand a lateral force of 0.6 times the weight of the equipment.
- C. The following standard anchoring should be adequate for equipment not classified as communications, emergency, or standby:
  - 1. Dry transformers floor-mounted with four anchor bolts

BOLT DIAMETER

Under 150 kVA	-	3/8
150 to 500 kVA	-	1/2
Over 500 kVA	-	5/8

2. Panels - floor-mounted with four 1/2-inch diameter anchor bolts

## 2.6 PAINTING

A. Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside in accordance with MS MIL-T-704 and the equipment sections of this specification.

ITEM	FINISH COLOR
Circuit Breakers	ANSI No. 61 gray
Substations	ANSI No. 61 gray

Switchgear	ANSI No. 61 gray
Transformers	ANSI No. 61 gray
Safety Switches	Manufacturer's standard
Panelboards	Manufacturer's standard
Electric Heaters	Manufacturer's standard
Motors	Manufacturer's standard
Limit Switches	Manufacturer's standard
Control Components	Manufacturer's standard

## **PART 3 - EXECUTION**

## 3.1 INSTALLATION

A. Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

## **3.2 PAINTING APPLICATION**

- A. Exposed conduit, supports, fittings, cabinets, pull boxes, and racks, if not factory painted, shall be thoroughly cleaned and painted as specified in the equipment sections in this specification unless otherwise noted. Work shall be left in a neat and clean condition at final completion of the contract.
- B. Emergency equipment, such as fire-alarm boxes, shall be cleaned, primed, and painted red.

## **3.3 IDENTIFICATION PLATE INSTALLATION**

A. Identification plates shall be fastened by means of corrosion-resistant steel or nonferrous metal screws. Hand lettering, marking, or embossed self-adhesive tapes are not acceptable.

## **3.4 EQUIPMENT PADS**

A. Equipment pads shall be constructed with a minimum 4-inch margin around the equipment and supports.

## **3.5 CUTTING AND PATCHING**

A. Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Advanced Engineering Consultants General Electrical Provisions 260001-5 (rev 07072023) B. Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

# **3.6 DAMAGE TO WORK**

A. Required repairs and replacement of damaged work shall be done as directed by and subject to the approval of the Owner, and at no additional cost to the Owner.

## 3.7 CLEANING

- A. Exposed surfaces of wireways, conduit systems, and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish or painting or are enclosed within the building structure.
- B. Before final acceptance, electrical equipment, including lighting fixtures and glass, shall be clean and free from dirt, grease, and fingermarks.

## 3.8 FIELD TESTING AND TEST EQUIPMENT

A. All Field testing specified in Divisions 16 electrical specification shall be made with test equipment specially designed and calibrated for the purpose intended. Test equipment used shall be calibrated and certified by an approved testing laboratory. Date of last calibration and certification shall not be more than 90 calendar days old at the time of field testing.

## END OF SECTION

#### 26 00 20 - BASIC ELECTRICAL MATERIALS AND METHODS

#### PART 1 - GENERAL

#### 1.1 **REFERENCES**

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

ASTM INTERNATIONAL (ASTM)

ASTM D 709 (2001) Laminated Thermosetting Materials INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) IEEE C2 (2005) National Electrical Safety Code IEEE Std 100 (2000) The Authoritave Dictionary of IEEE Standards Terms NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) **NEMA 250** (2003) Enclosures for Electrical Equipment (1000 Volts Maximum) NEMA C57.12.28 (1999) Pad-Mounted Equipment - Enclosure Integrity NEMA C57.12.29 (1999; E 2000) Pad-Mounted Equipment -Enclosure Integrity for Coastal Environments

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2017) National Electrical Code

#### **1.2 DEFINITIONS**

- A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- B. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

Advanced Engineering Consultants Basic Electrical Materials and Methods 260020-1 (rev 07072023) C. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

## **1.3 ELECTRICAL CHARACTERISTICS**

A. Electrical characteristics for this project shall be as noted on the drawings.

## 1.4 ADDITIONAL SUBMITTALS INFORMATION

- A. Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.
  - 1. Shop Drawings (SD-02)
    - a. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
  - 2. Product Data (SD-03)
    - a. Submittal shall include performance and characteristic curves.

## **1.5 QUALITY ASSURANCE**

- A. Regulatory Requirements
  - 1. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

## B. Standard Products

- 1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.
- C. Alternative Qualifications
  - 1. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
- D. Material and Equipment Manufacturing Date
  - 1. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

# 1.6 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

# **1.7 POSTED OPERATING INSTRUCTIONS**

- A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
  - 1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
  - 2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
  - 3. Safety precautions.
  - 4. The procedure in the event of equipment failure.

- 5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.
- B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

## **1.8 MANUFACTURER'S NAMEPLATE**

A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

## **1.9 FIELD FABRICATED NAMEPLATES**

A. ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; and/or as specified in the technical sections and/or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

## 1.10 WARNING SIGNS

- A. Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.
  - 1. When the enclosure integrity of such equipment is specified to be in accordance with NEMA C57.12.28 or NEMA C57.12.29, such as for padmounted transformers and pad-mounted SF6 switches, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.
  - 2. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the

legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

## **1.11 ELECTRICAL REQUIREMENTS**

A. Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

# **1.12 INSTRUCTION TO OWNER PERSONNEL**

A. Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Owner personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

# PART 2 - PRODUCTS

# 2.1 FACTORY APPLIED FINISH

A. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

# PART 3 - EXECUTION

# 3.1 FIELD APPLIED PAINTING

A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Division 09 of this specification.

# **3.2 FIELD FABRICATED NAMEPLATE MOUNTING**

A. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

# **3.3 WARNING SIGN MOUNTING**

A. Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

## **END OF SECTION**

# 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

## **1.1 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.

#### **1.3 ACTION SUBMITTALS**

A. Product Data: For each type of product.

## **PART 2 - PRODUCTS**

## 2.1 CONDUCTORS AND CABLES

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. Alcan Products Corporation; Alcan Cable Division.
  - 2. Alpha Wire.
  - 3. Belden Inc.
  - 4. Encore Wire Corporation.
  - 5. General Cable Technologies Corporation.
  - 6. Southwire Incorporated.
- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2, Type XHHW-2.

- D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC, TC/TC-ER, with ground wire.
- E. VFD Cable:
  - 1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
  - 2. UL approved as 1000V flexible motor supply cable per UL2277
  - 3. UL listed as VFD per UL 2277 for Flexible Motor Supply
  - 4. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

# 2.2 CONNECTORS AND SPLICES

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. AFC Cable Systems, Inc.
  - 2. Gardner Bender.
  - 3. Southwire.
  - 4. Hubbell Power Systems, Inc.
  - 5. Ideal Industries, Inc.
  - 6. Ilsco; a branch of Bardes Corporation.
  - 7. NSi Industries LLC.
  - 8. O-Z/Gedney; a brand of the EGS Electrical Group.
  - 9. 3M; Electrical Markets Division.
  - 10. Tyco Electronics.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

# 2.3 SYSTEM DESCRIPTION

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

## **PART 3 - EXECUTION**

## 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFD cable, which shall be extra flexible stranded.

# **3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS**

- A. Service Entrance: Type THHN-2-THWN-2, XHHW single conductors in raceway.
- B. Feeders: Type THHN-2-THWN-2, single conductors in raceway, Type XHHW-2, single conductors in raceway, or TC/TC-EC multiconductor in cable tray.
- C. Branch Circuits: Type THHN-2-THWN-2, single conductors in raceway, TC/TC-EC multiconductor in cable tray.
- D. VFD Output Circuits: VFD-rated cable, Type XHHW-2 in metal conduit or TC/TC-EC in cable tray.

# 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Non-Hazardous locations Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Hazardous Locations Branch circuits shall be installed in cable tray or conduit, exposed in highbay area.
- C. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables and cable tray according to Section 260529 "Hangers and Supports for Electrical Systems."

#### **3.4 CONNECTIONS**

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

## **3.5 IDENTIFICATION**

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

# **3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Provide listed conduit seals where raceways pass into classification hazardous spaces. Seals shall be located within 12" of barrier wall.
- B. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## **3.7 FIRESTOPPING**

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

## **3.8 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and any other feeder or branch circuit at the direction of the A/E.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Test and Inspection Reports: Prepare a written report to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Cables will be considered defective if they do not pass tests and inspections.

# END OF SECTION

#### 260526 - GROUNDING AND BONDING

## PART 1 - GENERAL

#### 1.1 **REFERENCES**

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

ASTM INTERNATIONAL (ASTM)

ASTM B 3

(2001) Standard Specification for Soft or Annealed Copper Wire

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 81(2012) Guide for Measuring Earth<br/>Resistivity, Ground Impedance, and Earth<br/>Surface Potentials of a Ground System

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2017) National Electrical Code Edition

UNDERWRITERS LABORATORIES (UL)

UL 467

(2013) UL Standard for Safety Grounding and Bonding Equipment

#### **1.2 SUBMITTALS**

- A. Owner approval is required for all submittals. Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:
  - 1. SD-01 Preconstruction Submittals
    - a. Material, equipment, and fixture lists shall be submitted for Grounding Systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

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- 2. SD-02 Shop Drawings
  - a. Record Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.
- 3. SD-03 Product Data
  - a. Equipment and performance data shall be submitted for the following items including life, test, system functional flows, safety features, and mechanical automated details.
- 4. Manufacturer's catalog data shall also be submitted for the following items:
  - a. Ground Rods
  - b. Ground Wires
  - c. Connectors and Fasteners
  - d. Bonding
- 5. SD-06 Test Reports
  - a. Test Reports shall be submitted for the following tests on grounding systems in accordance with the paragraph entitled, "Field Tests," of this section. Report shall include certified record of ground-resistance tests on each driven ground rod, ground rod assembly, and other grounding electrodes. Record shall include the number of rods driven and their depth at each location to meet the required resistance-toground measurements specified. A statement shall be included describing the condition of the soil at the time of measurement.
    - 1) Bond Resistance Test
    - 2) Ground Resistance Tests
    - 3) Ground Isolation Test
    - 4) Continuity Isolation Test
- 6. SD-08 Manufacturer's Instructions
  - a. Manufacturer's instructions shall be submitted for the Grounding Systems including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

## **1.3 DRAWINGS**

- A. Record Drawings shall indicate the location of ground rods, mats, grids, building ground bus, supplementary grounding electrodes, steel building columns, and other metal structures connected to the grounding system.
- B. Location of each ground rod and ground-rod assembly and other grounding electrodes shall be identified by letter in alphabetical order and keyed to the record of ground-resistance tests.

# PART 2 - PRODUCTS

## 2.1 GROUND RODS

- A. Ground rods shall conform to the requirements of NFPA 70.
- B. Ground rods shall be copper-clad steel rods not less than 3/4 inch in diameter and not less than 10 -feet long per section. Ground rods shall be clean and smooth and have a cone-shaped point on the first section and shall be die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in feet.

## 2.2 GROUND RINGS

- A. Ground rings shall conform to the requirements of NFPA 70.
- B. Ground rings shall consist of bare stranded copper wiring, not less than 4/0 AWG, buried at least 30" below grade in good contact with soil.

## 2.3 GROUND WIRES

- A. Ground wires shall be in accordance with Section 26 05 19 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- B. Ground and bond wires for substations, main panels and distribution points, and ground rod connections shall be annealed bare copper conforming to ASTM B 3, stranded, with 98 percent conductivity. Wire size shall be in accordance with the grounding requirements of NFPA 70.
- C. Ground wires for equipment receptacles for noncurrent carrying hardware, installed in conduit shall be soft drawn copper, in accordance with ASTM B 3, stranded, with green insulation. Wire size shall be as noted.

## 2.4 CONNECTORS AND FASTENERS

- A. Grounding and bonding fasteners and connectors shall conform to the requirements of UL 467 and the NATIONAL ELECTRIC CODE.
- B. Grounding and bonding fasteners shall be copper or bronze.
- C. Bonding straps and jumpers shall be copper and shall have a cross-sectional area of not less than No. 6 AWG. Bonding straps and jumpers for shock-mounted devices with moveable joints shall be made of woven-wire braid or flexible stranded wire.

# PART 3 - EXECUTION

## **3.1 BONDING AND GROUNDING**

A. Bonding and grounding requirements shall be in accordance with NFPA 70.

## **3.2 GROUNDING ELECTRODES**

- A. Grounding electrodes shall include ground rods installed expressly for grounding systems. Ground rods shall be driven into the earth.
- B. Minimum ground rod section shall be 10 feet. Sections shall be threaded together and exothermically fusion welded.
- C. Ground rods shall be installed so that the top of the rod is not less than 24 inches below finished grade. Minimum of three 10' sections (32') deep.

# **3.3 GROUND GRIDS**

- A. Ground grids shall consist of a series of ground rods installed with interconnecting grounding conductors between ground rods. Ground rods shall be spaced as noted.
- B. Ground grid shall be buried not less than 36 inches below the finish grade. Grounding conductors shall be not less than No. 2/0 AWG and shall be exothermically fusion welded together at crossover points and to ground rods.

# **3.4 BUILDING GROUNDS**

A. Steel framework of the building shall be grounded with a concrete encased electrode at the base of four (4) building corner steel columns and two (2) additional central steel columns column. Exterior equipment framework grounding conductor shall be electrically connected to each ground rod and to each steel column and shall extend

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around the perimeter of the framework and connected to the building grounding system.

## **3.5 EQUIPMENT GROUNDING**

- A. In addition to the green colored equipment grounding conductor required in each raceway and sized in accordance with Table 250.122 of the NEC, each panelboard/ switchboard enclosure, transformer housing, motor housing, disconnect, starter, and other electrical equipment, addressed under this contract, shall be bonded to the grounding system with a stranded copper conductor, routed external to the feeder raceway.
- B. Metallic raceway systems shall have electrical continuity with equipment individually and directly connected to the building ground, independent of the raceway system.
- C. Enclosures for panelboards shall be individually and directly connected to the building ground. Grounding conductor shall be connected from the building ground to a copper ground-bus terminal strip located in each panelboard.
- D. Polarized receptacles, lighting fixtures, and equipment enclosures shall be grounded with an identified (green color) insulated conductor, not smaller than No. 12 AWG, connected to the branch circuit ground-bus terminal strip. Ground-bus terminal strip in each panelboard enclosure shall be isolated and independent of the system neutral terminal strip.
- E. Indoor substations, transformers, switchboard frames, switchgear assemblies, motors, motor control centers, air compressors, air handlers, refrigerated air dryers shall be individually and directly connected and grounded to the building ground.
- F. Noncurrent carrying metallic parts of electrical equipment, including metallic cable sheaths, conduit, raceways, and electrical structural members, shall be bonded together and connected to the ground grid or ground connection rods.
- G. Secure ground systems shall be installed for power and instrumentation. Each system shall be independently connected to the building counterpoise as shown.

## **3.6 GROUNDING CONNECTIONS**

- A. Ground connections shall be bonded connections in accordance with paragraph entitled, "Bonding."
- B. Ground connections that are buried or in inaccessible locations shall be exothermically welded.

- C. Connections in accessible locations shall be bolted. Connections to steel building columns in accessible locations shall be cast-copper-alloy clamp lugs exothermically fusion-welded to the structure.
- D. Ground connection surfaces shall be cleaned and greased and foreign matter removed. Clad material shall not be penetrated in the cleaning process. Connection shall be made between like metals where possible. Where dissimilar metals are welded, brazed, or clamped, the weld kit manufacturer's instructions shall be followed. Connections between dissimilar metals shall not produce galvanic action in accordance with MIL-STD 889.

# 3.7 BONDING

- A. Type of Bonds
  - 1. Bonding of metal surfaces shall be accomplished by welding.
- B. Welding
  - 1. Welding shall be by the exothermic process. Welding procedure shall include the proper mold and powder charge and shall conform to the manufacturer's recommendations.
  - 2. Welding processes shall be of the exothermic fusion type that will make a connection without corroding or loosening. Process shall join all strands and shall not cause the parts to be damaged or weakened. Completed connection or joint shall be equal or larger in size than the conductors joined and shall have the same current-carrying capacity as the largest conductor. Buried ground connections shall be painted with a bitumastic paint.
- C. Clamping
  - 1. In external locations, clamping shall be used only where a disconnect type of connection is required. Connection device may utilize threaded fasteners. Device shall be constructed such that positive contact pressure shall be maintained at all times. Machine bolts with spring-type lockwashers shall be used.
- D. Structural Joining Methods
  - 1. Joints made with high-strength structural bolts, and clean unpainted faying surfaces shall be considered sufficiently bonded. A jumper shall be installed across the joint in the form of a No. 4 AWG bare copper wire exothermically welded at each end to the surfaces involved spanning the connection wire jumpers shall be used across joints employing miscellaneous machine bolts.

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## E. Cleaning of Bonding Surfaces

- 1. Surfaces that comprise the bond shall be thoroughly cleaned before joining. An appropriate abrasive shall be applied with a gentle and uniform pressure to ensure a smooth and uniform surface. Excessive metal shall not be removed from the surface. Clad metals shall be cleaned in such a manner that the cladding material is not penetrated by the cleaning process. Bare metal shall then be cleaned with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Bond to the cleaned area shall be made within one hour after cleaning. Joint shall be sealed and the exposed surfaces refinished within two hours of exposure to prevent oxidation. When additional time is required, a corrosion preventive compound shall be applied until the area can be refinished.
- F. Bonding Straps and Jumpers
  - 1. Jumpers shall be installed such that the vibration by the shock-mounted device shall not change its electrical characteristics.
  - 2. Bonds shall be welded for outdoor locations unless a disconnect type of connection is required. When a disconnect is required, clamping with bolts shall be used. A tooth-type lockwasher shall be inserted between the strap and metallic member for each bolt.
  - 3. Straps shall be bonded directly to the basic structure and shall not penetrate any adjacent parts. Straps shall be installed in an area that is accessible for maintenance.
  - 4. Single straps shall be used for the bonds and shall be installed such that they will not restrict movement of structural members. Two or more straps shall not be connected in series.
  - 5. Straps shall be installed such that they will not weaken structural members to which they are attached.
- G. Equipment and Enclosure Bonding
  - 1. Each metallic enclosure and all electrical equipment shall be bonded to ground. At least one copper connection shall be made from the system ground point to one or more enclosures in the area such that all enclosures and equipment provide a low-impedance path to ground when properly bonded together.
- H. Bonding of Conduit and Raceway Systems

- 1. Bond all metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways. Care shall be taken to ensure adequate electrical contact at the joints and terminations.
- I. Rigid Metal Conduit and Terminations
  - 1. Threaded connections must be wrench-tight and there shall be no exposed threads. All ends of the conduit shall be reamed to remove burrs and rough edges. Conduits entering boxes and enclosures shall be bonded to the box with bonding-type locknuts, one outside and one inside. Locknuts that gouge into the metal box when tightened are not acceptable.
  - 2. Conduit systems that are interrupted by PVC dielectric links shall be bonded separately on either side of the link. Dielectric link shall not be jumpered.
- J. Flexible Metal Conduit
  - 1. Flexible conduit shall have an integral grounding conductor.
- K. Cable Tray Bonding
  - 1. Cable tray sections shall be bonded together. Cable tray sections in tandem assembly shall be considered as having electrical continuity when these sections are bonded with the appropriate bolts. Bond straps shall be installed across expansion joints. Cable trays shall be bonded to the building ground system.
- L. Protection of Finished Bonds
  - 1. Finished bonds shall be protected by painting to match the original finish after the bond is made.
- M. Field Tests
  - 1. The following tests shall be performed by the Contractor in the presence of the Owner.
- N. Bond Resistance Test
  - 1. Resistance of any bond connection shall not exceed 0.5 milliohm. Bonds that exceed this resistance shall be reworked by the Contractor at no additional cost to the Owner.
- O. Ground Resistance Tests

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- 1. Grounding systems shall be tested for ground resistance. Total resistance from any point on the ground network to the building counterpoise shall not exceed 50 milliohms.
- 2. Ground resistance and counterpoise tests shall be made during dry weather, and no sooner than 48 hours after rainfall. Tests shall be conducted using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Measurements shall be performed in accordance with IEEE Std 81.
- 3. Indicating instrument shall be self-contained and shall include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Direct-reading ohmmeter shall be calibrated for ranges of 0 to 20 ohms and 0 to 200 ohms.
- 4. Auxiliary grounding electrodes shall be placed in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE Std 81.
- P. Ground Isolation Test
  - 1. Ground systems shall be tested for isolation from other ground systems.
- Q. Continuity Isolation Test
  - 1. Continuity test shall be performed on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

# **END OF SECTION**

## 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Metal conduits, tubing, and fittings.
  - 2. Nonmetal conduits, tubing, and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Nonmetal wireways and auxiliary gutters.
  - 5. Surface raceways.
  - 6. Boxes, enclosures, and cabinets.
  - 7. Handholes and boxes for exterior underground cabling.

#### **1.2 DEFINITIONS**

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.
- D. PVC: Polyvinyl Chloride

## **1.3 ACTION SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

# PART 2 - PRODUCTS

# 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. AFC Cable Systems, Inc.
  - 2. Allied Tube & Conduit.
  - 3. Anamet Electrical, Inc.
  - 4. Electri-Flex Company.
  - 5. O-Z/Gedney.
  - 6. Picoma Industries.
  - 7. Republic Conduit.
  - 8. Robroy Industries.
  - 9. Southwire Company.
  - 10. Thomas & Betts Corporation.
  - 11. Western Tube and Conduit Corporation.
  - 12. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Setscrew or compression.
  - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

- 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- F. Joint Compound for GRC,: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
- G. Provide conduit seals that are listed for the hazardous classification shown on plans.
- H. GRC with threaded fittings shall be utilized in hazardous areas, in compliance with NFPA 70 article 500.

# 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. AFC Cable Systems, Inc.
  - 2. Anamet Electrical, Inc.
  - 3. Arnco Corporation.
  - 4. CANTEX Inc.
  - 5. CertainTeed Corporation.
  - 6. Condux International, Inc.
  - 7. Electri-Flex Company.
  - 8. Kraloy.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Niedax-Kleinhuis USA, Inc.
  - 11. RACO; Hubbell.
  - 12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. Adalet.
  - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
  - 3. EGS/Appleton Electric.
  - 4. Erickson Electrical Equipment Company.
  - 5. FSR Inc.
  - 6. Hoffman.
  - 7. Hubbell Incorporated.
  - 8. Kraloy.
  - 9. Milbank Manufacturing Co.
  - 10. Mono-Systems, Inc.
  - 11. O-Z/Gedney.
  - 12. RACO; Hubbell.
  - 13. Robroy Industries.
  - 14. Spring City Electrical Manufacturing Company.
  - 15. Stahlin Non-Metallic Enclosures.
  - 16. Thomas & Betts Corporation.
  - 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, galvanized steel, Type FS, with gasketed cover, and explosion proof as required.
- E. Device Box Dimensions: 4 inches square by 2-1/8 inches deep 4 inches by 2-1/8 inches by 2-1/8 inches deep
- F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Plastic Fiberglass.
  - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

# 2.4 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

- 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
- 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. NewBasis.
    - d. Oldcastle Precast, Inc.
    - e. Quazite: Hubbell Power System, Inc.
    - f. Synertech Moulded Products.
  - 2. Standard: Comply with SCTE 77.
  - 3. Configuration: Designed for flush burial with open closed integral closed bottom unless otherwise indicated.
  - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 6. Cover Legend: Molded lettering, "ELECTRIC.".
  - 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

## 2.5 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by an independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

# **PART 3 - EXECUTION**

## **3.1 RACEWAY APPLICATION**

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Underground Conduit: Type EPC-40-PVC.
  - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC LFNC.
  - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage, non hazardous locations: EMT.
  - 2. Exposed in hazardous locations and Subject to Severe Physical Damage: GRC.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  - 3. EMT: Use setscrew fittings. Comply with NEMA FB 2.10.
  - 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where indicated on Drawings.

# 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

- C. Complete raceway installation before starting conductor installation.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inchesof enclosures to which attached.
- H. Raceways below slab:
  - 1. Where indicated on plans, feeder conduits may be installed below the slab. Overexcavate to lay conduit on a bed of sand. Backfill shall contain no large rocks or stones.
- I. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- L. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- N. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a

flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- Q. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- R. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- S. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center top bottom of box unless otherwise indicated.
- T. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- U. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- V. Locate boxes so that cover or plate will not span different building finishes.
- W. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- X. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Y. Set metal floor boxes level and flush with finished floor surface.
- Z. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

# **3.3 INSTALLATION OF UNDERGROUND CONDUIT**

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.

- 2. Install backfill as specified in Section 312000 "Earth Moving."
- 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
- 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
- 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
- 6. Warning Planks: Bury warning planks approximately 12 inches above directburied conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
- 7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

# 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

# 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## **3.6 FIRESTOPPING**

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

# **3.7 PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

# END OF SECTION

## 26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Ladder cable trays.
  - 2. Single-rail cable trays.
  - 3. Trough cable trays.
  - 4. Cable tray accessories

#### **1.2 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

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

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
  - 1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. Component Importance Factor: 1.0.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
#### 2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
  - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: Refer to the drawings for specific size and configuration requirements.

#### 2.3 LADDER CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 2. Chalfant Manufacturing Company.
  - 3. Cooper B-Line, Inc.
  - 4. Mono-Systems, Inc.
  - 5. MP Husky.
  - 6. Niedax-Kleinhuis USA, Inc.
- B. Description:
  - 1. Finish: The tray shall be constructed of: Hot-Dipped Galvanized Steel, Stainless Steel, or Aluminum.
  - 2. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
  - 3. Rung Spacing: 12 inches.
  - 4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
  - 5. No portion of the rungs shall protrude below the bottom plane of side rails.
  - 6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
  - 7. Minimum Usable Load Depth: 3.5 inches with an overall height of 4 inches.
  - 8. Straight Section Lengths: 20 feet except where shorter lengths are required to facilitate tray assembly.
  - 9. Width: 6 inches, 9 inches, 12 inches unless otherwise indicated on Drawings.
  - 10. Fitting Minimum Radius: 12 inches.
  - 11. Class Designation: Comply with NEMA VE 1, Class 12B.
  - 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
  - 13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
  - 14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

#### 2.4 SINGLE-RAIL CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following
  - 1. Allied Tube & Conduit.
  - 2. Cooper B-Line, Inc.
  - 3. Mono-Systems, Inc.
  - 4. MP Husky.
- B. Description:
  - 1. Configuration: Center rail with rungs arranged symmetrically about the center rail.
  - 2. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
  - 3. Rung Spacing: 9 inches o.c.
  - 4. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
  - 5. Straight Section Lengths: 10 feet except where shorter lengths are required to facilitate tray assembly.
  - 6. Width: 6 inches, minimum, or as indicated on Drawings.
  - 7. Support Point: Splice fittings shall be hanger support point.
  - 8. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
  - 9. Loading Depth: 4 inches.
  - 10. Class Designation: Comply with NEMA VE 1, Class 12B.
  - 11. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
  - 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
  - 13. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
  - 14. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
  - 15. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.

#### 2.5 TROUGH CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following
  - 1. Allied Tube & Conduit.
  - 2. Chalfant Manufacturing Company.
  - 3. Cooper B-Line, Inc.
  - 4. Mono-Systems, Inc.
  - 5. MP Husky.
  - 6. Niedax-Kleinhuis USA, Inc.
- B. Description:

- 1. Finish: The tray shall be constructed of: Hot-Dipped Galvanized Steel, Stainless Steel, or Aluminum.
- 2. Configuration: Two longitudinal members (side rails) with a solid sheet over rungs exposed on the interior of the trough, or corrugated sheet with both edges welded to the side rails.
- 3. Solid bottom.
- 4. Rung Spacing: Rungs or corrugations shall be spaced a maximum of 6 inches o.c. and have a minimum flat bearing surface of 2 inches.
- 5. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
- 6. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
- 7. Minimum Usable Load Depth: 5.5 inches.
- 8. Straight Section Lengths: 20 feet except where shorter lengths are required to facilitate tray assembly.
- 9. Width: 6 inches, minimum, or as indicated on Drawings.
- 10. Fitting Minimum Radius: 12 inches.
- 11. Class Designation: Comply with NEMA VE 1, Class 12B.
- 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
- 13. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
- 14. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

#### 2.6 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: Solid type made of same materials and with same finishes as cable tray. Covers shall be Flat.
- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

#### 2.7 WARNING SIGNS

- A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

#### 2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

#### **PART 3 - EXECUTION**

#### 3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb.
- H. Place supports so that spans do not exceed maximum spans specified and provide clearances where shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Do not install more than one cable tray splice between supports.
- M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.

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- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- U. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- W. Install warning signs in visible locations on or near cable trays after cable tray installation.

#### **3.2 CABLE TRAY GROUNDING**

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

#### **3.3 CABLE INSTALLATION**

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

#### **3.4 CONNECTIONS**

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

#### **3.5 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections :
  - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
  - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
  - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
  - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
  - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
  - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
  - 7. Check for improperly sized or installed bonding jumpers.
  - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
  - 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
- B. Prepare test and inspection reports.

#### **3.6 PROTECTION**

- A. Protect installed cable trays and cables.
  - 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
  - 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
  - 3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

#### **END OF SECTION**

# 260923 - LIGHTING CONTROL DEVICES

## PART 1 - GENERAL

## **1.1 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Time switches.
  - 2. Photoelectric switches.
  - 3. Indoor occupancy sensors.
  - 4. Lighting contactors.
  - 5. Emergency shunt relays.

#### **1.3 ACTION SUBMITTALS**

A. Product Data: For each type of product.

## 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. Manufacturers - Subject to compliance with requirements, provide materials from one of the following manufacturers:

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- 1. <u>Cooper Industries, Inc</u>.
- 2. <u>Intermatic, Inc</u>.
- 3. <u>Invensys Controls</u>.
- 4. <u>Leviton Manufacturing Co., Inc</u>.
- 5. <u>NSi Industries LLC;</u> TORK Products.
- 6. <u>Tyco Electronics;</u> ALR Brand.
- 7. Watt Stopper
- 8. Lutron
- 9. Pass & Seymore

## 2.2 TIME SWITCHES

- A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Contact Rating: 20A
  - 3. Programs: Eight on-off set points; max time 30 minutes.

# 2.3 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, dry contacts rated for 1800-VA, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
  - 3. Time Delay: Fifteen second minimum, to prevent false operation.
  - 4. Surge Protection: Metal-oxide varistor.
  - 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

# 2.4 INDOOR OCCUPANCY SENSORS

- A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time, delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
- 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
- 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
- 5. Mounting:
  - a. Sensor: Suitable for mounting in any position on a standard outlet box.
  - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
  - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
- 7. Bypass Switch: Override the "on" function in case of sensor failure.
- B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
  - 1. Sensitivity Adjustment: Separate for each sensing technology.
  - 2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

# 2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
  - 3. Switch Rating: Not less than 800-VA.
  - 4. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
  - 5. Sensing Technology: Dual technology PIR and ultrasonic.

- 6. Voltage: Match the circuit voltage 120 V or 277 V, passive-infrared dualtechnology type.
- 7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
- 8. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
- 9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

# 2.6 LIGHTING CONTACTORS

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. Allen-Bradley/Rockwell Automation.
  - 2. ASCO Power Technologies, LP.
  - 3. Eaton Corporation.
  - 4. General Electric Company;
  - 5. Square D.
- B. Description: Electrically operated and mechanically electrically held, combination-type lighting contactors, complying with NEMA ICS 2 and UL 508.
  - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  - 3. Enclosure: Comply with NEMA 250.
  - 4. Provide with control and pilot devices as indicated on Drawings scheduled, matching the NEMA type specified for the enclosure.

# 2.7 EMERGENCY SHUNT RELAY

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. Watt Stopper.
  - 2. Bodine.
  - 3. Iota
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

## **PART 3 - EXECUTION**

#### 3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

#### **3.2 CONTACTOR INSTALLATION**

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

#### 3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Label time switches and contactors with a unique designation.

## 3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

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- 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
- 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

# **END OF SECTION**

#### **261816 - OVERCURRENT PROTECTIVE DEVICES**

#### PART 1 - GENERAL

#### 1.1 **REFERENCES**

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

ASTM INTERNATIONAL (ASTM)

ASTM D 877

(2002) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

**NEMA 250** 

(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2017) National Electrical Code Edition

#### UNDERWRITERS LABORATORIES (UL)

UL 489

(2016); UL Standard for Safety Molded-Case Circuit Breakers and Circuit-Breaker Enclosures

#### 1.2 SUBMITTALS

- A. Owner approval is required for all submittals. Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:
  - 1. SD-01 Preconstruction Submittals
    - a. No change in continuous-current rating, interrupting rating, and clearing or melting time of fuses shall be made unless written permission has first been secured from the Owner.
  - 2. SD-02 Shop Drawings

- a. Connection Diagrams and Fabrication Drawings shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.
- b. Installation drawings shall also be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.
  - 1) Control Devices
  - 2) Protective Devices
- 3. SD-03 Product Data
  - a. Equipment and performance data shall be submitted for the following items including use life, system functional flows, safety features, and mechanical automated details.
  - b. Manufacturer's catalog data shall also be submitted for the following items:
    - 1) Motor Control
    - 2) Instrument Transformers
    - 3) Enclosures
    - 4) Circuit Breakers
    - 5) Fuses
    - 6) Control Devices
    - 7) Time Switches
    - 8) Protective Relays
    - 9) Indicating Instruments
    - 10) Indicating Lights
- 4. SD-06 Test Reports
  - a. Factory Test Reports shall be submitted for Power, High Voltage, and Oil Circuit Breakers in accordance with ANSI C37.09.
    - 1) Dielectric Tests
    - 2) Timing Test
    - 3) Insulation Power Factor Test
- 5. SD-07 Certificates
  - a. Certificates shall be submitted for Circuit Tests on similar motorcontrol or motor-circuit protector (MCP) units under actual conditions may be submitted in lieu of factory tests on the actual units provided.
- 6. SD-08 Manufacturer's Instructions

- a. Manufacturer's Instructions shall be submitted for the following items, including special provisions required to install equipment components and system packages. Special notices shall detail, resistance impedances, hazards and safety precautions.
  - 1) Control Devices
  - 2) Protective Devices
- 7. SD-10 Operation and Maintenance Data
  - a. Operation and Maintenance Manuals shall be submitted for the following equipment:
    - 1) Manual Motor Controllers
    - 2) Magnetic Motor Controllers
    - 3) Combination Motor Controllers
    - 4) High Voltage Motor Controllers
    - 5) Circuit Breakers
    - 6) Time Switches
    - 7) Protective Relays
    - 8) Indicating Instruments

## 1.3 GENERAL REQUIREMENTS

- A. Section 16003 GENERAL ELECTRICAL PROVISIONS applies to work specified in this section.
- B. Connection Diagrams shall be submitted showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.
- C. Fabrication Drawings shall be submitted for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

## PART 2 - PRODUCTS

#### 2.1 CIRCUIT BREAKERS

- A. Circuit breakers shall conform to UL 489.
- B. Molded-Case Circuit Breakers

- 1. Circuit breakers shall be molded case, manually operated, trip-free, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Circuit breakers shall be completely enclosed in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.
- 2. Thermal-magnetic tripping elements shall be located in each pole of the circuit breaker and shall provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Instantaneous magnetic tripping element shall be adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.
- 3. Breaker size shall be as required for the continuous current rating of the circuit. Breaker class shall be as required.
- 4. Interrupting capacity of the panel and lighting branch circuit breakers shall be sufficient to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Circuit breaker interrupting capacities shall be a minimum of 10,000 amperes and shall conform to NEMA AB 3.
- 5. Multipole circuit breakers shall be of the common-trip type having a single operating handle and shall a have two-position on/off indication. Circuit breakers shall have temperature compensation for operation in an ambient temperature of 104 degrees F. Circuit breakers shall have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).
- 6. Breaker body shall be of phenolic composition. Breakers shall be capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.
- 7. Circuit breakers used for motor-circuit disconnects shall meet the applicable requirements of NFPA 70 and shall be of the motor-circuit protector type.
- 8. Circuit breakers used for service disconnection shall be the enclosed circuitbreaker type with external handle for manual operation. Enclosures shall be sheet metal with a hinged cover suitable for surface mounting.
- C. Enclosed Molded-Case Circuit Breakers
  - 1. Enclosed circuit breakers shall be thermal-magnetic molded-case circuit breakers in surface-mounted, nonventilated enclosures conforming to the appropriate articles of NEMA 250 and NEMA AB 1.
  - 2. Enclosed circuit breakers in nonhazardous locations shall be as follows:
    - a. Circuit breakers installed inside, clean, dry locations shall be contained in NEMA Type 1, general purpose sheet steel enclosures.
    - b. Circuit breakers installed in unprotected outdoor locations shall be contained in NEMA Type 3R, weather-resistant sheet steel enclosures that are splashproof, weatherproof, sleetproof, and moisture resistant.

- c. Circuit breakers installed in wet locations shall be contained in NEMA Type 4, watertight corrosion-resistant sheet steel enclosures constructed to prevent entrance of water.
- d. Circuit breakers installed in industrial locations shall be contained in NEMA Type 12, industrial-use sheet steel enclosures constructed to prevent the entrance of dust, lint, fibers and flyings, and oil and coolant seepage.
- D. Power Circuit Breakers
  - 1. Power circuit breakers rated below 600 volts shall be the air-break type enclosed in ventilated housings. Current, voltage, and interrupting ratings shall be as required.
  - 2. Power circuit breakers shall comply with ANSI C37.16 and IEEE C37.13.
  - 3. Power circuit breakers shall be equipped with electromechanical devices with instantaneous elements. Breakers shall be electrically and mechanically trip-free in any position of the closing stroke. Ground fault protection shall be included in either type trip device. Main contacts shall be silver-plated. Arcing contacts shall be sintered tungsten alloy. Tripping shall be accomplished by a shunt-trip device. Closing shall be by electrical operation.
  - 4. Breakers installed in metal housings such as unit substations shall be the drawout type. Breakers installed in isolated locations or not as units of a central distribution center shall be wall -mounted, provided a correctly ventilated protective metal cover is installed.
  - 5. Alarms, auxiliary switches, interlocks, and similar devices shall be supplied.
  - 6. Breakers shall have a removable operating handle, provision for padlocking, and position indicator.
  - 7. Power Circuit Breakers shall be factory tested in accordance with ANSI C37.09.

## 2.2 FUSES

- A. A complete set of fuses for all switches and switchgear shall be provided. Fuses shall have a voltage rating not less than the circuit voltage.
- B. Fuses rated 30 amperes, 125 volts or less shall be the nonrenewable cartridge type. Fuses rated above 30 amperes 600 volts or less shall be the renewable cartridge type with time-delay dual elements, except where otherwise indicated. Fuses shall conform to NEMA FU 1.
- C. Special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses shall be installed where required. Plug fuses are not permitted.

- D. Power fuses on ac systems above 600 volts shall be in accordance with NEMA SG 2.
- E. Fuses shall be labeled showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, fuse information shall be clearly listed on equipment drawings.
- F. Fuse holders field-mounted in a cabinet or box shall be porcelain. Field installation of fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber shall not be used.

## 2.3 CONTROL DEVICES

- A. Magnetic Contactors
  - 1. Magnetic contactors for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the primary windings of low-voltage transformers shall be in accordance with NEMA ICS 1 and NEMA ICS 2 as required.
  - 2. Core-and-coil assembly shall operate satisfactorily with coil voltage between 85 and 110 percent of its voltage rating.
  - 3. Contactor shall be designed with a normally open holding circuit auxiliary contact for control circuits. Rating of the auxiliary contact shall be in accordance with NEMA ICS 1 and NEMA ICS 2.
  - 4. Solderless pressure wire terminal connectors shall be furnished or made available for line-and-load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.
  - 5. Rating of magnetic contactors shall be in accordance with NEMA ICS 1 and NEMA ICS 2.
- B. Control-Circuit Transformers
  - 1. Control-circuit transformers shall be provided within the enclosure of magnetic contactors and motor controllers when the line voltage is in excess of 120 volts. Transformer shall be encapsulated dry type, single-phase, 60-hertz, with a 120-volt (or 24-volt) isolated secondary winding.
  - 2. Rated primary voltage of the transformer shall be not less than the rated voltage of the controller. Rated secondary current of the transformer shall be not less than continuous-duty current of the control circuit.
  - 3. Voltage regulation of the transformer shall be such that, with rated primary voltage and frequency, the secondary voltage shall not be less than 95 percent nor more than 105 percent of rated secondary voltage.
  - 4. Source of supply for control-circuit transformers shall be the load side of the main disconnecting device. Secondary winding of the transformer and control-circuit wiring shall be protected against overloads and short circuits

with fuses selected in accordance with JIC-01. Secondary winding of the control-circuit transformer shall be grounded in accordance with JIC-01.

- C. Magnetic Control Relays
  - 1. Magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices in response to variations in the conditions of electric control devices shall be in accordance with NEMA ICS 1, and NEMA ICS 2.
  - 2. Core-and-coil assembly shall operate satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.
  - 3. Relays shall be designed to accommodate normally open and normally closed contacts.
  - 4. Magnetic control relays shall be as indicated -volt, 60-hertz, Class AIB devices with a continuous contact rating of 10 amperes and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

## 2.4 **PROTECTIVE RELAYS**

- A. Overcurrent Relays
  - 1. Overcurrent relays shall conform to IEEE C37.90.
    - a. Overcurrent relays for protection against phase and ground faults shall be single-phase nondirectional removable induction type with built-in testing facilities. Relays shall be designed for operation on the dc or ac control circuit indicated.
    - b. Ground-fault overcurrent relays shall have short-time inverse time characteristics with adjustable current tap range as required.
    - c. Phase-fault overcurrent relays shall have varied inverse-time characteristics with adjustable current tap range as required and indicating instantaneous-trip attachments with adjustable current range as required.
    - d. Case shall be semiflush-mounted to the hinged instrument panel and shall have matching cover.
    - e. Solid-state static-type trips for low-voltage power circuit breakers shall be in accordance with EIA 443 and ANSI C37.17.
    - f. Trip unit shall employ a combination of discreet components and integrated circuits to provide the time-current protection functions required in a modern selectively coordinated distribution system.
    - g. Complete system selective coordination shall be provided by utilizing a combination of the following time-current curve-shaping

adjustments: ampere setting; long-time delay; short-time pickup; short-time delay; instantaneous pickup; and ground fault.

- h. Instantaneous and ground fault trips shall be switchable or easily defeatable.
- i. All adjustments shall be made using non-removable, discrete step, highly reliable switching plugs for precise settings. A sealable, transparent cover shall be provided over the adjustments to prevent tampering.
- j. Trip devices shall be furnished with three visual indicators to denote the automatic tripping mode of the breaker including: overload; short circuit; and ground fault.
- k. Trip unit shall be wired to appropriate terminals whereby an optional remote automatic trip accessory can be utilized to provide the same indication.
- 1. A series of optional automatic trip relays shall be available for use with the trip unit to provide remote alarm and lockout circuits.
- m. All trip units shall be provided with test jacks for in-service functional testing of the long-time instantaneous and ground fault circuits using a small hand-held test kit.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

A. Control devices and protective devices not factory installed in equipment shall be installed in accordance with the manufacturer's recommendations and shall be field adjusted and operation tested. Installations shall conform to NFPA 70, NEMA ICS 1, NEMA ICS 2, and NEMA ICS 3 requirements for installation of control and protective devices.

## 3.2 FIELD TESTING

- A. Control and protective devices not factory installed in equipment shall be demonstrated to operate as indicated.
- B. Instrumentation, potential, and current transformers shall be ratio'd and tap settings verified.
- C. Circuit breakers rated 15KV and above shall be given a timing test to verify proper contact speed, travel, bounce, and wipe.
- D. Oil and high-voltage circuit breakers and their bushings shall be given an insulation power factor test to establish condition monitoring baselines.

- E. Insulating oil in oil circuit breakers shall have dielectric tests performed before the breakers are energized. Oil shall be tested in accordance with ASTM D 877, and breakdown voltage shall be not less than 25,000 volts Manufacturer shall certify that the oil contains no PCB's and shall affix a label to that effect on each breaker tank and on each oil drum containing the insulating oil.
- F. Reduced-voltage starting devices shall be field adjusted to obtain optimum operating conditions. Test meters and instrument transformers shall conform to IEEE C12.1 and IEEE C57.13.
- G. Control and protective devices shall not be energized until recorded test data have been approved by the Owner. Final test reports shall be provided to the Owner. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

## **END OF SECTION**

## 262416 - PANELBOARDS

## PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:1. Lighting and appliance branch-circuit panelboards.

## **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

#### 1.3 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

## PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces.
- B. Enclosures: surface-mounted cabinets.
  - 1. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  - 3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

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- 4. Finishes:
  - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
  - b. Back Boxes: Galvanized steel.
- 5. Directory Card: Inside panelboard door, mounted in transparent card holder metal frame with transparent protective cover.
- C. Incoming Mains Location: Top, or as indicated on the drawings.
- D. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Main and Neutral Lugs: Compression Mechanical type.
  - 3. Ground Lugs and Bus-Configured Terminators: Compression Mechanical type.
  - 4. Subfeed (Double) Lugs: Compression Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

# 2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include:
  - 1. General Electric Company; GE Consumer & Industrial Electrical Distribution.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D; a brand of Schneider Electric.

- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

# 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully rated interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  - 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Compression Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

# 2.4 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

# PART 3 - EXECUTION

## **3.1 EXAMINATION**

A. Receive, inspect, handle, and store panelboards according to NECA 407 NEMA PB 1.1.

- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407 NEMA PB 1.1.
- B. Mount top of trim 72 inches above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install filler plates in unused spaces.
- E. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- F. Comply with NECA 1.

# **3.3 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified.
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified.

# **3.4 FIELD QUALITY CONTROL**

- A. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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- 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 3. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
  - c. Instruments and Equipment:
    - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- B. Panelboards will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

# **END OF SECTION**

# 262726 - WIRING DEVICES

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Weather-resistant receptacles.
  - 3. Snap switches and wall-box dimmers.
  - 4. Wall-switch and exterior occupancy sensors.
  - 5. Cord and plug sets.

#### **1.2 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

## 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

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## **PART 2 - PRODUCTS**

## 2.1 MANUFACTURERS

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with the requirements in this Section.
- D. Supplied devices shall be specification grade.

# 2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
- B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

# 2.4 GFCI RECEPTACLES

A. General Description: (If shown on drawings)

- 1. Straight blade, feed non-feed-through type.
- 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
- 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A.

# 2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

# 2.6 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Pilot-Light Switches, 20 A:
  - 1. Single pole, with neon-lighted handle, illuminated when switch is "off."
  - 2. Single pole, with factory-supplied key in lieu of switch handle.

# 2.7 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Type 302 stainless steel 0.04-inch- thick
- B. Wet-Location, Weatherproof Covers: NEMA 250, complying with Type 3R, weatherresistant, die-cast aluminum lockable cover.

# 2.8 FINISHES

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: Gray, unless otherwise indicated or required by NFPA 70 or device listing.

# **PART 3 - EXECUTION**

## 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

- 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
- 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
- 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
- 8. Tighten unused terminal screws on the device.
- 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
  - 1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

# **3.2 GFCI RECEPTACLES**

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

# 3.3 **IDENTIFICATION**

- A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black white red-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- B. Tests for Convenience Receptacles:
  - 1. Line Voltage: Acceptable range is 105 to 132 V.
  - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
  - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  - 5. Using the test plug, verify that the device and its outlet box are securely mounted.

- 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

# **END OF SECTION**

## 262813 - FUSES

#### PART 1 - GENERAL

#### 1.1 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

#### **1.2 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

## PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers Subject to compliance with requirements, provide materials from one of the following manufacturers:
  - 1. Bussman
  - 2. Mersen
  - 3. Littelfuse

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## 2.2 PLUG-FUSE ADAPTERS

A. Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

#### 2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
  - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

## **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

## **3.2 FUSE APPLICATIONS**

- A. Cartridge Fuses:
  - 1. Service Entrance: Class L, fast acting where 600A or larger.
  - 2. Feeders: Class L, fast acting Class L, time delay Class RK1,
  - 3. Motor Branch Circuits: Class RK1 Class RK5, time delay.

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- 4. Other Branch Circuits: Class RK1, time delay Class RK5,
- 5. Control Circuits: Class CC, fast acting time delay.

#### 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
- C. Install spare-fuse cabinet(s).

#### **3.4 IDENTIFICATION**

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

#### **END OF SECTION**
### 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

## PART 1 - GENERAL

#### 1.1 **REFERENCES**

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

ASTM INTERNATIONAL (ASTM)

ASTM B 173

(2001a) Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors

#### NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA PE 1

(2012) Uninterruptible Power Systems --Specification and Performance Verification

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2017) National Electrical Code

## **1.2 SUBMITTALS**

- A. Owner approval is required for all submittals. Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:
  - 1. SD-02 Shop Drawings
    - a. UPS System
    - b. Installation
      - 1) Detail drawings consisting of a complete list of equipment and materials, manufacturer's descriptive and technical literature, battery sizing calculations per IEEE Std 485, installation instructions, single-line diagrams, ladder-type schematic diagrams, elevations, layout drawings, and details required to demonstrate that the system has been coordinated and will function properly as a unit.

- 2. SD-03 Product Data
  - a. Performance Requirements
    - 1) Pertinent performance data for the UPS system, using a copy of the data sheets supplied with this specification. Data sheets shall be certified by a responsible officer of the UPS manufacturer.
  - b. Spare Parts
    - 1) Spare parts data, as specified.
  - c. Field Training
    - 1) Lesson plans and training manuals for the training phases, including type of training to be provided and proposed dates, with a list of reference materials.
- 3. SD-06 Test Reports
  - a. Factory Testing
  - b. Field Supervision, Startup and Testing
    - 1) A detailed description of proposed factory test and field test procedures, including proposed dates and steps outlining each test, how it is to be performed, what it accomplishes, and its duration, not later than one months prior to the date of each test.
    - 2) Factory and field test reports in booklet form tabulating factory and field tests and measurements performed, upon completion and testing of the installed system. Factory and field test reports shall be signed by an official authorized to certify on behalf of the manufacturer of the UPS system that the system meets specified requirements. The reports shall be dated after the award of this contract, shall state the Contractor's name and address, shall name the project and location, and shall list the specific requirements which are being certified.

## **1.3 SYSTEM DESCRIPTION**

A. The UPS system shall consist of UPS module, battery system, battery protective device, system cabinet, static bypass transfer switch, controls and monitoring. Input ac power shall be connected to the normal source ac input of the UPS module. The

battery shall be connected to the dc input of the UPS module through the battery protective device. The ac output of the UPS system shall be connected to the critical loads.

- 1. UPS Module and Battery System
  - a. UPS module shall contain required input isolation transformer, rectifier/charger unit, inverter unit and controls, battery protective device, and any other specified equipment/devices. Battery system shall contain the battery cells, racks, battery disconnect, battery monitor and cabinet, if required.
- 2. Cabinet, Static Bypass Transfer Switch, Control and Monitoring
  - a. The UPS system shall include the system cabinet, static bypass transfer switch, system protective devices, monitoring and controls, means of isolating the system from the critical load, and remote monitoring interfaces.
- 3. Design Requirements
  - a. Parts and Materials
    - 1) Parts and materials comprising the UPS system shall be new, of current manufacture, of a high grade and free of defects and imperfections, and shall not have been in prior service except as required during aging and factory testing.
  - b. Components
    - 1) Active electronic devices shall be solid state. Semiconductor devices shall be sealed. Relays shall be dust-tight.
  - c. Semiconductor Fusing
    - 1) Power semiconductors shall be fused to prevent cascaded or sequential semiconductor failures. Indicator lamp denoting blown fuse conditions shall be readily observable by the operator without removing panels or opening cabinet doors.
  - d. Interchangeability

1) The subassemblies in one UPS module shall be interchangeable with the corresponding modules within the same UPS, and from one UPS system to another of identical systems.

# e. Control Power

1) Control power shall be derived from two sources, input and output, with automatic selective control. The control power circuit shall have suitable protection, appropriately marked and located in the immediate vicinity of the input protective device.

# f. EMI/RFI Protection

1) The components and the system shall be designed to minimize the emission of electromagnetic waves that may cause interference with other equipment.

# g. Wiring

1) Wiring practices, materials, and coding shall be in accordance with the requirements of NFPA 70 and other applicable standards. Wire runs shall be protected in a manner which separates power and control wiring. Control wiring shall be minimum No. 16 AWG extra-flexible stranded copper. Logiccircuit wiring may be smaller. Ribbon cables shall be minimum No. 22 AWG. Control wiring shall have permanently attached wire numbers.

# h. Terminations

- 1) Terminals shall be supplied for making power and control connections. Terminal blocks shall be provided for field wiring terminals. Terminal blocks shall be heavy-duty, strap-screw type. Terminal blocks for field wiring shall be located in one place in each module and in the system cabinet. Control wiring shall be extended to the terminal block location. No more than two wires shall land on any terminal point. Where control wiring is attached to the same point as power wiring, a separate terminal shall be provided. If bus duct is used, bus stubs shall be provided where bus duct enters cabinets.
- i. Internal Assembly

- 1) The subassemblies shall be mounted in pull-out and/or swingout trays where feasible. Cable connections to the trays shall be sufficiently long to allow easy access to all components. Where not feasible to mount subassemblies in pull-out or swing-out trays, they shall be firmly mounted inside the enclosure. Test points or logic indicators shall be labeled and located on the front edge of the control logic cards, if used.
- j. Cabinet Structure
  - 1) UPS system shall be installed in cabinets of heavy-duty structure meeting the NEMA PE 1 standards for floor mounting. UPS module cabinet shall be structurally adequate for forklift handling or lifting. Removable lifting eyes shall be provided on top of each cabinet. UPS module cabinet shall have hinged and lockable doors on the front only, with assemblies and components accessible from the front. Doors shall be key lockable. Operating controls shall be located outside the locked doors. Input, output, and battery cables shall be installed through the top or bottom of the cabinet.
- k. Cabinet Finish
  - 1) Equipment cabinet shall be cleaned, primed and painted in the manufacturer's standard colors, in accordance with accepted industry standards.
- 1. Mimic Bus
  - 1) If painted, mimic bus and other front-panel markings (such as those showing circuit breakers or switches and fuses) shall be painted with durable acrylic-based paint.
- m. Live Parts (300 Volts and Above)
  - 1) Live parts (300 volts and above) that are exposed when front access doors are open shall be adequately protected or covered to minimize the chance of accidental contact.
- n. Drawout Assemblies
  - 1) Drawout assemblies weighing 50 lbs or more shall be provided with a means of lifting, either an overhead device or a hoisting device.

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- o. Safety
  - 1) UPS shall be equipped with instruction plates including warnings and cautions, suitably located, describing any special or important procedures to be followed in operating and servicing the equipment.
- 4. Performance Requirements
  - a. Normal Operation
    - 1) The UPS module rectifier/charger shall convert the incoming ac input power to dc power for the inverter and for float charging the battery. The inverter shall supply ac power continuously. Inverter output shall be synchronized with the bypass ac power source, provided that the bypass ac power source is within the specified frequency range. The UPS system shall supply ac power to the critical loads.
  - b. Loss of ac Input Power
    - 1) The battery shall supply dc power to the inverter so that there is no interruption of ac power to the critical load whenever the ac input power source deviates from the specified tolerances or fails completely. The battery shall continue to supply power to the inverter for the specified protection time. At the same time, an alarm shall sound to alert operating personnel, allowing startup of a secondary power source or orderly shutdown of the critical load.
  - c. Return of ac Input Power Source
    - 1) The rectifier/charger shall start and assume the dc load from the battery when the ac input power source returns. The rectifier/charger shall then simultaneously supply the inverter with dc power and recharge the battery. This shall be an automatic function and shall cause no disturbance to the critical load.
  - d. Failure of ac Input Power to Return

1) Should the ac input power fail to return before the battery voltage reaches the discharge limit, the UPS system shall disconnect from the critical load to safeguard the battery.

# e. Failure of a Module

- 1) In a redundant configuration, failure of one module shall cause that module to be disconnected from the system critical load bus by its internal protective devices and its individual output protective device. The remaining module shall continue to carry the load. Upon restoration of the failed module, it shall be possible to reconnect the failed module to the critical load bus to resume redundant operation without disruption of the critical load.
- f. Transfer to Bypass ac Power Source
  - 1) When the static bypass switch senses an overload, two or more inverter shutdown signals, or degradation of the inverter output, the bypass switch shall automatically transfer the critical load from the inverter output to the bypass ac power source without an interruption of power only if the connected load exceeds the capacity of the remaining on-line modules. If the bypass ac power source is out of normal tolerance limits, the UPS and the critical load shall shut down.
- g. Retransfer to Inverter
  - 1) The static bypass switch shall be capable of automatically retransferring the load back to the inverter output after the inverter output has returned to normal conditions. Retransfer shall not occur if the two sources are not synchronized.
- h. UPS Module Maintenance
  - 1) UPS modules shall be capable of manual disconnection from the critical load bus for maintenance without disturbing the critical load bus.
- i. UPS System Maintenance
  - 1) Manual closure of the maintenance bypass switch shall transfer the critical load from the inverter output to the bypass ac power source without disturbing the critical load bus. UPS module

shall be capable of manual return to normal operation after completion of maintenance.

- j. Battery Maintenance
  - 1) The battery protective device shall provide the means of disconnecting the battery from the rectifier/charger and inverter for maintenance. The UPS module shall continue to function and meet the performance criteria specified except for the battery function.

## 1.4 QUALITY ASSURANCE

- A. Reliability
  - 1. UPS shall have a minimum acceptable system Mean Time Between Failures (MTBF) of 20,000 hours. A failure is defined as any interruption to or degradation of the UPS output. Automatic switching to bypass due to a problem with the UPS system does not constitute a failure, provided that the critical load is not disturbed.
- B. Maintainability
  - 1. UPS shall have a maximum acceptable system Mean Time To Repair (MTTR) of 30 minutes. Repair time is defined as the clock time from the arrival of the service technician to the time when the UPS is restored to service either by repair or substitution of the failed component.

#### **1.5 DELIVERY AND STORAGE**

A. Equipment placed in storage shall be protected from humidity and temperature variations, dirt, dust, or other contaminants.

#### **1.6 PROJECT/SITE CONDITIONS**

- A. Environmental Conditions
  - 1. The UPS and battery system shall be capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics.
    - a. Operating altitude: Sea level to 4,000 feet. (Systems applied at higher altitudes shall be derated in accordance with the manufacturer's instructions).

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- b. Non-operating altitude: Sea level to 40,000 ft.
- c. Operating ambient temperature range: 32 to 104 degrees F.
- d. Non-operating and storage ambient temperature range: Minus 4 to plus 140 degrees F.
- e. Operating relative humidity: 0 to 95 percent, without condensation.
- B. Sound Pressure Levels
  - 1. Sound pressure levels produced by the UPS, when operating under full rated load, at a distance of 5 feet in any direction from the perimeter of the unit, shall not exceed 55 dB as measured on the A scale of a standard sound level meter at slow response.
- C. Verification of Dimensions
  - 1. The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Owner of any discrepancy before performing the work.

## **1.7 NAME PLATES**

A. Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

# **1.8 SPECIAL TOOLS**

A. One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

## **1.9 OPERATION AND MAINTENANCE MANUALS**

A. Six complete copies of operation manuals for the UPS System outlining the step-bystep procedures required for system startup, operation and shutdown shall be provided. The instructions shall include the manufacturer's name, equipment model number, service manual, parts list, and brief description of equipment and its basic operational features. Six complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment. Operation and maintenance manuals may be either combined or separate.

### **1.10 SPARE PARTS**

A. The Contractor shall submit spare parts data for each different item of material and equipment specified, not later than the date of beneficial occupancy. The data shall include a complete list of parts and supplies with current unit prices and source of supply and an itemized price breakdown of spare parts recommended for stocking. The recommended spare parts selected shall be those which, in the manufacturer's judgment, will be involved in the majority of maintenance difficulties encountered.

## **PART 2 - PRODUCTS**

## 2.1 STANDARD PRODUCTS

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Owner, reasonably convenient to the site.

## 2.2 LOAD PROFILE

A. The UPS system shall be compatible with the load characteristics defined on the drawings. Compensation for UPS/load interaction problems resulting from nonlinear loads or transformer and motor inrush shall be provided.

## 2.3 UPS SYSTEM RATINGS

- A. Unless stated otherwise, the parameters listed are under full output load at 0.8 power factor, with batteries fully charged and floating on the dc bus and with nominal input voltage.
  - 1. System Capacity
    - a. Refer to the drawings for size and configuration requirements.
  - 2. Battery Capacity
    - a. Discharge time to end voltage: 90 minutes, at 77 degrees F. Battery shall be capable of delivering 125 percent of full rated UPS load at initial start-up.
  - 3. Static Switch

- a. Amperes sized by the manufacturer for the use intended, and amperes symmetrical interrupting capacity as indicated on the drawings.
- 4. System Bus Bracing
  - a. Braced for amperes symmetrical interrupting capacity as indicated on the drawings.
- 5. AC Input
  - a. Voltage 208 volts line-to-line, 120 volts line-to-neutral.
  - b. Number of phases: 3-phase, 4-wire, plus ground.
  - c. Voltage Range: Plus 10 percent, minus 15 percent, without affecting battery float voltage or output voltage.
  - d. Frequency: 60 Hz, plus or minus 5 percent.
  - e. Power walk-in: 20 percent to 100 percent over 15 to 24 seconds.
  - f. Total harmonic current distortion (THD) reflected into the primary line: 5 percent maximum.
  - g. Transformer sub-cycle inrush: 4 to 8 times full load rating.
- 6. AC Output
  - a. Voltage 208 volts line-to-line, 120 volts line-to-neutral.
  - b. Number of phases: 3-phase, 4-wire, plus ground.
  - c. Voltage regulation:
    - 1) Balanced load: Plus or minus 1.0 percent.
    - 2) 50 percent load imbalance, phase-to-phase: Plus or minus 2 percent.
    - 3) No-load voltage modulation: Plus or minus 1 percent.
    - 4) Voltage drift: Plus or minus 1 percent over any 30 day interval (or length of test) at stated ambient conditions.
  - d. Voltage adjustment: Plus or minus 5 percent manually.
  - e. Frequency: 60 Hz.
  - f. Frequency regulation: Plus or minus 0.1 percent.
  - g. Frequency drift: Plus or minus 0.1 percent over any 24 hour interval (or length of test) at stated ambient conditions when on internal oscillator.
  - h. Harmonic content (RMS voltage): 3 percent single harmonic, maximum; 5 percent total maximum with linear load. Voltage THD shall be less than 7 percent with up to 50 percent nonlinear load and a crest factor of less than 3 to 1.
  - i. Load power factor operating range: 1.0 to 0.8 lagging.

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- j. Phase displacement:0.5
  - 1) Balanced load: Plus or minus 1 degree of bypass input.
  - 2) 50 percent load imbalance phase-to-phase: Plus or minus 3 degrees of bypass input.
- k. Wave-form deviation factor: 5 percent at no load.
- 1. Overload capability (at full voltage) (excluding battery):
  - 1) 125 percent load for 10 minutes.
  - 2) 150 percent load for 30 seconds.
  - 3) 300 percent load for one cycle after which it shall be current limited to 150 percent until fault is cleared or UPS goes to bypass.
- m. Load sharing of parallel modules: Plus or minus 5 percent of average load per module.
- B. Transient Response
  - 1. Voltage Transients
    - a. 50 percent load step/0 percent to 50 percent load: Plus or minus 8 percent.
    - b. 50 percent load step/50 percent to 100 percent load: Plus or minus 8 percent.
    - c. Loss or return of ac input: Plus or minus 1 percent.
    - d. Loss or return of redundant module:
      - 1) Manually: Plus or minus 8 percent.
      - 2) Automatically: Plus or minus 8 percent.
    - e. Automatic transfer of load from UPS to bypass: Plus or minus 4 percent.
    - f. Manual retransfer of load from bypass to UPS: Plus or minus 4 percent.
    - g. Response time: Recovery to 99 percent steady-state condition within 50 milliseconds after any of the above transients.
  - 2. Frequency
    - a. Transients: Plus or minus 0.5 Hz maximum.
    - b. Slew Rate: 1.0 Hz maximum per second.

- 3. Efficiency
  - a. Minimum Single-Module Efficiency: 90 percent at full load kW.
  - b. Minimum System Efficiency: 89 percent at full system load kW.

# 2.4 UPS MODULE

- A. General Description
  - 1. UPS module shall consist of a rectifier/charger unit and a 3-phase inverter unit with their associated transformers, synchronizing equipment, protective devices and accessories as required for operation.
- B. Rectifier/Charger Unit
  - 1. Rectifier/charger unit shall be solid state and shall provide direct current to the dc bus.
- C. Input Protective Device
  - 1. Rectifier/charger unit shall be provided with an input protective device. The protective device shall be sized to accept simultaneously the full-rated load and the battery recharge current. The protective device shall be capable of shunt tripping and shall have amperes symmetrical interrupting capacity as indicated. The protective device shall have provision for locking in the "off" position. A surge suppression device shall be installed at the UPS input to protect against lightning and switching surges.
- D. Power Transformer
  - 1. A dry-type, isolated-winding power transformer shall be used for the rectifier unit. The transformer's hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation material when operating at full load. The transformer insulation shall be Class H, 150 degrees C rise. Transformer connections shall be accessible from the front.
- E. Power Walk-In
  - 1. Rectifier/charger unit shall be protected by a power walk-in feature such that when ac power is returned to the ac input bus, the total initial power requirement will not exceed 20 percent of the rated full load current. This demand shall increase gradually to 100 percent of the rated full load current plus the battery charging current over the specified time interval.

- F. Sizing
  - 1. Rectifier/charger unit shall be sized for the following two simultaneous operating conditions:
    - a. Supplying the full rated load current to the inverter.
    - b. Recharging a fully-discharged battery to 95 percent of rated amperehour capacity within ten times the discharge time after normal ac power is restored, with the input protective device closed.
- G. Battery Charging Current
  - 1. Primary current limiting: Battery-charging current shall be voltage regulated and current limited. The battery-charging current limit shall be separately adjustable from 2 percent to 25 percent of the maximum discharge current. After the battery is recharged, the rectifier/charger unit shall maintain the battery at full float charge until the next operation under input power failure. Battery charger shall be capable of providing equalizing charge to the battery.
  - 2. Second step current limiting: The rectifier/charger unit shall also have a second-step battery current limit. This second-step current limit shall sense actual battery current and reduce the input power demand for battery recharging to 50 percent (adjustable from 30 percent to 70 percent) of the normal rate without affecting the system's ability to supply full-rated power to the connected load. The second-step current-limit circuit shall be activated by a dry contact signal from the generator set controls and shall prevent normal rate battery recharging until utility power is restored.
- H. Output Filter
  - 1. Rectifier/charger unit shall have an output filter to minimize ripple current supplied to the battery; the ripple current into the battery shall not exceed 3 percent RMS.
- I. dc Voltage Adjustment
  - 1. Rectifier/charger unit shall have manual means for adjusting dc voltage for battery equalization, to provide voltage within plus 10 percent of nominal float voltage.
- J. Battery Isolation Protective Device
  - 1. Module shall have a dc protective device to isolate the module from the battery system. The protective device size and interrupting rating shall be as required by system capacity and shall incorporate a shunt trip as required by

circuit design. The protective device shall have provision for locking in the "off" position.

- K. Inverter Unit
  - 1. Inverter unit shall be a solid-state device capable of accepting power from the dc bus and providing ac power within specified limits.
- L. Output Overload
  - 1. The inverter shall be able to sustain an overload as specified across its output terminals. The inverter shall not shut off, but shall continue to operate within rated parameters, with inverse-time overload shutdown protection.
- M. Synchronism
  - 1. The inverter shall normally operate in phase-lock and synchronism with the bypass source. Should the bypass source frequency deviate beyond 60 Hz by more than 0.5 Hz, the internal frequency oscillators contained in the power module shall be used to derive the new frequency reference. Upon restoration of the bypass source within the required tolerance, the inverter shall resynchronize with that source at a slew rate not exceeding the specified rate. The oscillator shall be temperature compensated and shall be manually adjustable. The design of the oscillator and synchronizing circuits shall be such that failure of any associated component, connector pin, terminal lead wire or dc power source in either the open or shorted mode shall affect only one inverter leg. Such failure shall not cause transient disturbance of the critical load in excess of the stated limits.
- N. Phase Balance
  - 1. Electronic controls shall be incorporated to provide individual phase voltage compensation to obtain phase balance.
- O. Modular Construction
  - 1. Each control logic printed circuit board shall be electrically and physically packaged on an individual plug-in module with separate indication and adjustments.
- P. Output Protective Device

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- 1. The output protective device shall be capable of shunt tripping and shall have interrupting capacity as specified. Protective device shall have provision for locking in the "off" position.
- Q. Output Transformer
  - 1. The inverter output transformer shall be similar to the input transformer and shall be capable of handling up to K-13 nonlinear loads as described in IEEE C57.110.
- R. Modular Inverter Isolation
  - 1. Each inverter in the UPS system shall have fault sensing and static isolation as well as an output protective device, to remove a faulted module from the system without affecting the critical load bus beyond the stated limits.
- S. External Protection
  - 1. UPS module shall have built-in self-protection against undervoltage, overvoltage, overcurrent and surges introduced on the ac input source and/or the bypass source. The UPS system shall sustain input surges without damage in accordance with IEEE C62.41. The UPS shall also have built-in self-protection against overvoltage and voltage surges introduced at the output terminals by paralleled sources, load switching, or circuit breaker operation in the critical load distribution system.
- T. Internal Protection
  - 1. UPS module shall be self-protected against overcurrent, sudden changes in output load and short circuits at the output terminals. UPS module shall be provided with output reverse power detection which shall cause that module to be disconnected from the critical load bus when output reverse power is present. UPS module shall have built-in protection against permanent damage to itself and the connected load for predictable types of failure within itself and the connected load. At the end of battery discharge limit, the module shall shut down without damage to internal components.
- U. Parallel Operation
  - 1. For parallel operation, the protection system shall have control logic capable of isolating only the faulted module, and shall not shut down the entire UPS system upon a fault in one module. Open protective devices shall be indicated by an alarm and indicator light.

## 2.5 STATIC BYPASS TRANSFER SWITCH

- A. A static bypass transfer switch shall be provided as an integral part of the UPS and shall consist of a static switch and a bypass protective device or bypass switch. The control logic shall contain an automatic transfer circuit that senses the status of the inverter logic signals and alarm conditions and provides an uninterrupted transfer of the load to the bypass ac power source, without exceeding the transient limits specified herein, when a malfunction occurs in the UPS or when an external overload condition occurs. The power section of the static bypass transfer switch shall be provided as a plug-in type assembly to facilitate maintenance. The static bypass transfer switch shall be used to connect the bypass ac power source or the UPS inverter output to the critical load when required, and shall have the following features:
- B. Uninterrupted Transfer
  - 1. The static bypass transfer switch shall automatically cause the bypass ac power source to assume the critical load without interruption when the bypass control logic senses one of the following conditions and the UPS inverter output is synchronized to the bypass ac power source:
    - a. Inverter overload exceeds unit's rating.
    - b. Battery protection period is expired and bypass is available.
    - c. Inverter failure.
- C. Interrupted Transfer
  - 1. If an overload occurs and the UPS inverter output is not synchronized to the bypass ac power source, the UPS inverter output shall current-limit for 200 milliseconds minimum. The inverter shall then turn off and an interrupted transfer to the bypass ac power source shall be made. If the bypass ac power source is beyond the conditions stated below, an interrupted transfer shall be made upon detection of a fault condition:
    - a. Bypass voltage greater than plus or minus 10 percent from the UPS rated output voltage.
    - b. Bypass frequency greater than plus or minus 0.5 Hz from the UPS rated output frequency.
    - c. Phase differential of ac bypass voltage to UPS output voltage greater than plus or minus 3 degrees.
- D. Manual Transfer

- 1. It shall be possible to make a manually-initiated static transfer from the system status and control panel by turning the UPS inverter off.
- E. Automatic Uninterrupted Forward Transfer
  - 1. The static bypass transfer switch shall automatically forward transfer, without interruption after the UPS inverter is turned "on", or after an instantaneous overload-induced reverse transfer has occurred and the load current has returned to less than the unit's 100 percent rating.
- F. Forced Transfer
  - 1. The control logic circuitry shall provide the means of making a forced or reverse transfer of the static bypass transfer switch on an interrupted basis. Minimum interruption shall be 200 milliseconds when the UPS inverter is not synchronized to the bypass ac power source.
- G. Overload Ratings
  - 1. The static bypass transfer switch shall withstand the following overload conditions:
    - a. 2000 percent of UPS output rating for two cycles.
    - b. 200 percent of UPS output rating for 5 minutes.
    - c. 125 percent of UPS output rating for 10 minutes.
- H. Static Switch Disconnect
  - 1. A static switch disconnect shall be incorporated to isolate the static bypass transfer switch assembly so it can be removed for servicing. The switch shall be equipped with auxiliary contacts and provision for padlocking in either the "on" or "off" position.

# 2.6 MAINTENANCE BYPASS SWITCH

- A. General
  - 1. A maintenance bypass switch shall be provided as an integral part of the UPS and located within the UPS module. The maintenance bypass switch shall provide the capability to continuously support the critical load from the bypass ac power source while the UPS is isolated for maintenance. The maintenance bypass switch shall be housed in an isolated compartment inside the UPS cabinet in such a way that service personnel will not be exposed to electrically live parts while maintaining the unit. Switch shall contain a

maintenance bypass protective device and a module isolation protective device.

- B. Load Transfer
  - 1. The maintenance bypass switch shall provide the capability of transferring the critical load from the UPS static bypass transfer switch to maintenance bypass and then back to the UPS static bypass transfer switch with no interruption to the critical load.
- C. Load Bank Protective Device
  - 1. A load bank protective device shall be provided to allow the UPS system to be tested using a portable load bank. The load bank protective device shall be connected on the line side of the maintenance bypass switch isolation protective device.

## 2.7 MODULE CONTROL PANEL

- A. The UPS module shall be provided with a control/indicator panel. The panel shall be on the front of the UPS module. Controls, meters, alarms and indicators for operation of the UPS module shall be on this panel.
  - 1. Module Meters
    - a. Monitored Functions
  - 2. The following functions shall be monitored and displayed:
    - a. Input voltage, phase-to-phase (all three phases).
    - b. Input current, all three phases.
    - c. Input frequency.
    - d. Battery voltage.
    - e. Battery current (charge/discharge).
    - f. Output voltage, phase-to-phase and phase-to-neutral (all three phases).
    - g. Output current, all three phases.
    - h. Output frequency.
    - i. Output kilowatts.
    - j. Elapsed time meter to indicate hours of operation, 6 digits.
    - k. Bypass voltage, phase-to-phase and phase-to-neutral (all three phases).
    - l. Output kilovars.
    - m. Output kilowatt hours, with 15-minute demand attachment.

- 3. Meter Construction
  - a. Meters shall have 1 percent accuracy and shall be digital type (minimum 4 significant digits).
- B. Module Controls
  - 1. Module shall have the following controls:
    - a. Lamp test/reset pushbutton.
    - b. Alarm test/reset pushbutton.
    - c. Module input protective device trip pushbutton, with guard.
    - d. Module output protective device trip pushbutton, with guard.
    - e. Battery protective device trip pushbutton, with guard.
    - f. Emergency off pushbutton, with guard.
    - g. dc voltage adjustment potentiometer, with locking guard.
    - h. Control power off switch.
    - i. UPS/bypass transfer selector switch.
    - j. Static bypass transfer switch enable/disable selector switch.
- C. Module Alarm Indicators
  - 1. Module shall have indicators for the following alarm items. Any one of these conditions shall turn on an audible alarm and the appropriate summary indicator. Each new alarm shall register without affecting any previous alarm.
    - a. Input ac power source failure.
    - b. Input protective device open.
    - c. Output protective device open.
    - d. Overload.
    - e. Overload shutdown.
    - f. dc overvoltage.
    - g. dc ground fault.
    - h. Low battery.
    - i. Battery discharged.
    - k. Battery protective device open.
    - 1. Blower failure.
    - m. Input transformer overtemperature.
    - n. Inverter transformer overtemperature.
    - o. Equipment overtemperature.
    - p. Operating on internal oscillator.
    - q. Fuse blown.
    - r. Control power failure.
    - s. Charger off.

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- t. Inverter off.
- u. Emergency off.
- v. UPS on battery.
- w. Critical load on static bypass.
- x. Static bypass transfer switch disabled.
- y. Inverter output overvoltage.
- z. Inverter output undervoltage.
- aa. Inverter output overfrequency.
- bb. Inverter output underfrequency.
- cc. Bypass source overvoltage.
- dd. Bypass source undervoltage.
- ee. Bypass source overfrequency.
- ff. Bypass source underfrequency.
- gg. Bypass source to inverter out of synchronization.
- D. Module Mimic Panel
  - 1. UPS module shall have a mimic panel in the format of a module single-line diagram, with status indicators for input, output, battery protective devices, and battery disconnect switch. Each protective device shall have indicators for open (green) and closed (red), to give positive indication. The mimic panel shall provide indication of the following additional functions:
    - a. Charger on (functional).
    - b. UPS on-line (inverter furnishing load power).
    - c. UPS on-bypass (static switch operating).
    - d. System alarm (flashes for abnormalities, minor or major faults).
- E. Module Emergency Off Button
  - 1. Pressing the emergency off button shall cause the affected module to be disconnected from the system, via its input protective device, output protective device, and battery protective device. Activation of this button shall not affect the operation of the remainder of the system.

## 2.8 SYSTEM CONTROL CABINET

- A. General Description
  - 1. The multi-module UPS system shall be provided with a separate control cabinet for system output, summary monitoring, and control. This unit shall contain; bus bar connections to collect the output from each module, the static switch and its bypass breaker, the UPS system output protective device, and the UPS output switchgear.

- B. UPS Output Switchgear
  - 1. The UPS output switchgear shall consist of a main protective device feeding the UPS output switchgear critical load bus, a load bank protective device (connected on the line side of the main protective device), a maintenance bypass protective device and associated feeder protective devices for the critical loads.
- C. Interlocking
  - 1. The main protective device and the load bank protective device shall be interlocked to prevent both being closed at the same time. The maintenance bypass protective device shall be interlocked with the UPS system output protective device and the static bypass switch. The maintenance bypass protective device shall not be capable of closing until the static bypass switch is closed and the UPS system output protective device is open. Once the maintenance bypass protective device is closed, the UPS output switchgear main protective device shall be capable of opening to isolate the critical loads from the UPS output. The load bank protective device as well as the UPS system output protective device shall then be capable of closing to permit load bank testing.
- D. Switchgear
  - 1. UPS output switchgear shall be provided in accordance with Section 16475 COORDINATED POWER SYSTEM PROTECTION.
- E. System Control Panel
  - 1. A separate control panel shall be provided for the overall UPS system. The panel shall be on the front surface of the system cabinet. The controls, meters, alarms and indicators for operation of the UPS system shall be on this panel.
- F. System Meters
  - 1. Meters shall have 1 percent accuracy and shall be digital type (minimum 4 significant digits). ac voltages shall be measured as true RMS voltages.
  - 2. The following functions shall be monitored:
    - a. Output voltage, phase-to-phase and phase-to-ground (all three phases).
    - b. Output current, all three phases.
    - c. Output frequency.
    - d. Bypass voltage, phase-to-phase and phase-to-ground (all three phases).

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- e. Output kilowatts.
- f. Output kilovars.
- g. Output kVA.
- h. Output kilowatt-hours, with demand attachment.
- i. Maintenance bypass voltage, phase-to-phase and phase-to-ground (all three phases).
- G. System Controls
  - 1. The system cabinet shall include the following controls:
    - a. Lamp test/reset.
    - b. Alarm test/reset.
    - c. Voltage adjustment potentiometer.
    - d. Emergency off pushbutton with protective cover.
    - e. UPS/bypass transfer selector switch.
    - f. Static switch enable/disable selector switch.
    - g. Control power off switch.
- H. System Alarm Indicators
  - 1. The system control panel shall contain indicators for the following additional alarm items. Any one of these alarm conditions shall also activate the audible alarm. Each new alarm shall register without affecting previous alarms.
    - a. Module summary alarm, one for each UPS module.
    - b. UPS on battery.
    - c. Low battery voltage.
    - d. Critical load on bypass.
    - e. Static switch disable.
    - f. Output overvoltage.
    - g. Output undervoltage.
    - h. Output overfrequency.
    - i. Output underfrequency.
    - j. Overload.
    - k. Bypass source overvoltage.
    - 1. Bypass source undervoltage.
    - m. Bypass source overfrequency.
    - n. Bypass source underfrequency.
    - o. Bypass source to inverter out of synchronization.
    - p. Equipment overtemperature.
    - q. Control power failure.

- I. System Mimic Panel
  - 1. The system control panel shall contain a mimic panel in the format of a singleline diagram, with status indicators for the following items:
    - a. Module on-line, one per UPS module.
    - b. UPS output protective device status, one for closed (red), one for open (green), and one for withdrawn (amber).
    - c. Static bypass protective device status, one for closed (red), one for open (green), and one for withdrawn (amber).
    - d. Static switch status, one for connected (red), and one for disconnected (green).
- J. Emergency Off
  - 1. Pressing the emergency off button shall cause the module input, output, and battery circuit breakers to open, completely isolating the UPS system from sources of power. The critical load shall be transferred to the bypass source when this occurs.

## 2.9 SELF-DIAGNOSTIC CIRCUITS

A. The control logic shall include status indicators for trouble-shooting the control circuits. These indicators shall be mounted on the circuit card edge or face such that they will be visible without repositioning the card, and shall be labeled with the function name.

## 2.10 **REMOTE MONITORING PANEL**

A. A remote monitoring panel shall be provided in the Control Room to monitor system status. The panel shall be designed for wall mounting near the critical load.

## 2.11 INDICATORS

- A. Minimum display shall include the following indicators:
  - 1. Load on UPS.
  - 2. Load on battery.
  - 3. Load on bypass.
  - 4. Low battery.
  - 5. Summary alarm.
  - 6. New alarm (to alert the operator that a second summary alarm condition has occurred).

### B. Audible Alarm

1. Any single indicator shall also turn on the audible alarm. An audible alarm test/reset button and lamp test/reset button shall be included. This reset button shall not affect nor reset the alarm on the module or on the system cabinet.

## 2.12 COMMUNICATIONS AND DATA ACQUISITION PORT

A. An RS 232C communications and data acquisition port shall be provided. This port shall allow the system parameters, status, alarm indication and control panel functions specified to be remotely monitored and controlled.

## 2.13 TEMPERATURE CONTROL

- A. General
  - 1. Cabinet and enclosure ventilation shall be adequate to ensure that components are operated within their ratings. Forced-air cooled rectifier, inverter, and control unit will be acceptable. The cooling fans shall continue operation if UPS input power is lost. Redundancy shall be provided so that failure of one fan or associated circuit breaker will not cause an overheat condition. Cooling air shall enter the lower front of the cabinets and exhaust at the top. Blower power failure shall be indicated as a visual and audible alarm on the control panel. Air inlets shall have filters that can be replaced without opening the cabinet doors.
- B. Blower Power Source
  - 1. Blower power source shall be internally derived from the input and output sides of UPS module, with automatic transfer arrangement.
- C. Temperature Sensors
  - 1. Temperature sensors shall be provided to monitor the air temperature. Separate sensors shall monitor the temperature of rectifier and inverter heat sinks. Separate sensors shall also monitor the transformer temperature. Critical equipment overtemperature indication shall start a timer that shall shut down the UPS system if the temperature does not return below the setpoint level in 90 minutes.

# 2.14 BATTERY SYSTEM

A. General

- 1. A storage battery with sufficient ampere-hour rating to maintain UPS output at full capacity for the specified duration shall be provided for each UPS module. The battery shall be of heavy-duty, industrial design suitable for UPS service. The cells shall be provided with flame arrestor vents, intercell connectors and cables, cell-lifting straps, cell-numbering sets, and terminal grease. Intercell connectors shall be sized to maintain terminal voltage within voltage window limits when supplying full load under power failure conditions. Cell and connector hardware shall be stainless steel of a type capable of resisting corrosion from the electrolyte used.
- B. Battery Ratings
  - 1. Type: lead calcium.
  - 2. Specific gravity when fully charged: 1.215.
  - 3. End voltage 1.67 volts per cell.
  - 4. Float voltage: 2.17 to 2.26 volts per cell.
  - 5. Equalizing voltage: 2.33 to 2.38 volts per cell.
- C. Battery Construction
  - 1. The battery shall be of the valve-regulated, sealed, non-gassing, recombinant type .
- D. Battery Cabinet
  - 1. The battery pack assembly shall be furnished in a battery cabinet matching the UPS cabinet. The battery cabinet shall be designed to allow for checking the torque on the connections in the battery system and to provide adequate access for annual housekeeping chores. External wiring interface shall be through the bottom or top of the assembly. A smoke and high temperature alarm shall annunciate detection of either smoke or high temperature within the battery cabinet.
- E. Cell-Terminal Covers
  - 1. Acid-resistant transparent cell-terminal covers not exceeding 6 feet in length and with vent holes drilled on top where needed shall be provided.
- F. Battery Disconnect
  - 1. Each battery pack assembly shall have a fused disconnect switch provided in a NEMA 1 enclosure, finished with acid-resistant paint and located in line with the assembly. Switch shall be complete with line side and load side bus bars for connection to battery cells. Switch shall be rated as required, 3-pole with

interrupting rating as required by system capacity, and shall have an external operator that is lockable in the "off" position.

- G. Seismic Requirements
  - 1. The battery support system shall conform to Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT, 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT, AND 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.
- H. Battery Monitor
  - 1. A battery monitor shall be provided for each battery pack assembly. At a minimum, this device shall monitor the following parameters:
    - a. Total system voltage.
    - b. Ambient room temperature.
    - c. Total battery discharge cycles with a duration of greater than 5 minutes.
  - 2. The monitor shall also record the total accumulated discharge minutes and accumulated battery system discharge kW hours.

# 2.15 FACTORY TESTING

- The UPS system shall be factory tested to meet the requirements specified using a A. test battery (not the battery to be supplied with the system). UPS module shall be factory load tested as an independent assembly with 3-phase ac input power and with battery power for a minimum of 8 hours, with meter readings taken every 30 minutes. Load shall be balanced at rated kVA and rated power factor. Factory tests for the UPS module shall be run under full load, and will be witnessed by the Owner. Should a malfunction occur, the problem shall be corrected and the test shall be repeated. As a minimum, the factory tests shall include the parameters described in paragraphs ac Input, ac Output, Transient Response and Efficiency. The tests shall encompass all aspects of operation, such as module failure, static bypass operation, battery failure, input power failure and overload ratings. The Owner shall be notified in writing at least 2 weeks before testing. Factory-test time shall not be used for system debugging and/or checkout. Such work shall be done prior to notifying the Owner that the system is ready for testing. Factory tests shall be performed during normal business hours. The system shall be interconnected and tested for an additional 8 hours to ensure proper wiring and performance.
- B. Transient Tests

- 1. Transient tests shall be conducted using high-speed oscillograph type recorders to demonstrate the operation of the components to the satisfaction of the Owner. These tests shall include 50 percent to 100 percent load changes, manual transfer, manual retransfer, low dc bus initiated transfer and low ac output bus transfer. A recording instrument equipped with an event marker shall be used.
- C. Efficiency Tests
  - 1. Testing for efficiency shall be performed at zero output up to 100 percent of stated kVA output in 25 percent steps, 0.8 power factor, with battery fully charged and floating on the dc bus, with nominal input voltage, and with modules connected to the system to represent actual operating conditions.

### 2.16 INSPECTION

1. Inspection before shipment is required. The manufacturer shall notify the Owner at least 2 weeks before shipping date so that an inspection can be made.

## **PART 3 - EXECUTION**

## 3.1 INSTALLATION

A. The UPS system shall be set in place, wired and connected in accordance with the approved shop drawings and manufacturer's instructions. The UPS battery shall be shipped to the site dry.

## **3.2** FIELD SUPERVISION, STARTUP AND TESTING

- A. The services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment and testing of the equipment. The representative shall check the wiring between equipment, start up the system, and field test the functions, interlocks and protective devices to ensure that the total system is functioning according to the intent of the design. The field tests shall be performed under the supervision of a factory-trained representative of the equipment manufacturer and witnessed by the Owner. The Owner shall be given 2 weeks written advance notice of the date and time when testing will be conducted.
- B. Field Tests
  - 1. As a minimum, the startup and field test procedures shall include the following:

- a. Ensure that shipping members have been removed.
- b. Check for damage (dents, scratches, frame misalignment, damage to panel devices, etc).
- d. Ensure that interiors are free of foreign materials, tools and dirt.
- e. Attach a phase rotation meter to the UPS input, output and bypass buses, and observe proper phase sequences.
- f. Torque test bus connections at shipping splits. Also torque test battery connections.
- g. Check each electrical bus for proper phasing and identification.
- h. Check and test selector switches and meters for proper operation.
- i. Check doors for proper alignment and operation.
- j. Check and test each protective device for proper mechanical and electrical operation.
- k. Check protective device overcurrent trip settings.
- 1. Check and test indicating lights for proper operation and color.
- m. Perform onsite field test procedures.
- n. Demonstrate to the Owner that the specified functions and interlocks have been implemented.
- o. Provide IEEE Std 450 battery installation certification.
- p. Check key interlock key numbers, if used, to ensure agreement with interlocking scheme.
- C. Load Test
  - 1. The installed system shall be load tested for a continuous 24 hour period by means of resistive load banks. The system shall be continuously tested at 1/2 load for 8 hours, 3/4 load for 8 hours and full load for 8 hours. The equipment manufacturer shall provide resistive load banks of total kW load of equipment to facilitate startup under load conditions, and to conduct load tests described above. Instrument readings shall be recorded every half hour for the following:
    - a. Input voltage (all three phases, for each module).
    - b. Input current (all three phases, for each module).
    - c. Input frequency.
    - d. Battery voltage for each module.
    - e. Output voltage (all three phases, for each module).
    - f. Output current (all three phases, for each module).
    - g. Output kilowatts for each module.
    - h. Output frequency.
    - i. Output voltage (all three phases system output).
    - j. Output current (all three phases system output).
    - k. Output kilowatts (system output).

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## D. Full Load Burn In Test

- 1. The installed system shall undergo an additional full load burn-in period of 24 continuous hours. If a failure occurs during the burn-in period, the tests shall be repeated. Instrument readings shall be recorded every half hour as above. During the burn-in period, the following tests shall be performed:
  - a. With the UPS carrying maximum continuous design load and supplied from the normal source, switch 100 percent load on and off a minimum of five times within the burn-in period.
  - b. With the UPS carrying maximum continuous design load and supplied from the emergency source, repeat the switching operations described in step a. Also, verify that the UPS module rectifier charger unit(s) go into the second-step current limit mode.
  - c. With the UPS carrying maximum continuous design load and operating on battery power, repeat the switching operations described in step a above.
  - d. Continue operation on battery power for 1 minute, then restore normal power.
- 2. The Contractor shall furnish a high-speed dual trace oscillograph to monitor ten or more cycles of the above tests at the ON and OFF transitions and two typical steady-state periods, one shortly after the load is energized (at 30 to 60 seconds) and one after operation has stabilized (at 8 to 10 minutes). Four copies of the traces shall be delivered to the Owner.
- E. Battery Discharge Test
  - 1. With the battery fully charged, the system shall undergo a complete battery discharge test to full depletion and a recharge to nominal conditions. Instrument readings shall be recorded every minute during discharge for the following:
    - a. Battery voltage for each module.
    - b. Battery current for each module.
    - c. Output voltage (all three phases) for each module.
    - d. Output current (all three phases) for each module.
    - e. Output kilowatts for each module.
    - f. Output voltage (all three phases system output).
    - g. Output current (all three phases system output).
    - h. Output kilowatts (system output).
    - i. Output frequency.

### **3.3 POSTING FRAMED DATA AND INSTRUCTIONS**

1. Framed data and instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

## **3.4 FIELD TRAINING**

1. A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 12 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Field training shall cover the items contained in the operating and maintenance manuals. The 12 hours shall be divided into two sessions of 6 hours each. Each session shall be conducted on a different day. A factory training DVD shall be provided as part of the training materials.

### UPS SYSTEM PERFORMANCE DATA SHEET 1 OF 6

	ITEM	SPECIFIED	SUBMITTED
SYST	EM OPERAT	ION:	
	[SINGLE MO	DDULE]	
	[PARALLEL	REDUNDANT]	۲ <b>۰</b>
	IPAKALLEL	, NON KEDUNDAN I F SVSTEMS [ 1	]
	NOWBER		
<u>GENF</u>	ERAL:		
	NUMBER O	F MODULES PRESE	ENT []
	IN EACH SY	STEM FUTURE	[]
	SYSTEM CA	PACITY	
	PRESENT	[ ] kW/[	] kVA
	FUTURE	[] kW/[]	kVA
	BATTERY	ONE PER MOD	DULE
	MTBF (SYS	ГЕМ)	
	MTTR		
MOD	III F.		
MOD	MODULE R.	ATING [] kV	V/[] kVA
	DC VOLTAG	GE WINDOW [	] Vdc
	INPUT/OUT	PUT	
	PROTECTIV	YE DEVICE [] A	A SYM.
	INTERRUPT	. RATING	
MAN	UFACTURER	• •	
TVPE	· [[EA		
TITE	· [LEA [LEA	D-ANTIMONY]	
	[NIC	KEL-CADMIUM]	
BATT	ERY:		
	FND VOL T	ETIMETU AGEAT I IMI	INUTES
	FULL LOAF		
	END VOLTA	AGE [ ] V/C	ELL
	SPECIFIC G	RAVITY []	
	FLOAT VOI	LTAGE [] V/	CELL
	NUMBER O	F CELLS [] C	ELLS

### UPS SYSTEM PERFORMANCE DATA SHEET SHEET 2 OF 6

ITEM	SPECIFIED	SUBMITTED
BATTERY:		
HYDRO	GEN	
GENER	ATION	
RECHA	RGE TIME TO	
95% CA	PACITY 10 X D	DISCHARGE
YSTEM CABI	NET:	
PROTEC	CTIVE DEVICE [AIR]	POWER, DRAW-OUT] []
MANUF	ACTURER	
INTERR	UPTING RATE	] A SYM.
STATIC	SWITCH [] A	A
AC INPUT:		
VOLTS,	LINE/LINE []	
PHASES	$5 \qquad [3-PHASE, 3-V]$	•WIRE][]
	$\begin{array}{llllllllllllllllllllllllllllllllllll$	, - 13% [1_
FREQUI	ENCY $\begin{bmatrix} 30 \end{bmatrix} \begin{bmatrix} 00 \end{bmatrix} \Pi$	ΠZ :0/
FREQUI	ENCI KANGE $\pm -37$	70
POWER	WALK-IN	
20% TO	100% LOAD 15 - 24	SECONDS
TOTAL	HARMONIC DISTOR	TION [5% MAX (CURRENT)] [ ]
REFLEC	TED-PRIMARY	
ORI	DER OF HARMONIC	PERCENTAGE OF TOTAL
	$2^{nd}$	
	3 <sup>rd</sup>	
	4 <sup>th</sup>	
	5 <sup>th</sup>	
	$6^{\text{th}}$	
	$7^{\text{th}}$	
	8 <sup>th</sup>	
	9 <sup>th</sup>	
FIL	L IN AS REQUIRED	
TDANSFODMI	D SUR .	
CYCLE	INRUSH [ ] x	x FULL LOAD

POWER FACTOR [0.8] [0.9]

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### UPS SYSTEM PERFORMANCE DATA SHEET SHEET 3 OF 6

ITEM SPECIFIED	SUBMITTED
VOLTAGE: LINE-LINE [] V	
PHASES 3-PHASE, 4-W	/IRE
POWER FACTOR 0.8 LAGO	GING, 1.0
VOLTAGE REGULATION BALANCED LOAD +/- 1.0%	
50% IMBALANCE +/- 2.0% BETWEEN PHASES	
(a) NO-LOAD: MODULATION +/- 1.0%	
DRIFT (30 DAYS) +/- 1.0%	
VOLTAGE ADJUST. +/- 5.0%	6 MANUALLY
AC OUTPUT: FREQUENCY 60 Hz	
REGULATION +/- 0.1%	
DRIFT (24 HRS.) +/- 0.1%	
HARMONIC CONTENT TOTAL (50% NON-LINEAR LO TOTAL (LINEAR LOAD) SINGLE HARMONIC (LINEAR	DAD 7.0% MAX. 5.0% MAX. LOAD) 3.0% MAX.
PHASE DISPLACEMENT:	
BALANCED LOAD +/- 1.0 DI	EG. OF BYPASS
50% IMBALANCE +/- 3.0 DE	G. OF BYPASS

WAVE FORM DEVIATION FACTOR 5.0% (NO LOAD)

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#### UPS SYSTEM PERFORMANCE DATA SHEET SHEET 4 OF 6

ITEM	SPECIFIED	SUBMITTED	
<b>OVERLOAD CAP</b>	ACITY:		
	125%	10 MINUTES	
	150%	30 SECONDS	
	300%	MOMENTARY	
LOAD SHARING	+/- 5.0% OF	AVERAGE LOAD	
AMONG M	ODULES		
VOLT. TRA	NSIENT RESPO	NSE	
50% STEP I	LOAD		
	0% to 50%	+/- 8.0%	
50% STEP I	LOAD		
50% STEP I	LOAD 50% to 100%	+/- 8.0%	
50% STEP L LOSS OR R	LOAD 50% to 100% ETURN OF INPU	+/- 8.0% JT+/- 1.0%	
50% STEP L LOSS OR R LOSS OR R	LOAD 50% to 100% ETURN OF INPU ETURN OF A RI	+/- 8.0% JT+/- 1.0% EDUNDANT MODULE	
50% STEP L LOSS OR R LOSS OR R AUT	LOAD 50% to 100% ETURN OF INPU ETURN OF A RE FOMATICALLY	+/- 8.0% JT+/- 1.0% EDUNDANT MODULE +/- 8.0%	

AUTO TRANSFER, FULL LOAD:

FROM UPS TO BYPASS +/- 4.0%

MANUAL TRANSFER, AT FULL LOAD, FROM BYPASS TO UPS +/- 4.0%

RECOVERY TIME TO 99% STEADY- STATE COND 50 MILLISECONDS.

FREQUENCY TRANSIENT RESPONSE - +/- 0.5 Hz

SLEW RATE 1.0 Hz/SECOND

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	UPS SYS	TEM PERFORMANC	CE DATA SHEET SHEET 5 OF 6	
	ITEM	SPECIFIED	SUBMITTED	
	EFFICIEI N	NCY @ FULL LOAD IODULE []	) _]%	
	SYSTEM	[]%		
BAT	TERY ROC	M ENVIRONMENT	<u>T:</u>	
	SYSTEM	NOISE GEN. LEVEL	L @ FT. FROM EQUIPMENT [] DBA	
	OPERAT	ING AMBIENT TEMI	Image: MPERATURE 32 to [104] [122] DEG. F	
	STORAG	E AMBIENT TEMPE	ERATURE -4 to +140 DEG. F.	
	AMBIEN	T TEMP. 77 DEG.	G. F NOMINAL	
	RELATIV	VE HUMIDITY (NON-	N-CONDENSING) 0 - 95%	
	BAROMI NON-OP	ETRIC PRESSURE (A ERATING 0 - 40,000	ALTITUDE) OPERATING 0 - [] FT. 0 FT.	
	HEAT RI	EJECTION		
	MODULI SYSTEM	3		
P H Y	MODULE			
S I C	SIZE WEIGHT			
A L	SYSTEM CA	ABINET		
D A T A	SIZE WEIGHT			

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#### UPS SYSTEM PERFORMANCE DATA SHEET 6 OF 6

## **SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES**

## PART 1 - GENERAL

#### **1.1 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. Section includes lightning protection for structures, structure elements, building site components.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
  - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
  - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- C. Field quality-control reports.
- D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

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- 1. Ground rods.
- 2. Ground loop conductor.

## **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
  - 1. UL Master Label.
  - 2. LPI System Certificate.
  - 3. UL Master Label Recertification.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

## **1.6 COORDINATION**

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

# PART 2 - PRODUCTS

# 2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class II, aluminum unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. East Coast Lightning Equipment Inc.

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- b. ERICO International Corporation.
- c. Harger.
- d. Heary Bros. Lightning Protection Co. Inc.
- e. Independent Protection Co.
- f. Preferred Lightning Protection.
- g. Robbins Lightning, Inc.
- h. Thompson Lightning Protection, Inc.
- 2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
- 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.
- C. Main and Bonding Conductors: Copper.
- D. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- E. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.
- F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Solid copper.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
  - 1. System conductors.
  - 2. Down conductors.
  - 3. Interior conductors.
  - 4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

- E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
  - 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- G. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.
- H. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure, area or item indicated.
  - 1. Bury ground ring not less than 24 inches (600 mm) from building foundation.
  - 2. Bond ground terminals to the ground loop.
  - 3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.
- I. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

# 3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

#### **3.3 CORROSION PROTECTION**

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

#### **3.4 FIELD QUALITY CONTROL**

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

# **END OF SECTION**

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### 265100 - INTERIOR LIGHTING

#### PART 1 - GENERAL

#### **1.1 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Interior lighting fixtures, lamps, and ballasts.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Lighting fixture supports.
  - 5. Retrofit kits for fluorescent lighting fixtures.
- B. Related Sections:
  - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

#### **1.3 DEFINITIONS**

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. Lumen: Measured output of lamp and luminaire, or both.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.

#### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

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- 1. Physical description of lighting fixture including dimensions.
- 2. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
- B. Warranty: Sample of special warranty.

# 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. LED Replacement boards: Qty. of four (4) highbay fixture boards, with Class 1 Division 2 hazardous classification.
  - 2. LED Replacement drivers: Qty. of four (4) highbay fixture drivers, with Class 1 Division 2 hazardous classification.

# 1.6 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Lighting Unit Batteries: 2 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining years.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

# 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools.
- B. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

- C. Diffusers and Globes:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least **0.125 inch** minimum unless otherwise indicated.
    - b. UV stabilized.

## 2.3 LED LIGHTING FIXTURES

- A. Fixtures to be installed in hazardous areas of the facility shall be UL listed for the classification shown on plans.
- B. Fixtures depreciation shall meet LM80 rating for 50,000 hours.
- C. Fixtures shall be provided with LED circuit boards from the same batch or bin. Manufacture shall guarantee output color consistency for all similar products within 100 degrees kelvin. Refer to plans for specified color temperature.
- D. Minimum LED CRI shall be 80.
- E. Fixtures shall be capable of dimming where shown on plans, 0-10V.
- F. LED circuit boards shall be produced by a reputable manufacturer with a minimum of 5 years lighting industry experience.

## 2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

## 2.5 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
  - 1. Battery: Sealed, maintenance-free, lead-acid type.
  - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

- 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
- 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- 6. Integral Self-Test: Factory-installed electronic device automatically initiates coderequired test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

# 2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- C. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Lighting fixtures:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. Install lamps in each luminaire.
  - 3. Where installed in hazardous areas the conduit system supplying the lighting fixtures shall be compliant with NEC article 500.
- B. Suspended Lighting Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

# **3.2 FIELD QUALITY CONTROL**

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

- B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

#### **END OF SECTION**