# CITY of OWOSSO, MICHIGAN PART TWO: WASHINGTON PARK LIFT STATION

The Specifications that follow are to be used only for the portion of the work related to the Washington Park Lift Station (Part Two) as documented on the following Drawings as included in this Project:

DRAWING	TITLE		
C-001	General Notes & Legend		
C-101	Proposed Site Plan		
C-501	Standard Details		
C-502	Pump Station Details		
E-001	Notes & Legend		
E-101	Proposed Site Plan and One-Line		
E-501	Standard Details		
M-101	Mechanical New Work		

Prepared by



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## SECTION 011100 - SUMMARY OF WORK

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. PART TWO is located on W. Wesley Drive, 325-ft west of N. Water Street.
- B. PART TWO consists of installation of a new sewage lift station and associated piping, including gravity and force main that connects to other work described elsewehre in the Contract Documents.

#### 1.02 MISCELLANEOUS PROVISIONS

- A. CONTRACTOR shall notify all Owners of public utilities within the right-of-way or easement for the purpose of establishing the approximate locations of the utilities in accordance with the requirements of Act No. 53 Public Acts of 1974 of the State of Michigan. CONTRACTOR shall notify MISS DIG-Utility Communication System, 1-800-482-7171, three working days prior to starting any excavation with power equipment.
- B. CONTRACTOR shall be responsible for verifying the location of all underground utilities by magnetic or other type instruments before beginning excavation Work.
- C. Time and Sequence of Work: In general, it is the intention and understanding that CONTRACTOR shall have control over the sequence or order of execution of the several parts of the Work to be done under the Contract and over the method of accomplishing the required results, except as some particular sequence or method may be distinctly demanded by the Drawings and Project Manual or by the expressed provisions of the Contract. ENGINEER may, however, make such reasonable requirements as may, in ENGINEER's judgment, be necessary for the proper and effective protection of Work partially or wholly completed, and to these requirements CONTRACTOR shall conform.

PART 2 - PRODUCTS

## NOT USED

PART 3 - EXECUTION

## NOT USED

#### SECTION 012100 - ALLOWANCES

## PART 1 - GENERAL

#### 1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for processing Allowances. Selected materials and equipment, and in some cases their installation, are shown and specified in the Contract Documents by Allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. Additional requirements, if necessary, will be issued by Change Order.

## 1.02 SUBMITTALS

A. Submit invoices or delivery slips to indicate actual quantities of materials delivered to the Site for use in fulfillment of each Allowance.

#### 1.03 OWNER'S INSTRUCTIONS

- A. At the earliest feasible date after Contract Award, advise ENGINEER of the date when the final selection and purchase of each product or system described by an Allowance must be completed in order to avoid delay in performance of the Work.
- B. When requested by ENGINEER, obtain Bids for each Allowance for use in making final selections; include recommendations that are relevant to performance of the Work.
- C. Purchase products and systems as selected by ENGINEER from the designated supplier.
- D. Use Allowances only as directed for OWNER's purposes, and only by Change Orders which designate amounts to be charged to the Allowance.
- E. If the actual price for the specified Allowance is more or less than the stated Allowance, the Contract Price shall be adjusted accordingly by Change Order. The adjustment in Contract Price shall be made in accordance with Paragraph 11.02 of the General Conditions.
- F. Change Orders authorizing use of funds from the Contingency or Provisionary Allowances will include CONTRACTOR's related costs and reasonable overhead and profit margins.
- G. At Project closeout, any amounts remaining in Allowances will be credited to OWNER by Change Order.

## PART 2 - PRODUCTS

## NOT USED

## PART 3 - EXECUTION

## 3.01 INSPECTION

A. Inspect products covered by an Allowance promptly upon delivery for damage or defects.

## 3.02 PREPARATION

A. Coordinate materials and their installation for each Allowance with related materials and installations to ensure that each Allowance item is completely integrated and interfaced with related construction activities.

#### SCHEDULE OF ALLOWANCES

1. Allowance for Electrical Utility Connection. The CONTRACTOR shall coordinate with Consumers Energy to relocate the nearby residence existing service around the pump station footprint including overhead wiring, additional pole(s), etc. to allow for overhead maintenance of the pump station and obtain a permanent utility feed from the relocated overhead electrical power lines, as noted on Drawings to avoid conflicts during performance of the site Work. An Allowance of \$20,000 shall be included in the Contract Price for this Work. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract. For further information, contact:

## Company: Consumers Energy

2. Lump Sum allowance to furnish and install one Cellular RTU with MicroLogix PLC, UPS, ethernet switch, cables, 24VDC power supply, cellular modem, and antenna. UIS will provide submittals, panel drawings, and O&M manual. UIS will provide programming and startup services for integration to UIS cloud-based SCADA system to monitor the new lift station with functionality similar to the City's other facilities. An Allowance of \$20,000 for the base Bid Price shall be included in the Contract Price for this Work. CONTRACTOR shall allocate time within the contract to oversee this installation. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract. For further information, contact:

Contact: UIS - Ken Wesley (phone 734-424-1200), 2290 Bishop Circle East, Dexter, MI 48130

3. Lump Sum Allowance for Natural Gas Service. The Utility Company Consumers Energy will provide gas service as shown on Drawings. Equipment and Work to be included in the allowance shall include the material and labor from the point of utility disconnection and reconnection at the Washington Park Lift Station generator. An Allowance of \$10,000 shall be included in the Contract Price for this Work. CONTRACTOR shall make all arrangements for and shall pay for this Work under this Contract. The allowance shall not include the other equipment and materials beyond the disconnection services unless indicated otherwise. Site preparation work for the utility service shown shall be paid for under Division 31 of this Contract and is not part of this Allowance.

Company: Consumers Energy

## SECTION 013300 - SUBMITTALS

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals, including, but not necessarily limited to, the following:
  - 1. CONTRACTOR's Construction Schedule.
  - 2. Submittal Schedule.
  - 3. Shop Drawings.
  - 4. Product data.
  - 5. Samples.
  - 6. Progress photographs.
  - 7. Record photographs.
- B. Topics covered elsewhere include, but are not limited to:
  - 1. Permits.
  - 2. Applications for payment.
  - 3. Performance and payment bonds.
  - 4. Insurance certificates.
  - 5. List of subcontractors.

## 1.02 SUBMITTALS

- A. Bonds and Insurance Certificates shall be submitted to and approved by OWNER and ENGINEER prior to the initiation of any construction on Site.
- B. Permits, Licenses, and Certificates: For OWNER's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents; correspondence and records established in conjunction with compliance with standards; and regulations bearing upon performance of the Work.

## 1.03 SUBMITTAL PROCEDURES

- A. Coordination:
  - 1. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
  - 2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
  - 4. ENGINEER reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Processing:
  - 1. Allow sufficient review time so that installation shall not be delayed as a result of the time required to process submittals, including time for resubmittals.

- 2. ENGINEER will review and return submittals with reasonable promptness, or advise CONTRACTOR when a submittal being processed must be delayed for coordination or receipt of additional information by putting the submittal "On Hold" and returning a transmittal identifying the reasons for the delay.
- 3. No extension of Contract Time will be authorized because of failure to transmit submittals to ENGINEER sufficiently in advance of the Work to permit processing.
- C. Submittal Preparation:
  - 1. Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
  - 2. Provide a space approximately 4 inches by 5 inches on the label or beside the title block on submittals not originating from CONTRACTOR to record CONTRACTOR's review and approval markings and the action taken.
  - 3. Include the following information on the label for processing and recording action taken.
    - a. Project name.
    - b. Date.
    - c. Name and address of ENGINEER.
    - d. Name and address of CONTRACTOR.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Number and title of appropriate Specification Section.
    - i. Drawing number and detail references, as appropriate.
  - 4. Any markings done by CONTRACTOR shall be done in a color other than red. Red is reserved for ENGINEER's marking.
  - 5. The number of copies to be submitted will be determined at the pre-construction conference. Reproducibles may be submitted and will be marked and returned to CONTRACTOR. Blue or black line prints shall be submitted in sufficient quantity for distribution to ENGINEER and OWNER recipients.
- D. Submittal Transmittal:
  - 1. Package each submittal appropriately for shipping and handling. This shall include an index either on the transmittal or within the submittal itself. Transmit each submittal from CONTRACTOR to ENGINEER using a transmittal form. Submittals received from sources other than CONTRACTOR will be returned without action. Use separate transmittals for items from different specification sections. Number each submittal consecutively. Resubmittals should have the same number as the original, plus a letter designation for each resubmittal (i.e., 7-A, 7-B, etc.).
  - 2. Indicate on the transmittal relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include CONTRACTOR's certification that information complies with Contract Document requirements. On resubmittal, all changes shall be clearly identified for ease of review. Resubmittals shall be reviewed for the clearly identified changes only. Any changes not clearly identified will not be reviewed and original submittal shall govern.

## 1.04 CONSTRUCTION SCHEDULE

- A. Bar Chart Schedule:
  - 1. Prepare a fully developed, horizontal bar chart type Construction Schedule. Submit within 30 days of the date established for "Commencement of the Work."

- 2. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated on Schedule of Values.
- 3. Prepare Schedule on a sheet, or series of sheets, of stable transparency or other reproducible media, of sufficient width to show data for the entire construction period.
- 4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on Schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the Work.
- 5. Coordinate Construction Schedule with Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
- 6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on Schedule to allow time for ENGINEER's procedures necessary for certification of Substantial Completion.
- B. Schedule Updating: Revise Schedule after each meeting or activity where revisions have been recognized or made within 2 weeks following the meeting or activity.

## 1.05 SUBMITTAL SCHEDULE

- A. After development and acceptance of Construction Schedule, prepare a complete Schedule of Submittals. Submit Schedule within 10 days of the date required for establishment of Construction Schedule.
- B. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products, as well as Construction Schedule.
- C. Prepare Schedule in chronological order; include submittals required during the first 90 days of construction. Provide the following information:
  - 1. Scheduled date for the first submittal.
  - 2. Related Section number.
  - 3. Submittal category.
  - 4. Name of subcontractor.
  - 5. Description of the part of the Work covered.
  - 6. Scheduled date for resubmittal.
  - 7. Scheduled date ENGINEER's final release or approval.
- D. Following response to initial submittal, print and distribute copies to ENGINEER, OWNER, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project meeting room and field office.
- E. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.
- F. Schedule Updating: Revise Schedule after each meeting or activity where revisions have been recognized or made within 2 weeks following the meeting or activity.

## 1.06 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings. Include the following information:
  - 1. Dimensions.
  - 2. Identification of products and materials included.
  - 3. Compliance with specified standards.
  - 4. Notation of coordination requirements.
  - 5. Notation of dimensions established by field measurement.
- C. Nameplate data for equipment including electric motors shall be included on Shop Drawings. Electric motor data shall state the manufacturer, horsepower, service factor, voltage, enclosure type, oversize wiring box, etc.
- D. Shop Drawings shall indicate shop painting requirements to include type of paint and manufacturer.
- E. Standard manufactured items in the form of catalog work sheets showing illustrated cuts of the items to be furnished, scale details, sizes, dimensions, quantity, and all other pertinent information should be submitted and approved in a similar manner.
- F. Measurements given on Shop Drawings or standard catalog sheets, as established from Contract Drawings and as approved by ENGINEER, shall be followed. When it is necessary to verify field measurements, they shall be checked and established by CONTRACTOR. The field measurements so established shall be followed by CONTRACTOR and by all affected trades.
- G. Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 inches by 11 inches but no larger than 36 inches by 48 inches.
- H. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

## 1.07 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as Shop Drawings.
- B. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:
  - 1. Manufacturer's printed recommendations.
  - 2. Compliance with recognized trade association standards.
  - 3. Compliance with recognized testing agency standards.
  - 4. Application of testing agency labels and seals.

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- 5. Notation of dimensions verified by field measurement.
- 6. Notation of coordination requirements.
- C. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

## 1.08 SAMPLES

- A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
- B. Mount, display, or package Samples in the manner specified to facilitate review of qualities indicated. Prepare Samples to match ENGINEER's Sample. Include the following:
  - 1. Generic description of the Sample.
  - 2. Sample source.
  - 3. Product name or name of manufacturer.
  - 4. Compliance with recognized standards.
  - 5. Availability and delivery time.
- C. Submit Samples for review of kind, color, pattern, and texture, for a final check of these characteristics with other elements, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
- D. Where variation in color, pattern, texture, or other characteristics are inherent in the material or product represented, submit multiple units (not less than 3) that show approximate limits of the variations.
- E. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
- F. Preliminary Submittals: Where Samples are for selection of color, pattern, texture, or similar characteristics from a range of standard choices, submit a full set of choices for the material or product.
  - 1. Preliminary submittals will be reviewed and returned with ENGINEER's mark indicating selection and other action.
- G. Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit 3 sets; 1 will be returned marked with the action taken.
- H. Maintain sets of Samples, as returned, at the Site, for quality comparisons throughout the course of construction.
- I. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
- J. Sample sets may be used to obtain final acceptance of the construction associated with each set.

#### 1.09 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, ENGINEER will review each submittal, mark to indicate action taken, and return promptly.
  - 1. Compliance with specified characteristics is CONTRACTOR's responsibility.
- B. Action Stamp: ENGINEER will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
  - 1. Final Unrestricted Release: Where submittals are marked "No Exceptions Taken," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
  - 2. Final-But-Restricted Release: When submittals are marked "Furnish as Corrected," that part of the Work covered by the submittal may proceed, provided it complies with notation or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
  - 3. Returned for Resubmittal: When submittal is marked "Rejected" or "Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
    - a. Do not permit submittals marked "Rejected" or "Revise and Resubmit" to be used at Site, or elsewhere Work is in progress.
  - 4. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Acknowledge Receipt."
  - 5. The approval of ENGINEER shall not relieve CONTRACTOR of responsibility for errors on Drawings or submittals as ENGINEER's checking is intended to cover compliance with Drawings and Specifications and not enter into every detail of the shop work.

PART 2 - PRODUCTS

## NOT USED

## PART 3 - EXECUTION

## NOT USED

## SECTION 014500 - QUALITY CONTROL SERVICES

## PART 1 - GENERAL

## 1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for quality control services.
- B. Quality control services include inspections and tests and related actions including reports, performed by independent agencies, governing authorities, and CONTRACTOR. They do not include Contract enforcement activities performed by ENGINEER.
- C. Inspection and testing services are required to verify compliance with requirements specified or indicated. These services do not relieve CONTRACTOR of responsibility for compliance with Contract Document requirements.
- D. Requirements of this Section relate to customized fabrication and installation procedures, not production of standard products.
- E. Specific quality control requirements for individual construction activities are specified in the Sections that specify those activities. Those requirements, including inspections and tests, cover production of standard products as well as customized fabrication and installation procedures.
- F. Inspections, tests, and related actions specified are not intended to limit CONTRACTOR's quality control procedures that facilitate compliance with Contract Document requirements.
- G. Requirements for CONTRACTOR to provide quality control services required by ENGINEER, OWNER, or authorities having jurisdiction are not limited by provisions of this Section.

## 1.02 CONTRACTOR RESPONSIBILITIES

- A. Provide inspections, tests, and similar quality control services, specified in individual Specification Sections and required by governing authorities, except where they are specifically indicated to be OWNER's responsibility, or are provided by another identified entity; these services include those specified to be performed by an independent agency and not by CONTRACTOR. Costs for these services shall be included in the Contract Price.
- B. Employ and pay an independent agency to perform specified quality control services.
- C. CONTRACTOR and each agency engaged to perform inspections, tests, and similar services shall coordinate the sequence of activities to accommodate required services with a minimum of delay. In addition, CONTRACTOR and each agency shall coordinate activities to avoid the necessity of removing and replacing construction to accommodate inspections and tests.
- D. Schedule times for inspections, tests, taking samples, and similar activities.
- E. Retesting: CONTRACTOR is responsible for retesting where results of required inspections, tests, or similar services prove unsatisfactory and do not indicate compliance with Contract Document requirements, regardless of whether the original test was CONTRACTOR's responsibility.

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- 1. Cost of retesting construction revised or replaced by CONTRACTOR is CONTRACTOR's responsibility, where required tests were performed on original construction.
- F. Associated Services: Cooperate with agencies performing required inspections, tests, and similar services and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assignment of personnel. Auxiliary services required include but are not limited to:
  - 1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests.
  - 2. Taking adequate quantities of representative samples of materials that require testing or assisting the agency in taking samples.
  - 3. Providing facilities for storage and curing of test samples, and delivery of samples to testing laboratories.
  - 4. Providing the agency with a preliminary design mix proposed for use for materials mixes that require control by the testing agency.
  - 5. Security and protection of samples and test equipment at the Project site.

## 1.03 OWNER RESPONSIBILITIES

- A. Provide inspections, tests, and similar quality control services specified to be performed by independent agencies and not by CONTRACTOR, except where they are specifically indicated as CONTRACTOR's responsibility or are provided by another identified entity. Costs for these services are not included in the Contract Price.
- B. Engage and pay for the services of an independent agency to perform inspections and tests specified as OWNER's responsibility.
- C. OWNER will employ and pay for the services of an independent agency, testing laboratory, or other qualified firm to perform services which are OWNER's responsibility.

## 1.04 TESTING AGENCY RESPONSIBILITIES

- A. Where OWNER has engaged a testing agency or other entity for testing and inspection of a part of the Work, and CONTRACTOR is also required to engage an entity for the same or related element, CONTRACTOR shall not employ the entity engaged by OWNER, unless otherwise agreed in writing with OWNER.
- B. The independent testing agency engaged to perform inspections, sampling, and testing of materials and construction specified in individual Specification Sections shall cooperate with ENGINEER and CONTRACTOR in performance of its duties, and shall provide qualified personnel to perform required inspections and tests.
- C. The agency shall notify ENGINEER and CONTRACTOR promptly of irregularities or deficiencies observed in the Work during performance of its services.
- D. The agency is not authorized to release, revoke, alter, or enlarge requirements of the Contract Documents, or approve or accept any portion of the Work.
- E. The agency shall not perform any duties of CONTRACTOR.

#### 1.05 SUBMITTALS

- A. The independent testing agency shall submit a certified written report of each inspection, test, or similar service to ENGINEER in triplicate, unless CONTRACTOR is responsible for the service. If CONTRACTOR is responsible for the service, submit a certified written report of each inspection, test, or similar service through CONTRACTOR in triplicate.
- B. Submit additional copies of each written report directly to the governing authority, when the authority so directs.
- C. Written reports of each inspection, test, or similar service shall include, but not be limited to:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address, and telephone number of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making the inspection or test.
  - 6. Designation of the Work and test method.
  - 7. Identification of product and Specification Section.
  - 8. Complete inspection or test data.
  - 9. Test results and an interpretation of test results.
  - 10. Ambient conditions at the time of sample taking and testing.
  - 11. Comments or professional opinion as to whether inspected or tested Work complies with Contract Document requirements.
  - 12. Name and signature of laboratory inspector.
  - 13. Recommendations on retesting.

## PART 2 - PRODUCTS

#### NOT USED

#### PART 3 - EXECUTION

#### 3.01 REPAIR AND PROTECTION

- A. Upon completion of inspection, testing, sample taking, and similar services, repair damaged construction and restore substrates and finishes to eliminate deficiencies, including deficiencies in visual qualities of exposed finishes.
- B. Protect construction exposed by or for quality control service activities and protect repaired construction.
- C. Repair and protection is the CONTRACTOR's responsibility regardless of the assignment of responsibility for inspection, testing, or similar services.

## SECTION 015000 - TEMPORARY FACILITIES

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes: This Section specifies procedural and administrative requirements for temporary services and facilities.
- B. Temporary Construction and Support Facilities include, but are not limited to:
  - 1. Sanitary facilities.
- C. Sedimentation Control Facilities required include, but are not limited to:
  - 1. Soil erosion and sedimentation control.
  - 2. Dewatering trenches and disposal of excess excavated material.

## 1.02 REFERENCES

- A. Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994.
- B. Guidebook of Best Management Practices for Michigan Watersheds.
- C. Local Soil Erosion Control Ordinance or requirements.
- D. Michigan Manual of Uniform Traffic Control Devices (MMUTCD).
- E. Codes and Standards:
  - 1. Comply with NFPA Code 241, "Building Construction and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library, "Temporary Electrical Facilities."
  - 2. Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services," prepared jointly by AGC and ASC, for industry recommendations.
  - 3. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).

## 1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to:
  - 1. Building Code requirements.
  - 2. Health and Safety regulations.
  - 3. Utility Company regulations.
  - 4. Police, Fire Department, and Rescue Squad rules.
  - 5. Environmental Protection regulations.
  - 6. State and Local Soil Erosion and Sedimentation Control regulations.

#### 1.04 PROJECT CONDITIONS

- A. Unless otherwise provided in these Specifications, CONTRACTOR shall make CONTRACTOR's own arrangements for electricity, gas, water, and sewer services for use during the construction of the Work and shall pay for all temporary facilities, connections, extensions, and services.
  - 1. Cost or use charges for temporary facilities are not chargeable to OWNER or ENGINEER, and will not be accepted as a basis of claims for a Change Order.
- B. Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do no overload facilities or permit them to interfere with progress. Do not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on Site.

## PART 2 - PRODUCTS

## 2.01 MATERIALS

- A. Water: Provide potable water approved by local health authorities.
- B. Seed: Consisting of, per acre, 10 pounds Kentucky 31 fescue, 3 pounds Birdsfoot Trefoil, and 3 pounds white clover.
- C. Fertilizers: Consisting of, at least, 200 pounds per acre 12:12:12, or equivalent.
- D. Mulches: Consisting of 2 tons per acre of straw or hay. Chemical mulch or other approved material may be used.

#### 2.02 EQUIPMENT

- A. Temporary Toilet Units: Provide self-contained single-occupant toilet units, properly vented and fully enclosed with a glass fiber-reinforced polyester shell or similar nonabsorbent material.
- B. First Aid Supplies: Comply with governing regulations.
- C. Fire Extinguishers: Provide hand-carried, portable, UL rated, Class "A" fire extinguishers for temporary offices and similar spaces.
  - 1. In other locations, provide hand-carried, portable, UL rated, Class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
  - 2. Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.

#### PART 3 - EXECUTION

#### 3.01 TEMPORARY CONSTRUCTION AND SUPPORT FACILITIES INSTALLATION

A. Sanitary Facilities: Sanitary facilities include temporary toilets, wash facilities, and drinking water fixtures. Comply with regulations and health Codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best service the Project's needs.

- 1. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material.
- 2. Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.
- 3. Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.
- 4. Provide safety showers, eyewash fountains and similar facilities where needed for safety and sanitation of personnel.

## 3.02 SEDIMENTATION CONTROL FACILITIES INSTALLATION

- A. Soil Erosion and Sedimentation Control: CONTRACTOR shall take all precautions necessary to prevent soil erosion of areas disturbed by the construction and shall ensure that all soil erosion be contained within the construction Site. CONTRACTOR shall provide temporary slope protection, temporary dikes, etc., as required to prevent eroded materials from entering any sewers or natural watercourses.
  - 1. CONTRACTOR shall comply with Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994, Part 91 of the Michigan Complied Laws and local city or county soil erosion control programs.
- B. Dewatering Trenches and Disposal of Excess Excavated Material:
  - 1. Pumping or draining from trench excavations shall be made on either side of the pipeline and not into the waters of the State. It shall be CONTRACTOR's responsibility to secure the necessary approval of private landowners before discharging water from the trench excavation onto private lands. Water shall be discharged in such a manner as to cause no pollution or erosion problems.
  - 2. CONTRACTOR shall dewater to existing storm sewer systems wherever possible; method of disposal shall be approved by OWNER. All discharge from dewatering wells discharged onto the ground ahead of being piped to a natural watercourse or lake via an existing storm sewer system or by a temporary piping system shall have built at the point of entry into such storm sewer a silt retention structure.
  - 3. The silt retention structure may consist of several straw bales adequately anchored and placed as directed by ENGINEER. Any eventual silt or solids retained in the area of these structures shall be removed prior to removal of the structure. At no time will silt or similar materials be permitted to filter into a lake or natural watercourse. There shall be no sidecasting of any excavated material into any waterway. Excess excavated material from stream crossings and excavation near streams shall be removed and disposed of elsewhere, and not within the floodplain.
- C. Final Topography Protection: When final topography has been established, all bared soil shall be seeded, fertilized, and mulched in an effort to restore to a protected condition, except in flat, active farm fields. Critical areas shall be sodded as specified under Section 02315.
  - 1. The permanent protection measures shall be in effect not more than 30 days after the earth change is completed, except at tie-in areas at both sides of the stream where temporary measures will be installed within 3 days following a pipeline crossing. Temporary measures may include a row of sandbags at the top of the bank, a row of pegged bales of straw, or an earth berm or diversion ditch. These temporary measures shall be maintained until permanent measures are installed.
  - 2. Where construction involves placing pipes in roadways or under other impervious materials, special care shall be provided by CONTRACTOR.

## City of Owosso

- 3. Provide control measures at all storm sewer catch basins by providing straw or other types of filters or construct sediment traps adjacent to inlets.
- 4. If a roadway has a grass ditch area, minimize disturbance and provide filter berms (straw or gravel) or sediment traps as appropriate.
- 5. Provide proper downdrain structures to control increased runoff to streams and drains.
- 6. Stabilize the roadway as soon as possible after placement of the utility. Temporary erosion control measures shall be instituted until final paving is complete. Such measures may include a subbase surfacing application or gravel surfacing. Compaction of soil may suffice if other control measures are effected.

## 3.03 FIELD QUALITY CONTROL

- A. Any unforeseen situations that may be encountered during the course of construction that may cause accelerated erosion and deposition of sediment into waterways and/or lakes shall be controlled by methods that may include sediment traps, sediment basins, or holding ponds. Any slope failures or development of gullies after construction has been completed shall be corrected immediately.
- B. Should the local Regulatory Agency determine at any time during construction that the construction operation is in violation of the Natural Resources and Environmental Protection Act, P.A. 451 (Act 451) of 1994 and cite OWNER, CONTRACTOR or Subcontractor shall take immediate action, as directed by OWNER, to ensure compliance with the Act.

## 3.04 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.
- B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.
  - 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour-day basis where required to achieve indicated results and to avoid possibility of damage.

#### SECTION 016000 - GENERAL EQUIPMENT STIPULATIONS

## PART 1 - GENERAL

#### 1.01 SUMMARY

A. These General Equipment Stipulations apply, in general, to all equipment provided under other Specification Sections. They shall supplement the detailed equipment specifications, but in cases of conflict the equipment specifications shall govern.

#### 1.02 OPERATION AND MAINTENANCE

- A. All equipment suppliers shall submit to ENGINEER, through CONTRACTOR, 4 bound copies and 1 electronic/digital format copy of a manual containing specifications, Drawings, and descriptions of equipment; installation instructions; operation, maintenance, and lubrication manuals; parts lists; emergency instructions; and where applicable, test data with curves, wiring diagrams, PLC programs on CD and schematics. This information shall be submitted for each item of equipment furnished under this Contract and shall be specific to the exact equipment models complete with all appurtenances provided. It shall also include detailed, comprehensive directions for all required maintenance activities and for the repair or replacement of all wearing parts. Special attention shall be paid to necessary safety precautions that OWNER's staff should take when operating, maintaining, or repairing the equipment.
  - 1. Bound copies of O&M Manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after ENGINEER has given final approval of Shop Drawings. All manuals shall be submitted to ENGINEER following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Organize operation and maintenance manuals into suitable sets of manageable size, organized by section or process, as directed by ENGINEER. Bind properly indexed data in heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Appropriate identification shall be noted on the front and spine of each binder.
  - 2. Electronic Copy of O&M Manuals: Each equipment O&M manual shall be provided with an electronic disk, matching the content of the final approved printed O&M Manual. The information shall be saved in a single ".pdf" file, with bookmarks for each chapter, section, appendices, etc., as well as each piece of equipment. Where numerous pieces of equipment may be addressed within a section, a second tier of bookmarks shall be provided to allow quick access to each piece of equipment or key piece of information.
  - 3. "Sample" Table of Contents:

## <u>Bookmarks</u>

Table of Co	ontents
Section 1 -	Approved Shop Drawings
	Submersible Pumps
Section 2 -	Installation Instructions and Parts Identification
	Submersible Pumps
Section 3 -	Operations and Maintenance Information
Section 4 -	Troubleshooting (If not included in Section 3.)
Section 5 -	Parts List (If not included in Section 3.)
Section 6 -	Lubrication Instructions (If not included in Section 3.)

4. These manuals shall be in addition to any instructions shipped with the equipment and shall be submitted only after ENGINEER has given final approval of Shop Drawings. All manuals shall be submitted to ENGINEER following final Shop Drawing approval and prior to the date of shipment of the equipment to the Site. Each manual shall be bound in a heavy fiberboard or hardback cover having indicated thereon the type of equipment, manufacturer's name, and year of purchase. An index to the information contained therein shall be bound inside the front cover of each manual.

## 1.03 QUALITY ASSURANCE

- A. Compliance with OSHA: All equipment provided under this Contract shall meet all the requirements of the Federal and/or State Occupational Safety and Health Acts. Each equipment supplier shall submit to ENGINEER certification that the equipment furnished is in compliance with OSHA.
- B. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by CONTRACTOR.

## 1.04 SHIPPING AND HANDLING EQUIPMENT

A. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment and handling.

## PART 2 - PRODUCTS

## NOT USED

## PART 3 - EXECUTION

## 3.01 EQUIPMENT BASES

A. The baseplate shall be installed on a concrete base. Baseplates shall be anchored to the concrete base with suitable anchor bolts and grouted in place.

## 3.02 EQUIPMENT INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment shall visit Site of Work a minimum of 2 times, once prior to installation to review installation procedures with CONTRACTOR and once after installation to inspect, check, adjust if necessary, and approve the equipment's installation. The equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to ENGINEER.
- B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.

- C. Each equipment supplier's representative shall furnish to OWNER, through ENGINEER, a written report certifying that the equipment:
  - 1. Has been properly installed and lubricated;
  - 2. Is in accurate alignment;
  - 3. Is free from any undue stress imposed by connecting piping or anchor bolts;
  - 4. Has been operated under full load condition and that it operated satisfactorily to ENGINEER;
  - 5. That OWNER's Representative has been instructed in the proper maintenance and operation of the equipment; and
  - 6. Furnish OWNER a copy of all test data recorded during the installation check including noise level and vibration readings.

## 3.03 OPERATION AND MAINTENANCE TRAINING

- A. Provide services of manufacturer's service representative to instruct OWNER's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.
  - 1. Manufacturer's representative shall provide 1 day, 8 hours, on-Site training.
  - 2. Review operating and maintenance data contained in the operating and maintenance manuals.
  - 3. Schedule training with OWNER, provide at least 7-day prior written notice to ENGINEER.

## SECTION 017700 - CONTRACT CLOSEOUT

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for Contract closeout including, but not limited to:
  - 1. Warranties and Bonds.
  - 2. Requirements for Substantial Completion.
  - 3. Project record document submittal.
  - 4. Equipment acceptance.
  - 5. Operating and maintenance manual submittal.
  - 6. Final cleaning.
- B. Refer to the General Conditions for terms of CONTRACTOR's special warranty of workmanship and materials.
- C. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions 2 through 16.
- D. Certifications and other commitments and agreements for continuing services to OWNER are specified elsewhere in the Contract Documents.

#### 1.02 WARRANTY REQUIREMENTS

- A. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve CONTRACTOR of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with CONTRACTOR.
- B. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- C. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- D. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. CONTRACTOR is responsible for the cost of replacing or rebuilding defective Work regardless of whether OWNER has benefited from use of the Work through a portion of its anticipated useful service life.
- E. OWNER's Recourse: Written warranties made to OWNER are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which OWNER can enforce such other duties, obligations, rights, or remedies.

- F. Rejection of Warranties: OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- G. OWNER reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

## 1.03 SUBSTANTIAL COMPLETION

- A. Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
  - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete. Include supporting documents for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price.
  - 2. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.
  - 3. Advise OWNER of pending insurance changeover requirements.
  - 4. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
  - 5. Obtain and submit releases enabling OWNER unrestricted use of the Work and access to services and utilities; include occupancy permits, operating certificates, and similar releases.
  - 6. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- B. Inspection Procedures: On receipt of a request for inspection, ENGINEER will either proceed with inspection or advise CONTRACTOR of unfilled requirements.
  - 1. ENGINEER will prepare the Certificate of Substantial Completion following inspection, or advise CONTRACTOR of construction that must be completed or corrected before the certificate will be issued.
  - 2. ENGINEER will repeat inspection when requested and assured that the Work has been substantially completed.
  - 3. Results of the completed inspection will form the basis of requirements for final acceptance.
- C. The warranty period for specific portions of the Work will begin on the date established on Component Acceptance Form or at such other date as agreed by OWNER, ENGINEER, and CONTRACTOR.

## 1.04 FINAL ACCEPTANCE

- A. Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
  - 1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
  - 2. Submit an updated final statement, accounting for final additional changes to the Contract Price.
  - 3. Submit a copy of ENGINEER's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by ENGINEER.

- 4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of Substantial Completion, or when OWNER took possession of and responsibility for corresponding elements of the Work.
- 5. Submit consent of surety to final payment.
- 6. Submit a final liquidated damages settlement statement.
- 7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- 8. Submit record drawings, maintenance manuals, final Project photographs, damage or settlement survey, property survey, and similar final record information.
- 9. Deliver tools, spare parts, extra stock, and similar items.
- 10. Make final changeover of permanent locks and transmit keys to OWNER. Advise OWNER's personnel of changeover in security provisions.
- 11. Complete start-up testing of systems, and instruction of OWNER's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- B. Reinspection Procedure: ENGINEER will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to ENGINEER.
  - 1. Upon completion of reinspection, ENGINEER will prepare a certificate of final acceptance, or advise CONTRACTOR of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
  - 2. If necessary, reinspection will be repeated.

## 1.05 SUBMITTALS

- A. Submit written warranties to ENGINEER prior to the date certified for Substantial Completion. If ENGINEER's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of ENGINEER.
- B. When a designated portion of the Work is completed and occupied or used by OWNER, by separate agreement with CONTRACTOR during the construction period, submit properly executed warranties to ENGINEER within 15 days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by CONTRACTOR, or CONTRACTOR and a subcontractor, supplier, or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to OWNER through ENGINEER for approval prior to final execution.
- D. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.

## 1.06 RECORD DOCUMENT SUBMITTALS

- A. Record Drawings:
  - 1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown.
  - 2. Mark whichever Drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on Contract

Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

- 3. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
- 4. Mark new information that is important to OWNER, but was not shown on Contract Drawings or Shop Drawings.
- 5. Note related Change Order numbers where applicable.
- 6. Organize Record Drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates, and other identification on the cover of each set.
- B. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and submittals in connection with actual performance of the Work.
  - 1. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to ENGINEER for OWNER's records.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 016000, operation and maintenance manuals for items included under this Section.

## PART 2 - PRODUCTS

## NOT USED

## PART 3 - EXECUTION

## 3.01 FINAL CLEANING

- A. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
  - 1. Clean Site, including landscape development areas, of rubbish, litter, and foreign substances. Sweep paved areas broom clean; remove stains, spills, and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth even-textured surface.
- B. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.
- C. Comply with regulations of authorities having jurisdiction and safety standards for cleaning.
  - 1. Do not burn waste materials. Do not bury debris or excess materials on OWNER's property.
  - 2. Do not discharge volatile, harmful, or dangerous materials into drainage systems.
  - 3. Remove waste materials from Site and dispose of in a lawful manner.
- D. Where extra materials of value remaining after completion of associated Work have become OWNER's property, arrange for disposition of these materials as directed.

#### SECTION 028050 - RESTORATION WORK

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Work including the replacement of all permanent type roadway bases and surfaces, concrete sidewalks, curbs and gutters, trees, lawns, and driveways damaged or removed due to the construction of the pipe and appurtenant structures. All such Work shall be in accordance with the Best Modern Practice, OWNER's standards, and/or as specified herein.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

#### 1.02 REFERENCES

- A. MDOT Standard Specifications for Construction, 2020 Edition:
  - 1. 302 Aggregate Base Course.
  - 2. 306 Aggregate Surface Course.
  - 3. 501 Plant Mixed Hot Mix Asphalt.
  - 4. 502 Hot Mix Asphalt Construction Practices
  - 5. 816 Turf Establishment
  - 6. 902 Aggregates

#### 1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013300, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
  - 1. Material Certificates: Provide copies of materials certificates signed by materials producer and CONTRACTOR, certifying that each materials item complies with or exceeds specified requirements.
- B. Warranty: Submit in accordance with requirements of Section 017700, warranties covering the items included under this Section.

#### 1.04 QUALITY ASSURANCE

A. Certification: CONTRACTOR shall submit certificates of compliance with applicable MDOT Standard Specifications.

#### 1.05 SITE CONDITIONS

A. Weather Conditions: Construct asphalt concrete surface course when atmospheric temperature is above 40 degrees F (4 degrees C), and when base is dry. Bituminous base course over 2 inches thick may be placed when air temperature is above 35 degrees F (-1 degree C) and rising. Asphalt may not be placed between November 15 and May 5.

## 1.06 WARRANTY

- A. Special Warranty: Provide, in accordance with Section 017700, warranties covering the items included under this Section.
  - 1. Warranty Period: 1 year from the time of planting.
  - 2. This warranty includes furnishing new plants as well as labor and materials for installation of replacements. Replacement plantings shall meet or exceed all requirements for original plant materials as specified herein.
  - 3. CONTRACTOR shall not assume responsibility for damages or loss of plants or trees caused by fire, flood, lightning storms, freezing rains, winds over 60 miles per hour, or vandalism.

## PART 2 - PRODUCTS

## 2.01 AGGREGATE BASE

A. Aggregate base shall be constructed with not less than 12 inches of compacted aggregate placed in two 6-inch layers. Aggregate base shall meet requirements of MDOT Specification for 21A or 22A aggregate. Aggregate base shall extend beyond pavements to match existing aggregate or a minimum of 24 inches.

## 2.02 AGGREGATE SURFACE

A. Aggregate surface shall be constructed with not less than 12 inches of aggregate placed in two 6-inch layers. Aggregate surface shall meet MDOT Specification No. 22A.

## 2.03 CONCRETE ROADWAYS

- A. Concrete pavement surfaces shall be replaced with concrete where shown on Drawings. Thickness shall be equal to that removed, but in no cases less than 6 inches.
- B. Concrete for pavements and bases shall be Class P concrete.
- C. Replacement of reinforcing steel shall be similar to that in the existing pavement and shall provide the same cross-sectional area of reinforcement per foot as the existing pavement.

#### 2.04 GRAVEL DRIVEWAYS

A. Gravel or dirt driveways removed shall be replaced with gravel, and shall be constructed to match existing thickness but with not less than 6 inches of gravel, compacted to 95 percent compaction. Gravel shall meet MDOT Specification No. 22A.

#### 2.05 STONE DRIVEWAYS

A. Existing stone drive surfaces removed during construction shall be replaced with washed stone, peastone, or limestone, of type and thickness that matches the existing surface. Road gravel (22A) shall not be used to replace stone drives unless authorized by OWNER and ENGINEER.

#### 2.06 CONCRETE DRIVEWAYS

A. All concrete driveways removed shall be replaced with Class P concrete, 6 inches thick. All driveways replaced shall have welded wire fabric, 6-inch by 6-inch, W1.4 by W1.4, for the full extent of new concrete paving. Joints shall be as specified in concrete work and/or concrete pavements.

#### 2.07 CONCRETE CURB AND GUTTER

A. Concrete curb and gutter to be replaced shall have the same cross-section as that removed, or as shown on Drawings, using Class P concrete and in accordance with OWNER's standards.

#### 2.08 CONCRETE SIDEWALKS

A. Concrete sidewalks shall be replaced with walks 4 inches thick (6 inches thick at driveway crossings) and to the same width as the existing walks. Concrete shall be Class B.

## 2.09 CONCRETE RAMPS

A. Ramps shall be constructed 6 inches thick and to the width and slope shown on Drawings using Class B concrete. Type of ramp shall be as noted on Drawings for different intersection conditions.

#### 2.10 SEEDING

- A. Seeding shall be one of the following types:
  - 1. Sodded Shoulders, Slope Area, or Flat Field: 4 inches of topsoil, 20 pounds of 10-6-4 commercial fertilizer per 1,000 square feet of area, and 5 pounds of MDOT mixture roadside per 1,000 square feet of area.
  - 2. Flat Lawn Area: 4 inches of topsoil, fertilizer as specified above and 3 pounds of MDOT mixture Class A per 1,000 square feet of area.
- B. Sod: Provide strongly rooted sod, not less than 2 years old, free of weeds and undesirable native grasses, and machine cut to pad thickness of 3/4 inch (plus or minus 1/4-inch), excluding top growth and thatch. Provide only sod capable of vigorous growth and development when planted (viable, not dormant). Peat sod will not be acceptable.
  - 1. Provide sod of uniform pad sizes with maximum 5 percent deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically with a firm grasp on upper 10 percent of pad will be rejected.
  - 2. Provide sod composed principally of following:
    - a. Mixed Kentucky Bluegrass (Poa pratensis).

## 2.11 TREE/SHRUB REPLACEMENT

- A. Stakes and Wrap: Trees shall be staked and wrapped. Stakes for guying shall be wood, 2-inch by 2-inch by 30 inches long, minimum size.
- B. Stakes for staking shall be sound, 4-inch-diameter, 9-foot-long cedar posts with bark skinned off for shade trees; 2-inch by 2-inch by 8 feet long for conifers under 5 feet in height.

C. Staking wire shall be No. 12-gauge galvanized steel. City of Owosso Washington Park Smart Homes Utility Extension Project Part Two – Washington Park Lift Station

- D. Hose for covering wire shall be new or used, black or red, 2-ply, fiber-reinforced garden hose, not less than 1/2-inch inside diameter. Seconds rejected by factory are acceptable.
- E. Tree wrap shall be treated wrapping Kraft wrap or approved equal.
- F. Plant Materials:
  - 1. Quality and Size: Plant materials shall be sound, healthy, vigorous, and free from plant diseases and insect pests or their eggs and shall have normal, healthy root systems. All measurements such as spread, ball size, number of canes, quality designation, etc., shall be in accordance with the latest edition of AAN USA Standard for nursery stock. Trees shall be calipered 6 inches above the ground.
  - 2. Sources: Must be located in the same or higher hardiness zone as determined by the latest edition of the "Plant Hardiness Zone Map," Agricultural Research Service, U.S. Department of Agriculture.
  - 3. Plant Material Quality Assurance, Plant Material Selection and Approval Operations: All trees required by this Contract shall be tagged by CONTRACTOR at the source for inspection and approval by ENGINEER in writing at least 2 weeks prior to each desired inspection date. Photographs of materials may be required for preliminary inspection of materials from remote sources.
  - 4. Root Protection: Trees and shrubs shall be balled and burlapped. They shall be dug with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root systems necessary for full recovery of the plant. Balls shall be securely wrapped with burlap and bound with cord. No balled and burlapped plant shall be planted if the ball is cracked or broken.
  - 5. Protection During and After Delivery: All plant material is to be delivered to Site in closed vehicles or in open vehicles with the entire load properly covered in transit for protection from drying winds. They shall be planted immediately upon delivery. No plant shall be bound with rope or wire in a manner that would damage the bark or break the branches.

## PART 3 - EXECUTION

- 3.01 COORDINATION OF WORK
  - A. Type of restoration shall be as noted on Drawings regardless of existing surface.
  - B. The placing of base and surface courses shall follow immediately after backfilling the trench so that not more than 600 feet of length of trench shall be incomplete at one time. If areas of trench in excess of 600 feet are left incomplete, CONTRACTOR shall provide such necessary temporary roadway surface as directed by ENGINEER. Any material placed in the trench other than that specified shall be considered as a temporary surface and shall be removed. No payment will be allowed for temporary roadway construction.
  - C. All utilities, such as catch basins, manhole castings, water valve boxes, etc., shall be adjusted prior to installation of new pavement so that the finished surface will meet such utilities smoothly when surfacing is completed.

## 3.02 SAW CUT JOINTS

A. Damaged areas shall be removed by sawing a straight-cut parallel with longitudinal and transverse construction or contraction joints. No saw cuts shall be nearer than 5 feet to a longitudinal or

transverse joint or to the edge of the pavement. If the damaged area is less than 5 feet from an existing joint, the existing surface shall be saw-cut 5 feet from the damaged area, removed, and replaced. If the damaged area is less than 5 feet from the edge of the pavement, the removal and replacement shall be extended to said edge of pavement.

- B. Saw cutting of concrete shall be done with a carborundum saw to a minimum depth of half the slab thickness or that depth required to cut reinforcing steel. Bituminous surfaces shall be cut full depth.
- C. After the trench is backfilled and before the pavement over the trench is replaced, all angular and ragged irregularities on the edges of the cut pavement shall be removed giving a smooth and regular edge of pavement. Payment for cut joints required shall be included under the unit price of pavement restoration.

## 3.03 EXCAVATION

A. Before repaying is started, all trenches and area around structures shall be excavated or backfilled to the level of the subgrade as required by the type of pavement replacement and cross-section specified. All existing pavement that has been undercut by the excavation for the pipe or structures shall be removed. The finished subgrade shall be smoothed, trimmed, and compacted to the required grade and cross-section. Compaction of the finish subgrade shall be obtained by suitable means approved by ENGINEER.

#### 3.04 AGGREGATE BASE

A. Place aggregate base on a prepared subbase or subgrade in accordance with construction methods described in the MDOT Specifications.

## 3.05 AGGREGATE PAVEMENTS

A. Aggregate surfaces shall be replaced with aggregate. After placing aggregate, this surface shall immediately be opened to traffic and as holes and ruts appear, they shall be filled with aggregate and the surface shall be maintained as a smooth, dust-free street surface until Work is accepted by ENGINEER and OWNER.

#### 3.06 BITUMINOUS BASE

A. Place bituminous base on a prepared subbase or subgrade in accordance with construction methods described in the MDOT Specifications.

#### 3.07 BITUMINOUS PAVEMENTS

- A. Pavement surfaces shall be replaced with bituminous concrete of the type and in locations shown on Drawings. Work shall consist of saw cutting existing surfaces as herein specified under Saw Cut Joints, conditioning and treating the base course with prime or bond material and constructing thereon a bituminous concrete surface consisting of mineral aggregate, mineral filler, and bituminous material combined by a plant hot mix method per MDOT Specification. Construction methods and equipment for placing bituminous materials shall be as specified in MDOT Standard Specifications.
- B. Pavement surfaces shall be replaced to match existing widths but new pavements shall not be less than 22 feet wide.

- C. Conditioning of Base: Bituminous base shall be treated with a bond coat applied at the rate of 0 0.10 gallon per square yard. Bond coat shall be SS-1h or MS-2a.
- D. Leveling Course: Bituminous leveling course mixture shall be placed in one or more layers to the cross-section shown on Drawings. When the total application rate exceeds 220 pounds per square yard, the leveling course shall be applied in 2 courses. A bond coat shall be applied at the rate of 0 0.10 gallon per square yard between courses.
- E. Wearing Course: Following completion of the leveling course or courses, the surface shall be treated with a bond coat of 0 0.10 gallon per square yard. The wearing course mixture shall be placed according to the cross-section shown on Drawings in one or more courses as required.
- F. All joints in the bituminous pavements shall be vertical joints. Where the joints are allowed to set before the adjoining pavement is placed, such joints shall be treated with bond coat material.
- G. Feathering to connect new pavement to an existing pavement will not be allowed.

## 3.08 CONCRETE CONSTRUCTION

- A. Pavement: The surface of concrete pavements shall be properly consolidated and struck off to such elevations so as to match adjacent pavement and made uniform by transverse floating. As soon as all excess moisture has disappeared, the pavement shall be given a final light brooming finish by dragging a seamless strip of damp burlap or cotton fabric. Edges of all joints shall be tooled.
  - 1. As soon as concrete surfaces have hardened sufficiently to prevent marring, they shall be covered by an approved curing compound, or they shall be thoroughly wetted and cured by an approved method for a period of 6 days unless otherwise directed by ENGINEER.

## 3.09 SEEDING

- A. Wherever the pipe trench passes through an area to be seeded, the backfilling shall be carried up to the surface except the top 4 inches, which shall be selected topsoil preserved or secured elsewhere for this purpose. This topsoil shall be rich, black surface earth, free from sod, weed stalks, or debris. The trench surface shall be carefully raked to an even surface, and all stones, sticks and other debris removed therefrom.
- B. Seeded areas shall receive a proper mulch of chopped straw, jute matting, or woven Kraft paper yarn. Seed shall not be sown between June 15 and August 15, or between October 15 and April 15, or at any time when the soil has insufficient moisture to ensure proper germination, or CONTRACTOR shall provide sufficient application of water by sprinkling until a growing catch of grass is established.

## 3.10 SODDING

- A. Lay sod within 24 hours from time of stripping. Do not plant dormant sod or if ground is frozen.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.

C. Water sod thoroughly with a fine spray immediately after planting. City of Owosso Washington Park Smart Homes Utility Extension Project Part Two – Washington Park Lift Station D. Sodded areas shall be kept moist for the maintenance period. After the sod is installed, all areas greater than 1 foot which fail to show a uniform stand of grass, shall be resodded.

## 3.11 RECONDITIONING EXISTING LAWNS

- A. Recondition existing lawn areas damaged by CONTRACTOR's operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas where minor regrading is required.
- B. Provide fertilizer, seed or sod, and soil amendments as specified for new lawns, and as required, to provide a satisfactorily reconditioned lawn.
- C. Provide new topsoil, as required, to fill low spots and meet new finish grades.
- D. Cultivate bare and compacted areas thoroughly to provide a satisfactory planting bed.
- E. Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from CONTRACTOR's operations, including oil drippings, stone, gravel, and other loose building materials.
- F. Where substantial lawn remains but is thin, mow, rake, aerate if compacted, fill low spots, remove humps, and cultivate soil, fertilize, and seed. Remove weeds before seeding, or if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.
- G. Water newly planted lawn areas and keep moist until new grass is established.

## 3.12 PROTECTION

- A. Protection and Maintenance: CONTRACTOR shall assume responsibility for maintaining CONTRACTOR's Work to the end of the guarantee period. During this period, CONTRACTOR shall make a minimum of 1 maintenance trip every 4 weeks during the growing season, and as many more as necessary to keep the plantings in a thriving condition.
  - 1. Maintenance of plants shall consist of pruning, cultivating, weeding, watering, keeping guying taut and trees erect, raising tree balls which settle below grade, and providing such sprays as are necessary to keep the planting free of insects and diseases.
- B. Acceptance: At the end of the warranty period, final acceptance will be made by ENGINEER and OWNER, provided all requirements of the Specifications have been fulfilled.
  - 1. Inspection of the plantings will be made jointly by CONTRACTOR and ENGINEER at completion of planting. All plants not in a healthy growing condition shall be removed and replaced with plants of like kind, size, and quality as originally specified before close of next planting season.

#### SECTION 033150 - CONCRETE WORK

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Extent of concrete work as shown on Drawings and specified in this Section.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

#### 1.02 REFERENCES

#### A. ASTM:

- 1. A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- 2. C 150 Portland Cement.
- 3. C 260 Air-Entraining Admixtures for Concrete.
- 4. C 309 Liquid Membrane-Forming Compounds for Curing Concrete.
- 5. C 494 Chemical Admixtures for Concrete.
- 6. C 595 Blended Hydraulic Cements.
- 7. C 618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

## B. MDOT:

- 1. 8.02.03 Coarse Aggregates for Portland Cement Concrete.
- 2. 8.02.07 Fine Aggregates for Portland Cement Concrete and Mortar 2NS.

#### 1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013300, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
  - 1. Mix Design: Submit concrete mix design as early as possible, but no later than 4 weeks before scheduled pouring. Submittal shall also include a sieve analysis of the coarse aggregates, including the quantity of deleterious materials present, and certificates for all materials indicating compliance with standards listed in spec.
  - 2. Product Data: Submit data for proprietary materials and items, including reinforcement, admixtures, patching compounds, waterstops, joint systems, curing compounds, and others used under this Section.
  - 3. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.
- B. Test and Inspection Report: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 016000.

## 1.04 QUALITY ASSURANCE

- A. Testing: During the progress of construction and at direction of ENGINEER, perform tests to determine that the concrete complies with the compressive strength and consistency requirements.
  - 1. Independent testing laboratory will witness the preparation of test cylinders.
  - 2. Provide concrete for test cylinders. Make, handle, and store test specimens. Pack and ship specimens in substantial packages to prevent damage during transit.

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3. CONTRACTOR shall bear expenses of shipment and testing specimens by an approved, independent testing laboratory.

#### PART 2 - PRODUCTS

#### 2.01 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Use plywood, metal, metal-framed plywood faced, or other acceptable panel materials, to provide continuous, straight, smooth, exposed surfaces. Provide largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.
- B. Form for Unexposed Finished Concrete: Use plywood, lumber, metal, or other acceptable material. Use lumber dressed on at least two edges and one side for tight fit.

#### 2.02 REINFORCING MATERIALS

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

## 2.03 CONCRETE MATERIALS

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301
  - 2. ACI 117
- B. Portland Cement: ASTM C 150, Type I or Type III. Use Type III where high-early-strength is required.
- C. Blended Hydraulic Cement: Conforming to ASTM C 595, Type IP (Portland Pozzolan cement), with Pozzolan content not to exceed 20 percent by weight.
- D. Fly Ash: ASTM C 618, Type C or Type F, with loss on ignition not more than 6 percent.
- E. Aggregates: Fine aggregate MDOT (Michigan Department of Transportation) 2NS. Coarse aggregate MDOT 6AA.
- F. Water: Potable.
- G. Air-Entraining Admixture: ASTM C 260.
- H. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.1 percent chloride ions.
- I. Curing Compound: ASTM C 309, Type 1 or Type 2, Class B. Limit moisture loss to 0.040 gm per square centimeter when applied at 200 square feet per gallon coverage.

## 2.04 CONCRETE MIX DESIGN

- A. Classes:
  - 1. Class A: Pre-engineered building slab foundation, and all concrete not otherwise indicated.
  - 2. Class P: Exterior pavements on compacted base materials.
  - 3. Class B: Sidewalks and manhole bases (unless otherwise indicated on Drawings).
  - 4. Class C: Fill within manholes, mud mats, fill under structures, encasement for piping below or adjacent to structures and encasement for floor drains, sewer inlets and similar items.
  - 5. Class F: Flowable fill for filling spaces as permitted and directed by ENGINEER
- B. Proportions: Proportion concrete by volume in agreement with the following table:

Concrete Class	Α	Р	В	С	F
28-day Compressive strength, psi *	4,000	3,500	3,000	2,000	50-100
Laboratory Trial Batch for Selecting					
Concrete Proportions, average 28-day					
Compressive Strength, psi, design mix	4,700	4,100	3,600	2,600	N/A
Cement Content per cubic yard of concrete, sacks minimum **	6	5.5	5	4	0.4-3.0 12-16.0**
Water/Cement Ratio by weight, maximum	0.44	0.44	0.58	0.75	0.40-0.75
Air Content, percent by volume	5+1	6.5+1.5	6.5+1.5	NA	NA
Slump at point of placement, inches ***	2-4	2-4	3-5	3-6	NA

\* 7-day compressive strength for high-early-strength concrete.

\*\* For concrete with fly ash, values are total of cement plus fly ash (Except Class F).

\*\*\* For concrete containing HRWR admixture (superplasticizer), slump shall not exceed 8 inches after addition of HRWR to verified 2-4 inches slump concrete.

## PART 3 - EXECUTION

## 3.01 FORMS

- A. Install forms to conform to the shape, lines, and dimensions of the structures as called for on Drawings. Forms shall be substantial and sufficiently tight to prevent leakage of mortar, and shall be properly braced or tied together to maintain position and shape. Forms shall be clean inside before concrete is poured.
- B. Reinforcement: Place bars in the exact position shown on Drawings. Fasten bars to prevent displacement while depositing concrete.
  - 1. Space bars with a clear distance of not less than the diameter of the bar, or 1-inch. Place bars so that the distance from the surface of the concrete to the nearest surface of the nearest bars is 2 inches in slabs, walls, and 3 inches in the bottom of footings (where no mud mat is used).
- C. Splicing of Reinforcement: At splices, lap bars a distance of not less than the following to ensure full bond development of each bar:

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Bar Size	Lap Length	Bar Size	Lap Length
No. 3	16 inches	No. 8	38 inches
No. 4	20 inches	No. 9	42 inches
No. 5	24 inches	No. 10	50 inches
No. 6	28 inches	No. 11	62 inches
No. 7	34 inches		

## 3.02 PLACING CONCRETE

- A. Forms shall be moist when concrete is placed. Concrete shall be handled to maintain its consistency and not to permit the ingredients to separate. Place concrete in layers not over 18 inches deep. Vibrate, rod, tamp, or work into places after each layer so that no voids or segregation of the aggregate show when the forms are removed.
- B. Discharge concrete at Work within 1-1/2 hours after the cement has been added to the water or the aggregates. When the air temperature exceeds 85 degrees F, reduce the maximum permitted mixing time to 45 minutes.
- C. When depositing concrete against the ground for slabs and footings, place the concrete on undisturbed or compacted granular base moistened but free from standing water, mud, frost, and ice.

## 3.03 REMOVAL OF FORMS

- A. The removal of forms shall be made without damage to the concrete and in a manner to ensure complete safety to the structures. Do not remove shoring until the member has acquired sufficient strength to support safely its weight and loads placed thereon.
- B. After form removal, exposed vertical surfaces shall have burrs and fins removed, and holes filled with nonshrink nonmetallic grout. The surfaces shall be true to line, with full corners and shall be reasonably smooth.

## 3.04 CURING

- A. Maintain concrete in a moist condition for at least the first 7 days after placing for normal concrete, and 3 days after placing for high-early-strength concrete. This shall be done by keeping the surface continuously wet, covering it with a plastic membrane, or by the application of a curing compound approved by ENGINEER.
- B. The surfaces of concrete from which forms are removed before 7 days after placing shall be similarly protected until the concrete has been in place for 7 days.

## 3.05 CONCRETE WORK IN COLD WEATHER

A. Concrete, when deposited, shall have a temperature of not less than 50 degrees F or more than 85 degrees F. During cold weather, which shall be taken to mean weather in which the temperature of the air falls as low as 40 degrees F during any part of the 24 hours which follows, the ingredients of the concrete, including the water, shall be heated immediately before being mixed.

- 1. Do not use antifreeze additives except as allowed by ENGINEER.
- 2. During cold weather, concrete work shall be housed, or covered with canvas or other suitable material, and shall be kept warm by salamanders or by other means which shall ensure protection from freezing during the setting period.

# 3.06 CONCRETE WORK IN HOT WEATHER

- A. During hot weather, concrete temperature shall be closely monitored and kept below 85 degrees F with the use of cold water or ice for mixing water.
  - 1. The total water in the concrete mix shall not exceed the quantity approved in the concrete mix design.

## 3.07 FIELD QUALITY CONTROL

- A. Inspections:
  - 1. Steel reinforcement placement.
  - 2. Steel reinforcement welding.
  - 3. Verification of use of required design mixture.
  - 4. Concrete placement, including conveying and depositing.
  - 5. Curing procedures and maintenance of curing temperature.
  - 6. Verification of concrete strength before removal of shores and forms from slabs.
- B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd., or fraction thereof.
  - 2. Testing Frequency: Obtain at least one composite sample for each 20 cu. yd. or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  - 3. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  - 4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
  - 6. Compression Test Specimens: ASTM C 31.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
  - 7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  - 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

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- 9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- 10. Test results shall be reported in writing to ENGINEER, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- 11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by ENGINEER but will not be used as sole basis for approval or rejection of concrete.
- 12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by ENGINEER. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by ENGINEER.
- 13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

# SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

# 1.01 RELATED DOCUMENTS

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

## 1.02 SUMMARY

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Pipe stands.

## 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Pipe stands.
  - 2. Equipment supports.

## 1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

## 1.05 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

## PART 2 - PRODUCTS

## 2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

## 2.02 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

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- 2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
- 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

# 2.03 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.
- B. Slab-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary slab.

## 2.04 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

## 3.01 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

## 3.02 HANGER AND SUPPORT INSTALLATION

- A. Install supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- B. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- C. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

# 3.03 METAL FABRICATIONS

- A. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- B. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

# 3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

# 3.05 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

# END OF SECTION

## SECTION 231123 - FACILITY NATURAL-GAS PIPING

# PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
  - 1. Pipes, tubes, and fittings.
  - 2. Piping specialties.
  - 3. Piping and tubing joining materials.
  - 4. Manual gas shutoff valves.
  - 5. Pressure regulators.
  - 6. Dielectric fittings.

## 1.03 DEFINITIONS

- A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

#### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Piping specialties.
  - 2. Corrugated, stainless-steel tubing with associated components.
  - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 4. Pressure regulators. Indicate pressure ratings and capacities.
  - 5. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
  - 1. Shop Drawing Scale: 1/4 inch per foot.
  - 2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.
- F. CLOSEOUT SUBMITTALS
- G. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

## 1.06 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. 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.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- C. Protect stored PE pipes and valves from direct sunlight.

# 1.08 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.

# 1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

# PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
  - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
  - 3. Minimum Operating Pressure of Service Meter: 10 psig.
    - a. For reference only, Service regulator is provided by utility

## 2.02 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - a. Material Group: 1.1.
    - b. End Connections: Threaded or butt welding to match pipe.
    - c. Lapped Face: Not permitted underground.
    - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
  - 5. Mechanical Couplings:
    - a. Steel flanges and tube with epoxy finish.
    - b. Buna-nitrile seals.
    - c. Stainless-steel bolts, washers, and nuts.
    - d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    - e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Annealed-Temper Copper Tube: Comply with ASTM B88, Type K.
  - 1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
  - 2. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.
- C. PE Pipe: ASTM D2513, SDR 11.
  - 1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
  - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
  - 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
    - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
    - b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
    - c. Aboveground Portion: PE transition fitting.

#### City of Owosso

- d. Outlet shall be threaded or flanged or suitable for welded connection.
- e. Tracer wire connection.
- f. Ultraviolet shield.
- g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 4. Transition Service-Line Risers: Factory fabricated and leak tested.
  - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
  - b. Outlet shall be threaded or flanged or suitable for welded connection.
  - c. Bridging sleeve over mechanical coupling.
  - d. Factory-connected anode.
  - e. Tracer wire connection.
  - f. Ultraviolet shield.
  - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
  - a. PE body with molded-in, stainless-steel support ring.
  - b. Buna-nitrile seals.
  - c. Acetal collets.
  - d. Electro-zinc-plated steel stiffener.
- 6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe.
  - a. Fiber-reinforced plastic body.
  - b. PE body tube.
  - c. Buna-nitrile seals.
  - d. Acetal collets.
  - e. Stainless-steel bolts, nuts, and washers.

## 2.03 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
  - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
  - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
  - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
  - 4. Corrugated stainless-steel tubing with polymer coating.
  - 5. Operating-Pressure Rating: 0.5 psig.
  - 6. End Fittings: Zinc-coated steel.
  - 7. Threaded Ends: Comply with ASME B1.20.1.
  - 8. Maximum Length: 72 inches
- B. Y-Pattern Strainers:
  - 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

# 2.04 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

#### 2.05 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig.
  - 2. Threaded Ends: Comply with ASME B1.20.1.
  - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
  - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
  - 1. Body: Bronze, complying with ASTM B584.
  - 2. Ball: Chrome-plated brass.
  - 3. Stem: Bronze; blowout proof.
  - 4. Seats: Reinforced TFE; blowout proof.
  - 5. Packing: Separate packnut with adjustable-stem packing threaded ends.
  - 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  - 7. CWP Rating: 600 psig.
  - 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  - 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. PE Ball Valves: Comply with ASME B16.40.
  - 1. Body: PE.
  - 2. Ball: PE.
  - 3. Stem: Acetal.
  - 4. Seats and Seals: Nitrile.
  - 5. Ends: Plain or fusible to match piping.
  - 6. CWP Rating: 80 psig.
  - 7. Operating Temperature: Minus 20 to plus 140 deg F.
  - 8. Operator: Nut or flat head for key operation.
  - 9. Include plastic valve extension.
  - 10. Include tamperproof locking feature for valves where indicated on Drawings.

# 2.06 PRESSURE REGULATORS

- A. General Requirements:
  - 1. Single stage and suitable for natural gas.
  - 2. Steel jacket and corrosion-resistant components.
  - 3. Elevation compensator.
  - 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Service Pressure Regulators: Comply with ANSI Z21.80.
  - 1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
  - 2. Springs: Zinc-plated steel; interchangeable.
  - 3. Diaphragm Plate: Zinc-plated steel.
  - 4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
  - 5. Orifice: Aluminum; interchangeable.
  - 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  - 7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
  - 8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
  - 9. Overpressure Protection Device: Factory mounted on pressure regulator.
  - 10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
  - 11. Maximum Inlet Pressure: 100 psig (690 kPa).

# 2.07 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Description:
    - a. Standard: ASSE 1079.
    - b. Pressure Rating: 125 psig minimum at 180 deg F
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.

## 2.08 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

## PART 3 - EXECUTION

#### 3.01 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.02 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

# 3.03 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earthwork" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D2774.
- D. Install fittings for changes in direction and branch connections.

# 3.04 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Locate valves for easy access.
- E. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Verify final equipment locations for roughing-in.
- I. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

- J. Drips and Sediment Traps: Install drips at points where condensate may collect, including servicemeter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- K. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- M. Connect branch piping from top or side of horizontal piping.
- N. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- O. Do not use natural-gas piping as grounding electrode.
- P. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

## 3.05 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install anode for metallic valves in underground PE piping.

# 3.06 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  - 2. Cut threads full and clean using sharp dies.
  - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
  - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
  - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

- 2. Bevel plain ends of steel pipe.
- 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
  - 1. Plain-End Pipe and Fittings: Use butt fusion.
  - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

## 3.07 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for steel piping and copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of steel piping and copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

## 3.08 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

## 3.09 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

# 3.10 PAINTING

- A. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 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.
    - d. Color: .Safety Yellow
- B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

## 3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## 3.12 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
  - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground natural-gas piping shall be the following:1. Steel pipe with malleable-iron fittings and threaded joints.

# 3.13 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:

1. PE valves.

## 3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:1. One-piece, bronze ball valve with bronze trim.
- B. Valves in branch piping for single appliance shall be the following:
  - 1. One-piece, bronze ball valve with bronze trim.

# END OF SECTION

## SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

# PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 26.
- B. The Drawings are schematic and are not intended to show every detail of construction.
  - 1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
  - 2. CONTRACTOR shall fully coordinate electrical Work with other trades to avoid interferences.
  - 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

## 1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 013300, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:

   Submit product data covering the items included under this Section of Work.
  - 1. Submit product data covering the items included under this Section of Work.
- B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to ENGINEER in electronic format (PDF), one full size print, and one 11x17 print.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 016000, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing instructions and lubrication charts and schedules.

#### 1.03 RECORD DOCUMENTS

A. Prepare Record Documents in accordance with requirements in Section 017700. In addition, CONTRACTOR shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.

B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor, motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

## 1.04 QUALITY ASSURANCE

- A. National Electrical Code: Comply with NFPA 70, National Electrical Code.
- B. UL Compliance and Labeling: Use products and components labeled by UL.
- 1.05 PERMITS, INSPECTIONS, AND LICENSES
  - A. CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
    - 1. Upon completion of Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS

# NOT USED

# PART 3 - EXECUTION

## 3.01 GENERAL ELECTRICAL INSTALLATION

- A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
  - 1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).
- B. Provide nonmetallic electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; City of Owosso

explosion-proof NEC Class I, Division 1, Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.

- C. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- D. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.
- F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- G. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.
- I. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

## 3.02 RACEWAY INSTALLATION

- A. Outdoors, use the following materials:
  - 1. Exposed Conduit: PVC externally coated rigid metal conduit and fittings.
  - 2. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.
- B. Indoors, use the following wiring materials:
  - 1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
    - a. Exception: NEMA 7 or 9 areas require explosion-proof flexible conduit.
  - 2. Exposed Conduit: Rigid metal conduit or intermediate metal conduit.
    - a. Exceptions:
      - 1) Areas indicated as NEMA 4X, use rigid Schedule 40 PVC conduit.
      - 2) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid steel conduit.
- C. Minimum size conduit shall be 3/4 inch unless shown otherwise.

- D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit. Conduit shall be RMC or PVC-coated RMC.
- E. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.
- F. Install expansion fittings in all exposed rigid nonmetallic conduit runs of 20 feet or more.
- G. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.
- H. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.
- I. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. 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.
- J. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.
- K. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.
- L. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.
- M. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway

system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.

- O. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- P. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
  - 1. Where conduits enter or leave hazardous locations.
  - 2. Where conduits enter or leave NEMA 4X areas.
  - 3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
  - 4. Where required by the NEC.
- Q. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- R. Install device boxes at the height above the floor as follows for:
  - 1. Light switches, 4 feet.
  - 2. Receptacles and telephone jacks, 18 inches except in NEMA 4 and 4X areas, 4 feet.
  - 3. Thermostats, 4'-0".
  - 4. Clock receptacles, 7'-0".
- S. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.
- T. Position recessed outlet boxes accurately to allow for surface finish thickness.
- U. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.
- V. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.
- W. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
- X. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.
- Y. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection

shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.

- Z. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- AA. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

## 3.03 WIRE AND CABLE INSTALLATION

- A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.
- B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.
- C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.
- D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.
- E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.
  - 1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.
- F. Seal wire and cable ends until ready to splice or terminate.

## 3.04 CUTTING AND PATCHING

- A. Perform cutting and patching in accordance with the following requirements.
  - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover Work to provide for installation of ill-timed Work, remove and replace Work that is either defective or does not conform to requirements of Drawings.
  - 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by new Work. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.

3. Patch existing finished surfaces and building components using new materials matching existing materials.

# 3.05 EQUIPMENT CHECKOUT AND TESTING

- A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.
- B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:

 $R_{min.} = 4 (KV + 1)$  at 25 degrees C winding temp.  $R_{min.} = IV + 1$  at 40 degrees C winding temp.

- 1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.
- 2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.
- C. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
  - 1. Vacuum interior of cubicles and remove foreign material.
  - 2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
  - 3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or ENGINEER.
  - 4. Fill motor bearings requiring oil.
  - 5. Check and change, as required, thermal overload heater elements to correspond with motor fullload current and service factors of installed motor.
  - 6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
  - 7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
  - 8. Check exposed bolted power connections for tightness.
  - 9. Check operation of breakers, contactors, etc., and control and safety interlocks.
  - 10. Check tightness of bolted structural connections.
  - 11. Check leveling and alignment of enclosures.
  - 12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
  - 13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
  - 14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

# END OF SECTION

# SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

# PART 1 - GENERAL

# 1.01 RELATED DOCUMENTS

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

## 1.02 SUMMARY

- A. Section Includes:
  - 1. Copper building wire.

# 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

## PART 2 - PRODUCTS

#### 2.01 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cerro Wire LLC.
  - 2. General Cable; Prysmian Group North America.
  - 3. Okonite Company (The).
  - 4. Service Wire Co.
  - 5. Southwire Company, LLC.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. RoHS compliant.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:
  - 1. Type THHN and Type THWN-2: Comply with UL 83.

- F. Shield:
  - 1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

# PART 3 - EXECUTION

## 3.01 CONDUCTOR MATERIAL APPLICATIONS

#### A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

- B. Branch Circuits:
  - 1. Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

# 3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

#### 3.03 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. 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.
- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

# 3.04 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.

# 3.05 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.

#### END OF SECTION

# SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

## PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
  - 1. Low-voltage control cabling.
  - 2. Identification products.

#### 1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

#### 1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

#### 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise onsite testing.

#### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

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

#### 2.02 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
  - 1. Multi-pair, twisted, No. 14 AWG, stranded tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1685.

#### 2.03 CONTROL-CIRCUIT CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Encore Wire Corporation.
  - 2. General Cable; Prysmian Group North America.
  - 3. Service Wire Co.
- B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

#### 2.04 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Cable will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

#### PART 3 - EXECUTION

## 3.01 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

- 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
- 2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by 1-1/2 inches (38 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
- 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.

# 3.02 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C Series of standards.
  - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
  - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
  - 5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
  - 6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
  - 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
  - 9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
  - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
  - 11. Support: Do not allow cables to lie on removable ceiling tiles.
  - 12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
  - 13. Provide strain relief.
  - 14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
  - 15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
- C. Installation of Control-Circuit Conductors:
  - 1. Install wiring in raceways.
  - 2. Use insulated spade lugs for wire and cable connection to screw terminals.

3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

# 3.03 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
  - 1. Class 1 remote-control and signal circuits; [No 14] <Insert wire size> AWG.
  - 2. Class 2 low-energy, remote-control, and signal circuits; [No. 16] <Insert wire size> AWG.
  - 3. Class 3 low-energy, remote-control, alarm, and signal circuits; [No 12] <Insert wire size> AWG.

## 3.04 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

#### 3.05 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

## 3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
  - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement

Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- E. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- F. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

# END OF SECTION

## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section includes grounding and bonding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.

#### 1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
  - 1. Test wells.
  - 2. Ground rods.
  - 3. Ground rings.
  - 4. Grounding arrangements and connections for separately derived systems.

#### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
  - 1. Include the following items:
    - a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:
      - 1) Test wells.
      - 2) Ground rods.
      - 3) Ground rings.
      - 4) Grounding arrangements and connections for separately derived systems.
    - b. Instructions for periodic testing and inspection of grounding features at test wells NFPA 70B.
      - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      - 2) Include recommended testing intervals.

## 1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

#### PART 2 - PRODUCTS

#### 2.01 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 UL 467 for grounding and bonding materials and equipment.

#### 2.02 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B3.
  - 2. Stranded Conductors: ASTM B8.
  - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
  - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

#### 2.03 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tinplated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.

- I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with socket set screw.
- J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- N. Straps: Solid copper, copper lugs. Rated for 600 A.
- O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.
- P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

# 2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m).
- B. Ground Plates: 1/4 inch (6 mm) thick, hot-dip galvanized.

# PART 3 - EXECUTION

## 3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
  1. Bury at least 24 inches below grade.
- C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- D. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

# 3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

# 3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

# 3.04 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

## 3.05 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
  - 7. Armored and metal-clad cable runs.
  - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  - 9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
## 3.06 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. Use exothermic welds for all below-grade connections.
  - 3. For grounding electrode system, install at least three spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.
  - 1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of area or item indicated.bh
  - 1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
  - 2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.
- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 .
  - 1. If concrete foundation is less than 20 feet (6 m) > long, coil excess conductor within base of foundation.
  - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- L. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

# 3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

- 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells Make tests at ground rods before any conductors are connected.
  - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  - b. Perform tests by fall-of-potential method according to IEEE 81.
- 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- F. Grounding system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Report measured ground resistances that exceed the following values:
  - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  - 2. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
  - 3. Substations and Pad-Mounted Equipment: 5 ohms.
  - 4. Manhole Grounds: 10 ohms.
- I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

## END OF SECTION

## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

## 1.02 SUMMARY

- A. Section Includes:
  - 1. Conduit and cable support devices.
  - 2. Support for conductors in vertical conduit.
  - 3. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
  - 4. Fabricated metal equipment support assemblies.

## 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Slotted support systems, hardware, and accessories.
    - b. Clamps.
    - c. Hangers.
    - d. Sockets.
    - e. Eye nuts.
    - f. Fasteners.
    - g. Anchors.
    - h. Saddles.
    - i. Brackets.
  - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
  - 1. Hangers. Include product data for components.
  - 2. Slotted support systems.
  - 3. Equipment supports.
  - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

## PART 2 - PRODUCTS

## 2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014500 "Quality Control Services," to design hanger and support system.

# 2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABB, Electrification Business.
    - b. Allied Tube & Conduit; Atkore International.
    - c. Cooper B-line; brand of Eaton, Electrical Sector.
    - d. Metal Ties Innovation.
    - e. Unistrut; Atkore International.
  - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  - 3. Material for Channel, Fittings, and Accessories: Stainless steel, Type 316.
  - 4. Channel Width: 1-5/8 inches (41.25 mm).
  - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      - 2) MKT Fastening, LLC.
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1) Cooper B-line; brand of Eaton, Electrical Sector.
  - 2) Empire Industries, Inc.
  - 3) Hilti, Inc.
  - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
- 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
- 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325 (Grade A325M).
- 6. Toggle Bolts: Stainless-steel springhead type.
- 7. Hanger Rods: Threaded steel.

## PART 3 - EXECUTION

## 3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  - 1. NECA 1.
  - 2. NECA 101
  - 3. NECA 102.
  - 4. NECA 105.
  - 5. NECA 111.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

## 3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.

- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

## 3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033150 "Concrete Work."
- C. Anchor equipment to concrete base as follows:
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

# 3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

# END OF SECTION

## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

## 1.02 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings.
  - 2. Boxes, enclosures, and cabinets.
  - 3. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
  - 1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

#### 1.03 DEFINITIONS

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

#### 1.04 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.

## 1.05 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

## 2.01 METAL CONDUITS AND FITTINGS

- Metal Conduit: A.
  - Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, 1. and marked for intended location and application.
  - GRC: Comply with ANSI C80.1 and UL 6. 2.
  - 3. ARC: Comply with ANSI C80.5 and UL 6A.
  - IMC: Comply with ANSI C80.6 and UL 1242. 4.
  - 5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit. a.
    - Comply with NEMA RN 1.
    - Coating Thickness: 0.040 inch (1 mm), minimum. b.
  - EMT: Comply with ANSI C80.3 and UL 797. 6.
  - FMC: Comply with UL 1; zinc-coated steel. 7.
  - LFMC: Flexible steel conduit with PVC jacket and complying with UL 360. 8.
- Β. Metal Fittings:
  - Comply with NEMA FB 1 and UL 514B. 1.
  - Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, 2. and marked for intended location and application.
  - Fittings, General: Listed and labeled for type of conduit, location, and use. 3.
  - 4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
  - Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for 5. environmental conditions were installed, and including flexible external bonding jumper.
  - Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with 6. overlapping sleeves protecting threaded joints.
- Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having С. jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.02 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- D. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4 with continuous-hinge E. cover with flush latch unless otherwise indicated.
  - Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel. 1.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

- F. Cabinets:
  - 1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
  - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.03 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. Standard: Comply with SCTE 77.
  - 2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
  - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "ELECTRIC."
  - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
  - 7. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.04 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

## 3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC
  - 2. Concealed Conduit, Aboveground: GRC
  - 3. Underground Conduit: PVC, direct buried

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- 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- C. 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. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C)

## 3.02 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. 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.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. 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 (300 mm) of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
  - 5. Change from ENT to GRC before rising above floor.
- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- P. 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 (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. 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.
- S. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- U. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- V. 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.
- W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Conduit extending from interior to exterior of building.
  - 4. Conduit extending into pressurized duct and equipment.
  - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Y. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches (915 mm) of flexible conduit for 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.
- AA. 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 bottom of box unless otherwise indicated.

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- BB. 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.
- CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- DD. Locate boxes so that cover or plate will not span different building finishes.
- EE. 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.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Set metal floor boxes level and flush with finished floor surface.
- HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.03 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 "Earthwork" for pipe less than 6 inches (150 mm) in nominal diameter.
  - 2. Install backfill as specified in Section 312000 "Earthwork."
  - 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 (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earthwork."
  - 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 (75 mm) of concrete for a minimum of 12 inches (300 mm) 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 (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
  - 6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
  - 7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

## 3.04 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 1/2inch (12.5-mm) sieve to No. 4 (4.75-mm) 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 (25 mm) above finished grade.
- D. Install handholes with bottom below frost line.
- E. 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.
- F. 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.

## 3.05 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

## SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

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

## 1.02 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
  - 2. Utility structure accessories.

## 1.03 DEFINITIONS

- A. GRC: Galvanized rigid (steel) conduit.
- B. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

## 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 2. Include accessories for utility structures.
  - 3. Include underground-line warning tape.
  - 4. Include warning planks.

## 1.05 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

## 1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

## 1.07 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

## PART 2 - PRODUCTS

## 2.01 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Coated Steel Conduit: PVC-coated GRC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

## 2.02 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Campbell Foundry Company.
  - 2. Elmhurst-Chicago Stone Co.
  - 3. McKinley Iron Works, Inc.
  - 4. Osburn Associates, Inc.
  - 5. Underground Devices, Inc.
  - 6. Utility Concrete Products, LLC.
- C. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches (660 mm).
  - 1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    - a. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
  - 2. Cover Legend: Cast in. Selected to suit system.
    - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
- D. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (31 mm) minimum at base.
  - 1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
- E. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
- F. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
  - 1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches (38 mm) in width by nominal 24 inches (600 mm) long; punched with 14 hook holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
  - 2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (450 mm) with 250-lb (114-kg) minimum capacity. Arms shall

have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

## 2.03 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

## PART 3 - EXECUTION

## 3.01 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

# 3.02 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

## 3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of utility structures.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

# END OF SECTION

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
  - 1. Labels.
  - 2. Bands and tubes.
  - 3. Tapes and stencils.
  - 4. Tags.
  - 5. Signs.
  - 6. Cable ties.
  - 7. Miscellaneous identification products.

## 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

## PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E requirements for arc-flash warning labels.

- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.02 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage.
- B. Color-Coding for Phase- Identification, 600 V or Less: Use colors listed below for ungrounded service conductors.
  - 1. Color shall be factory applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 240-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
  - 4. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 5. Color for Neutral: White.
  - 6. Color for Equipment Grounds: Bare copper.
  - 7. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
  - 1. Black letters on an orange field.
  - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER ELECTRICAL SHOCK HAZARD EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
- F. Equipment Identification Labels:
  - 1. Black letters on a white field.

## 2.03 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemicalresistant coating and matching wraparound clear adhesive tape for securing label ends.

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- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Brady Corporation.
  - b. Champion America.
  - c. Grafoplast Wire Markers.
  - d. HellermannTyton.
  - e. LEM Products Inc.
- B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, polyester flexible label with acrylic pressure-sensitive adhesive.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Brady Corporation.
    - b. Brother International Corporation.
    - c. Ideal Industries, Inc.
    - d. Marking Services Inc.
  - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  - 3. Marker for Labels:
    - a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
    - b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- C. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Brady Corporation.
    - b. Brother International Corporation.
    - c. Grafoplast Wire Markers.
    - d. Marking Services Inc.
  - 2. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
    - b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
    - c. As required by authorities having jurisdiction.

## 2.04 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. Champion America.
    - d. HellermannTyton.
    - e. Ideal Industries, Inc.
    - f. Marking Services Inc.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Brady Corporation.
  - b. Carlton Industries, LP.
  - c. emedco.
- C. Underground-Line Warning Tape:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Brady Corporation.
    - b. Ideal Industries, Inc.
    - c. Marking Services Inc.
  - 2. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  - 3. Color and Printing:
    - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" .
    - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE". Insert drawing designation in four "Tape" subparagraphs below. Use these designations on Drawings to identify each product.

## 2.05 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. Marking Services Inc.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch (0.38 mm) thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Brady Corporation.
    - b. Carlton Industries, LP.
    - c. LEM Products Inc.
    - d. Marking Services Inc.

## 2.06 SIGNS

- A. Baked-Enamel Signs:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Carlton Industries, LP.
    - b. Champion America.
  - 2. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 3. 1/4-inch (6.4-mm) grommets in corners for mounting.
  - 4. Nominal Size: 7 by 10 inches (180 by 250 mm).

## 2.07 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. HellermannTyton.
  - 2. Ideal Industries, Inc.
  - 3. Marking Services Inc.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch (5 mm).
  - 2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D638: 12,000 psi (82.7 MPa).
  - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - 4. Color: Black, except where used for color-coding.

## 2.08 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

## 3.01 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

## 3.02 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- M. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Labels:
  - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

- P. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- Q. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
  - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- R. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- S. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- T. Underground Line Warning Tape:
  - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall.
  - 2. Limit use of underground-line warning tape to direct-buried cables.
  - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- U. Metal Tags:
  - 1. Place in a location with high visibility and accessibility.
  - 2. Secure using general-purpose cable ties.
- V. Nonmetallic Preprinted Tags:
  - 1. Place in a location with high visibility and accessibility.
  - 2. Secure using general-purpose cable ties.
- W. Baked-Enamel Signs:
  - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on minimum 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use signs minimum 2 inches (50 mm) high.
- X. Cable Ties: General purpose, for attaching tags, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.
  - 2. In Spaces Handling Environmental Air: Plenum rated.

## 3.03 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- (75-mm-) high, black letters on 20-inch (500-mm) centers.

- 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot (10-m) maximum intervals.
- D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels.
   1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- H. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- I. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- J. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - a. Power-transfer switches.
    - b. Controls with external control power connections.
- L. Arc Flash Warning Labeling: Self-adhesive labels.
- M. Operating Instruction Signs: Self-adhesive labels.

- N. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- O. Equipment Identification Labels:
  - 1. Indoor Equipment: Baked-enamel signs
  - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
  - 3. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Switchgear.
    - e. Switchboards.
    - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    - g. Substations.
    - h. Emergency system boxes and enclosures.
    - i. Motor-control centers.
    - j. Enclosed switches.
    - k. Enclosed circuit breakers.
    - 1. Enclosed controllers.
    - m. Variable-speed controllers.
    - n. Push-button stations.
    - o. Power-transfer equipment.
    - p. Contactors.
    - q. Remote-controlled switches, dimmer modules, and control devices.
    - r. Battery-inverter units.
    - s. Battery racks.
    - t. Power-generating units.
    - u. Monitoring and control equipment.
    - v. UPS equipment.

## END OF SECTION

## SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

### 1.02 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

## 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
  - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  - 3. Include diagrams for power, signal, and control wiring.

#### 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Source quality-control reports.
- C. Field quality-control reports.

## 1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

## 1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer. City of Owosso

- 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

## PART 2 - PRODUCTS

## 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Eaton.
  - 2. Siemens Industry, Inc., Energy Management Division.
  - 3. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

## 2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified.

## 2.03 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
  - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
  - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
  - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

## 2.04 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
  - 1. One leg per phase.
  - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
  - 3. Grounded to enclosure.
- C. Coils: Continuous windings except for taps.
  - 1. Coil Material: Copper.
  - 2. Internal Coil Connections: Brazed or pressure type.
  - 3. Terminal Connections: Bolted.
- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
  - 1. NEMA 250, Type 4X, Stainless Steel: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
  - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
  - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- I. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
  - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
  - 2. Indicate value of K-factor on transformer nameplate.
  - 3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
- J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  - 2. Include special terminal for grounding the shield.
- K. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

- L. Wall Brackets: Manufacturer's standard brackets.
- M. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
  1. 9.01 to 30.00 kVA: 45 dBA.

#### 2.05 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

#### 2.06 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
  - 1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
  - 2. Ratio tests at rated voltage connections and at all tap connections.
  - 3. Phase relation and polarity tests at rated voltage connections.
  - 4. No load losses, and excitation current and rated voltage at rated voltage connections.
  - 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
  - 6. Applied and induced tensile tests.
  - 7. Regulation and efficiency at rated load and voltage.
  - 8. Insulation-Resistance Tests:
    - a. High-voltage to ground.
    - b. Low-voltage to ground.
    - c. High-voltage to low-voltage.
  - 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

## PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 033150 "Concrete Work" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
  - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchorbolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

## 3.03 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

# 3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

- 1. Visual and Mechanical Inspection.
  - a. Inspect physical and mechanical condition.
  - b. Inspect anchorage, alignment, and grounding.
  - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
  - d. Verify the unit is clean.
  - e. Perform specific inspections and mechanical tests recommended by manufacturer.
  - f. Verify that as-left tap connections are as specified.
  - g. Verify the presence of surge arresters and that their ratings are as specified.
- 2. Electrical Tests:
  - a. Measure resistance at each winding, tap, and bolted connection.
  - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
  - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
  - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- F. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, and grounding.
    - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    - d. Verify the unit is clean.
    - e. Perform specific inspections and mechanical tests recommended by manufacturer.
    - f. Verify that as-left tap connections are as specified.
    - g. Verify the presence of surge arresters and that their ratings are as specified.
  - 2. Electrical Tests:
    - a. Measure resistance at each winding, tap, and bolted connection.
    - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    - c. Perform power-factor or dissipation-factor tests on all windings.
    - d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    - e. Perform an excitation-current test on each phase.
    - f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
    - g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- G. Remove and replace units that do not pass tests or inspections and retest as specified above.
- H. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

- 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
- 2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
- 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- I. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

# 3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

# 3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

# END OF SECTION

## SECTION 262416 - PANELBOARDS

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

### 1.02 SUMMARY

A. Section Includes:1. Distribution panelboards.

## 1.03 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

#### 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. 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.
  - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
  - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
  - 4. Detail bus configuration, current, and voltage ratings.
  - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 6. Include evidence of NRTL listing for series rating of installed devices.
  - 7. Include evidence of NRTL listing for SPD as installed in panelboard.
- 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 9. Include wiring diagrams for power, signal, and control wiring.
- 10. Key interlock scheme drawing and sequence of operations.
- 11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 1.07 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. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
  - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## 1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

## 1.09 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

#### 1.10 FIELD CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system

is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

- 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
  - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Owner's written permission.
  - 3. Comply with NFPA 70E.

#### 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
  - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
  - 1. SPD Warranty Period: Five years from date of Substantial Completion.

#### PART 2 - PRODUCTS

1.

#### 2.01 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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 PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets.
  - Rated for environmental conditions at installed location.
  - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  - b. Outdoor Locations: NEMA 250, Type 4X.
  - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

- d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
- 2. Height: 84 inches (2.13 m) maximum.
- 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
- 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
- 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- 6. Finishes:
  - a. Panels and Trim: galvanized 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.
  - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- F. Incoming Mains:
  - 1. Location: Bottom.
  - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
    - a. Plating shall run entire length of bus.
    - b. Bus shall be fully rated the entire length.
  - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
  - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  - 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
  - 6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
  - 7. Split Bus: Vertical buses divided into individual vertical sections.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
  - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  - 4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
  - 5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.

- 6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- 7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- 8. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
- 9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
  - 1. Percentage of Future Space Capacity: 20 percent.
- K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
  - 1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
  - 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## 2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

## 2.03 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. ABB, Electrification Business.
  - 2. Eaton.

- 3. Siemens Industry, Inc., Energy Management Division.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.
- F. Branch Overcurrent Protective Devices: Fused switches.
- G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
  - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
  - 2. External Control-Power Source: 120-V branch circuit.

# 2.04 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

# 2.05 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

#### 3.01 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
  - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount panelboard cabinet plumb and rigid without distortion of box.
- G. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- H. Install filler plates in unused spaces.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- J. Mount spare fuse cabinet in accessible location.

#### 3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

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- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

# 3.04 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

# END OF SECTION

## SECTION 263213.16 - GAS-ENGINE-DRIVEN GENERATOR SETS

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
  - 1. Engine.
  - 2. Gas fuel system.
  - 3. Control and monitoring.
  - 4. Generator overcurrent and fault protection.
  - 5. Generator, exciter, and voltage regulator.
  - 6. Load bank.
  - 7. Outdoor generator-set enclosure.
  - 8. Remote radiator motors.
  - 9. Vibration isolation devices.
- B. Related Requirements:
  - 1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

#### 1.03 DEFINITIONS

- A. EPS: Emergency power supply.
- B. EPSS: Emergency power supply system.
- C. LP: Liquefied petroleum.
- D. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

## 1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Include thermal damage curve for generator.
  - 3. Include time-current characteristic curves for generator protective device.
  - 4. Include fuel consumption in cubic feet per hour (cubic meters per hour) at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
  - 5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
  - 6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95 deg F (35 deg C), 80 deg F (27 deg C), 70 deg F (21 deg C), and 50

deg F (10 deg C). Provide drawings showing requirements and limitations for location of air intake and exhausts.

- 7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.
- B. Shop Drawings:
  - 1. Include plans and elevations for engine generator and other components specified.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Identify fluid drain ports and clearance requirements for proper fluid drain.
  - 4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
  - 6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

## 1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Data: Certificates, for engine generator, 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: With engine and generator mounted on rails, identify center of gravity and total weight, supplied enclosure, and each piece of equipment not integral to the engine generator, 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.
- C. Source Quality-Control Reports: Including, but not limited to, the following:
  - 1. Certified summary of prototype-unit test report.
  - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
  - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
  - 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
  - 5. Report of sound generation.
  - 6. Report of exhaust emissions showing compliance with applicable regulations.
  - 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- D. Field quality-control reports.
- E. Warranty: For special warranty.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.
  - 1. Include the following:
    - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    - b. Operating instructions laminated and mounted adjacent to generator location.
    - c. Training plan.

## 1.07 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: One for every 10 of each type and rating, but no fewer than one of each.
  - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
  - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
  - 4. Tools: Each tool listed by part number in operations and maintenance manual.

## 1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.09 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: two years from date of Substantial Completion.

## PART 2 - PRODUCTS

## 2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Caterpillar, Inc.; Electric Power Division.
  - 2. Cummins Power Generation.
  - 3. GE Power; General Electric Company.
  - 4. Generac.
  - 5. Kohler Power Systems.
- B. Source Limitations: Obtain packaged engine generators and auxiliary components through one source from a single manufacturer.

#### 2.02 PERFORMANCE REQUIREMENTS

- A. B11 Compliance: Comply with B11.19.
- B. NFPA Compliance:
  - 1. Comply with NFPA 37.
  - 2. Comply with NFPA 70.
  - 3. Comply with NFPA 99.
  - 4. Comply with NFPA 110 requirements for Level 1 EPSS.
- C. UL Compliance: Comply with UL 2200.
- D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.
- E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - 1. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).
  - 2. Relative Humidity: Zero to 95 percent.
  - 3. Altitude: Sea level to 1000 feet (300 m).

## 2.03 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.
- C. Power Rating: Standby.
- D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.
- E. EPSS Class: Engine generator shall be classified as Class 2 according to NFPA 110.
- F. Service Load: 10 kW.
- G. Power Factor: 0.8, lagging.
- H. Frequency: 60 Hz.
- I. Voltage: 240/120VAC.
- J. Phase: Single-phase, three wire.
- K. Induction Method: Naturally aspirated.

- L. Governor: Adjustable isochronous, with speed sensing.
- M. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
  - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- N. Capacities and Characteristics:
  - 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
  - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- O. Engine Generator Performance:
  - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
  - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
  - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
  - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
  - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
  - 7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
  - 8. Start Time:
    - a. Comply with NFPA 110, Type 10 system requirements.
    - b. 10 seconds.

## 2.04 GAS ENGINE

- A. Fuel: Natural gas.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid-mounted.
  - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

- 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.
- E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
  - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- F. Muffler/Silencer:
  - 1. Commercial type sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
    - a. Minimum sound attenuation of 12 dB at 500 Hz.
    - b. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 90 dBA or less.
- G. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 12-V electric, with negative ground.
  - 1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
  - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
  - 4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least twice without recharging.
  - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.

- 7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
- 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
- 9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
  - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
  - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
  - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
  - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
  - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
  - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

# 2.05 GAS FUEL SYSTEM

- A. Gas Train: Comply with NFPA 37.
- B. Engine Fuel System:
- C. Natural Gas, Vapor-Withdrawal System:
  - 1. Carburetor.
  - 2. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
  - 3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
  - 4. Fuel Filters: One for each fuel type.
  - 5. Manual Fuel Shutoff Valves: One for each fuel type.
  - 6. Flexible Fuel Connectors: Minimum one for each fuel connection.
  - 7. LP gas flow adjusting valve.
  - 8. Fuel change gas pressure switch.

# D. CONTROL AND MONITORING

E. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

- F. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- G. Provide minimum run time control set for 30 > minutes with override only by operation of a remote emergency-stop switch.
- H. Comply with UL 508A.
- I. Configuration:
  - 1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine generator battery.
  - 2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
  - 3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:
    - a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.
- J. Control and Monitoring Panel:
  - 1. Digital controller with integrated LCD, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
  - 2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
  - 3. Instruments: Located on the control and monitoring panel and viewable during operation.
    - a. Engine lubricating-oil pressure gage.
    - b. Engine-coolant temperature gage.
    - c. DC voltmeter (alternator battery charging).
    - d. Running-time meter.
    - e. AC voltmeter, for each phase.
    - f. AC ammeter, for each phase.
    - g. AC frequency meter.
    - h. Generator-voltage adjusting rheostat.
  - 4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication, including the following:
    - a. Cranking control equipment.
    - b. Run-Off-Auto switch.
    - c. Control switch not in automatic position alarm.
    - d. Overcrank alarm.
    - e. Overcrank shutdown device.
    - f. Low water temperature alarm.
    - g. High engine temperature prealarm.
    - h. High engine temperature.
    - i. High engine temperature shutdown device.

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- j. Overspeed alarm.
- k. Overspeed shutdown device.
- 1. Low fuel main tank.
  - 1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.
- m. Coolant low-level alarm.
- n. Coolant low-level shutdown device.
- o. Coolant high-temperature prealarm.
- p. Coolant high-temperature alarm.
- q. Coolant low-temperature alarm.
- r. Coolant high-temperature shutdown device.
- s. EPS supplying load indicator.
- t. Battery high-voltage alarm.
- u. Low cranking voltage alarm.
- v. Battery-charger malfunction alarm.
- w. Battery low-voltage alarm.
- x. Lamp test.
- y. Contacts for local and remote common alarm.
- z. Low-starting air pressure alarm.
- aa. Low-starting hydraulic pressure alarm.
- bb. Remote manual stop shutdown device.
- cc. Air shutdown damper alarm when used.
- dd. Air shutdown damper shutdown device when used.
- ee. Hours of operation.
- ff. Engine generator metering, including voltage, current, Hz, kW, kVA, and power factor.
- gg. Generator overcurrent protective device not closed alarm.
- K. Connection to Datalink:
  - 1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
  - 2. Provide connections for datalink transmission of indications to remote data terminals via Ethernet.
- L. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.
- M. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
  - 1. Overcrank alarm.
  - 2. Coolant low-temperature alarm.
  - 3. High engine temperature prealarm.
  - 4. High engine temperature alarm.
  - 5. Low lube oil pressure alarm.
  - 6. Overspeed alarm.
  - 7. Low fuel main tank alarm.
  - 8. Low coolant level alarm.

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- 9. Low cranking voltage alarm.
- 10. Contacts for local and remote common alarm.
- 11. Audible-alarm silencing switch.
- 12. Air shutdown damper when used.
- 13. Run-Off-Auto switch.
- 14. Control switch not in automatic position alarm.
- 15. Fuel tank derangement alarm.
- 16. Fuel tank high-level shutdown of fuel supply alarm.
- 17. Lamp test.
- 18. Low cranking voltage alarm.
- 19. Generator overcurrent protective device not closed.
- N. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- O. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

#### 2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.
  - 1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
  - 2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Overcurrent Protective Device:
  - 1. Molded-case circuit breaker, thermal-magnetic type; 100 percent rated; complying with UL 489:
    - a. Tripping Characteristic: Designed specifically for generator protection.
    - b. Trip Rating: Matched to generator output rating.
    - c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
    - d. Mounting: Adjacent to or integrated with control and monitoring panel.
- C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:
  - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.
  - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated fullload current for up to 10 seconds.
  - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.

- 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
  - 1. Indicate ground fault with other engine generator alarm indications.
  - 2. Trip generator protective device on ground fault.

# 2.07 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six lead alternator.
- E. Range: Provide broad range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
  - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
  - 2. Maintain voltage within 20 percent on one step, full load.
  - 3. Provide anti-hunt provision to stabilize voltage.
  - 4. Maintain frequency within 10 percent and stabilize at rated frequency within 5 seconds.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

# 2.08 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description:
  - 1. Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
  - 2. Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure, erected on concrete foundation.

- B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).
- C. Hinged Doors: With padlocking provisions.
- D. Space Heater: Thermostatically controlled and sized to prevent condensation.
- E. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- F. Muffler Location: Within enclosure.
- G. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
  - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
  - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
  - 3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.
- H. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
  - 1. AC lighting system and connection point for operation when remote source is available.
  - 2. DC lighting system for operation when remote source and generator are both unavailable.
- I. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

## 2.09 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
  - 1. Material: Standard neoprene separated by steel shims.
  - 2. Shore "A" Scale Durometer Rating: 40.
  - 3. Number of Layers: Two.
  - 4. Minimum Deflection: 1 inch (25 mm).
- B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

- 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- 6. Minimum Deflection: 1 inch (25 mm).
- C. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

## 2.10 FINISHES

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

# 2.11 SOURCE QUALITY CONTROL

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

## PART 3 - EXECUTION

## 3.01 EXAMINATION

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

## 3.02 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

- 1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
- 2. Do not proceed with interruption of electrical service without Owner's written permission.

## 3.03 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:
  - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033150 "Concrete Work."
  - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
  - 3. Install packaged engine generator having a minimum deflection of 1 inch (25 mm) on 4-inch-(100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases.
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Exhaust System: Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
  - 1. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9-inch (225-mm) clearance from combustibles.
- F. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainlesssteel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.
- G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

## 3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Gaseous Fuel Connections:
  - 1. Connect fuel piping to engines with a gate valve and union and flexible connector.

- 2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
- 3. Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

# 3.05 IDENTIFICATION

- A. Identify system components according to Section 260553 "Identification for Electrical Systems."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

# 3.06 FIELD QUALITY CONTROL

- A. Testing Agency:
  - 1. Owner will engage a qualified testing agency to perform tests and inspections.
  - 2. Engage a qualified testing agency to perform tests and inspections.
  - 3. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
  - 4. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
  - 1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below as specified in the NETA ATS. Certify compliance with test parameters.
    - a. Visual and Mechanical Inspection:
      - 1) Compare equipment nameplate data with drawings and specifications.
      - 2) Inspect physical and mechanical condition.
      - 3) Inspect anchorage, alignment, and grounding.
      - 4) Verify the unit is clean.
    - b. Electrical and Mechanical Tests:
      - 1) Perform insulation-resistance tests in accordance with IEEE 43.
        - a) Machines larger than 200 hp (150 kW). Test duration shall be 10 minutes. Calculate polarization index.
        - b) Machines 200 hp (150 kW) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
      - 2) Test protective relay devices.
      - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      - 5) Perform vibration test for each main bearing cap.
      - 6) Verify correct functioning of the governor and regulator.

- 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
- 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
  - a. Measure charging voltage and voltages between available battery terminals for fullcharging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
  - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
  - c. Verify acceptance of charge for each element of the battery after discharge.
  - d. Verify that measurements are within manufacturer's specifications.
- 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
- 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
- 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
- 7. Exhaust Emissions Test: Comply with applicable government test criteria.
- 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.
- 9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
- 10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet (8 m) from edge of the generator enclosure, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
- D. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
  - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

# 3.07 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

#### 3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

# SECTION 263600 - TRANSFER SWITCHES

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

## 1.02 SUMMARY

- A. Section Includes:
  - 1. Contactor-type automatic transfer switches.
  - 2. Transfer switch accessories.

## 1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
  - 2. Include material lists for each switch specified.
  - 3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
  - 4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

## 1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer-authorized service representative.
- B. Seismic Qualification Data: Certificates, for transfer switches, 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.
- C. Field quality-control reports.

### 1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
  - 1. Include the following:
    - a. Features and operating sequences, both automatic and manual.
    - b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

#### 1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
  - 1. Member company of NETA.
    - a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### 1.07 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.

#### 1.08 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.

#### PART 2 - PRODUCTS

#### 2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 99.
- D. Comply with NFPA 110.
- E. Comply with UL 1008 unless requirements of these Specifications are stricter.
- F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

- G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
  - 2. Short-time withstand capability for three cycles.
- H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motoroperated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- K. Service-Rated Transfer Switch:
  - 1. Comply with UL 869A and UL 489.
  - 2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
  - 3. In systems with a neutral, the bonding connection shall be on the neutral bus.
  - 4. Provide removable link for temporary separation of the service and load grounded conductors.
  - 5. Surge Protective Device: Service rated.
  - 6. Ground-Fault Protection: Comply with UL 1008 for normal bus.
  - 7. Service Disconnecting Means: Externally operated, manual mechanically actuated.
- L. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles
- M. Neutral Terminal: Solid and fully rated unless otherwise indicated.
- N. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- O. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
- P. Battery Charger: For generator starting batteries.
  - 1. Ammeter to display charging current.
  - 2. Fused ac inputs and dc outputs.
- Q. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- R. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by colorcode or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

- 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
- 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
- 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- 4. Accessible via front access.
- S. Enclosures: General-purpose NEMA 250, Type 4X, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.02 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. ABB, Electrification Business.
  - 2. Caterpillar, Inc.; Electric Power Division.
  - 3. Cummins Power Generation.
  - 4. Eaton.
  - 5. Generac.
  - 6. Kohler Power Systems.
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuitbreaker components are unacceptable.
  - 2. Switch Action: Double throw; mechanically held in both directions.
  - 3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
  - 4. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 5. Material: Hard-drawn copper, 98 percent conductivity.
  - 6. Main and Neutral Lugs: Mechanical type.
  - 7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  - 8. Ground bar.
  - 9. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
  - 1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- F. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- G. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

- H. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- I. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- J. Automatic Transfer-Switch Controller Features:
  - 1. Controller operates through a period of loss of control power.
  - 2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  - 5. Test Switch: Simulate normal-source failure.
  - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  - 9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
  - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
  - 11. Engine Shutdown Contacts:
    - a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    - b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
  - 12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    - b. Push-button programming control with digital display of settings.
    - c. Integral battery operation of time switch when normal control power is unavailable.

#### 2.03 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- B. Prepare test and inspection reports.
  - 1. For each of the tests required by UL 1008, performed on representative devices, for legally required systems. Include results of test for the following conditions:
    - a. Overvoltage.
    - b. Undervoltage.
    - c. Loss of supply voltage.
    - d. Reduction of supply voltage.
    - e. Alternative supply voltage or frequency is at minimum acceptable values.
    - f. Temperature rise.
    - g. Dielectric voltage-withstand; before and after short-circuit test.
    - h. Overload.
    - i. Contact opening.
    - j. Endurance.
    - k. Short circuit.
    - 1. Short-time current capability.
    - m. Receptacle withstand capability.
    - n. Insulating base and supports damage.

#### PART 3 - EXECUTION

## 3.01 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
  - 1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033150 "Concrete Work."
  - 2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
  - 3. Provide workspace and clearances required by NFPA 70.
- B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. Comply with NECA 1.

#### 3.02 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
  - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."
- G. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.
- H. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

## 3.03 FIELD QUALITY CONTROL

- A. Administrant for Tests and Inspections:
  - 1. Owner will engage qualified testing agency to administer and perform tests and inspections.
  - 2. Engage qualified testing agency to administer and perform tests and inspections.
  - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
  - 4. Administer and perform tests and inspections.
- B. Tests and Inspections:
  - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
  - 2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with Drawings and Specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, grounding, and required clearances.
    - d. Verify that the unit is clean.
    - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    - f. Verify that manual transfer warnings are attached and visible.
    - g. Verify tightness of all control connections.
    - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
      - 1) Use of low-resistance ohmmeter.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torquewrench method according to manufacturer's published data.
    - i. Perform manual transfer operation.
    - j. Verify positive mechanical interlocking between normal and alternate sources.
    - k. Perform visual and mechanical inspection of surge arresters.
    - 1. Inspect control power transformers.

- 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
- 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
- 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
- 3. Electrical Tests:
  - a. Perform insulation-resistance tests on all control wiring with respect to ground.
  - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
  - c. Verify settings and operation of control devices.
  - d. Calibrate and set all relays and timers.
  - e. Verify phase rotation, phasing, and synchronized operation.
  - f. Perform automatic transfer tests.
  - g. Verify correct operation and timing of the following functions:
    - 1) Normal source voltage-sensing and frequency-sensing relays.
    - 2) Engine start sequence.
    - 3) Time delay on transfer.
    - 4) Alternative source voltage-sensing and frequency-sensing relays.
    - 5) Automatic transfer operation.
    - 6) Interlocks and limit switch function.
    - 7) Time delay and retransfer on normal power restoration.
    - 8) Engine cool-down and shutdown feature.
- 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
  - a. Check for electrical continuity of circuits and for short circuits.
  - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
  - c. Verify that manual transfer warnings are properly placed.
  - d. Perform manual transfer operation.
- 5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
  - a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
  - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
  - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
  - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.

- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Transfer switches will be considered defective if they do not pass tests and inspections.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Prepare test and inspection reports.
- H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
  - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
  - 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

## 3.04 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.

END OF SECTION

### SECTION 312000 - EARTHWORK

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section includes the following:
  - 1. Preparing of subgrade for final surface grades and pavements.
  - 2. Aggregate base courses for pavements and aggregate surface courses.
- B. Final Grading, placement, and preparation of topsoil for lawns, planting, and paving are specified in other Division 2 Sections.

#### 1.02 DEFINITIONS

- A. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.
- B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of ENGINEER. Unauthorized excavation, as well as remedial Work directed by ENGINEER, shall be at CONTRACTOR's expense.
  - 1. Backfill and compact unauthorized excavations as specified for authorized excavations of same classification unless otherwise directed by ENGINEER.
- C. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, drainage fill, or topsoil materials.
- D. Subbase: The layer of specified materials of designed thickness placed to the subgrade as part of the pavement structure.
- E. Base Course: The layer or layers of specified or selected material of designed thickness placed on a subbase or a subgrade to support a surface course.
- F. Structure: Pavements, slabs, or other man-made stationary features occurring above or below ground surface.

## 1.03 SUBMITTALS

- A. Test Reports: Submit the following reports directly to ENGINEER from the testing services, with copy to CONTRACTOR:
  - 1. Test reports on borrow material.
  - 2. Gradation analysis for subbase and base materials.
  - 3. Field reports: in-place soil density tests will be performed by a representative of OWNER.

#### 1.04 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation Work in compliance with applicable requirements of authorities having jurisdiction. Construct subbase, base, and surface courses in accordance with Michigan Department of Transportation (MDOT) Standard Specifications for Construction.

B. Testing and Inspection Service: OWNER will employ and pay for a qualified independent geotechnical testing and inspection laboratory to perform soil testing and inspection service during earthwork operations.

## 1.05 PROJECT CONDITIONS

- A. 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 OWNER and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
  - 2. 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.
- B. Use of Explosives: Use of explosives is not permitted.
- C. Protection of Persons and Property: Barricade open excavations occurring as part of this.
  - 1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
  - 2. Perform excavation by hand within drip line 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

## 2.01 SOIL MATERIALS

- A. Satisfactory soil materials are defined as those complying with ASTM D 2487, Soil Classification Groups GW, GP, GM, SM, SW, and SP.
- B. Unsatisfactory soil materials are defined as those complying with ASTM D 2487, Soil Classification Groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.
- C. Sand Bedding and Backfill: MDOT Specifications Granular Materials Class III.
- D. Subbase Material: MDOT Specifications Granular Materials Class II.
- E. Aggregate Base: Aggregate shall meet MDOT Specification 21AA or 22A.
- F. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.
- G. Aggregate Surfaces and Shoulders: Surfaces on which no bituminous or concrete pavement is to be placed shall meet MDOT Specification 23A or 22A.
- H. Private Driveways: Surfaces on which no bituminous or concrete pavement is to be placed, and where no other material is specified, shall meet MDOT Specification 23A or 22A.

I. Earthen Berm: Soils used to build the embankment for the berm across the site shall consist of clayey, cohesive soils.

## PART 3 - EXECUTION

#### 3.01 EXCAVATION

A. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

#### 3.02 STABILITY OF EXCAVATIONS

- A. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- 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.

#### 3.03 DEWATERING

- A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding Project Site and surrounding area or from impacting the subgrade.
  - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades 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. Remove subsurface water below structure excavations until the water level is far enough below the subgrade elevation to allow the required subgrade compaction. Dewatering shall be completed before the subgrade is exposed and before ENGINEER inspects the subgrade condition. Place dewatering wells outside the load-bearing influence area of the structure foundation. Provide test pits, well points, piping, pumps, electrical power, and other equipment necessary for dewatering.
  - 3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

# 3.04 STORAGE OF EXCAVATED MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
  - 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 use as backfill or fill.

#### 3.05 EXCAVATION FOR PAVEMENTS

A. Cut surface under pavements to comply with cross-sections, elevations, and grades as indicated. City of Owosso
# 3.06 TRENCH EXCAVATION FOR PIPES AND CONDUIT

- A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.
- B. Excavate trenches for conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line or to elevations as shown on Drawings.
  - 1. For pipes and equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Where the subgrade is disturbed, fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads ensure continuous bearing of pipe barrel on bearing surface.

# 3.07 BACKFILL AND FILL

- A. Place and compact sand to a level 1 foot above the top of the pipe or conduit, then place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.
  - 1. Under grassed areas, use satisfactory excavated or borrow material.
  - 2. Under walks and pavements, use subbase material, satisfactory excavated, or borrow material, or a combination.
- B. Backfill excavations as promptly as Work permits, but not until completion of the following:
  - 1. Acceptance of construction below finish grade.
  - 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
  - 5. Removal of trash and debris from excavation.

## 3.08 PLACEMENT AND COMPACTION

- A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
  - 1. When existing ground surface has a density less than that specified in this Article for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.
- B. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material 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 ENGINEER if soil density tests indicate inadequate compaction.
  - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
    - a. Under structures, building slabs and steps, and pavements, compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
    - b. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum density.
  - 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.

# 3.09 GRADING

- A. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. 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 or other structures to drain away 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. Pavements: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.
- C. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

# 3.10 PAVEMENT SUBBASE COURSE

- A. Subbase course consists of placing subbase material, in layers of specified thickness, over subgrade surface to support a pavement base course.
  - 1. Refer to project drawings and details for pavement sections.
- B. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
  - 1. When a compacted subbase course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 15 inches thick, place material in equal layers,

except no single layer more than 8 inches or less than 3 inches in thickness when compacted. Subgrade shall be compacted to 95 percent maximum density.

#### 3.11 AGGREGATE BASE COURSE

- A. Aggregate base course consists of placing base materials of the type and thickness, over a prepared subgrade or subbase, as shown on Drawings.
- B. Placing: Aggregate base shall be placed in accordance with MDOT Specifications. Aggregate base shall be conditioned in accordance with Method No. 2.

#### 3.12 AGGREGATE SURFACE COURSE

- A. Aggregate surface courses consist of constructing an aggregate surface on prepared subgrade or subbase, an aggregate base or an existing aggregate surface.
- B. Placing: Aggregate surface courses shall be constructed in accordance with MDOT Specifications.

#### 3.13 EARTH BERM

- A. Earth berm shall consist of constructing an impermeable earth berm of clay or other suitable materials excavated from the site in order to hold a higher water level on the west side of the mitigation area. Top of the berm shall be a minimum of 12 feet wide with a ten foot wide vehicular driving surface as shown on the detailed drawings.
- B. Clay embankment shall be placed and compacted to 95% density along the entire length of the berm. With the top of the berm to receive 6 inches of topsoil and be seeded according to the specifications for Restoration.

#### 3.14 FIELD QUALITY CONTROL

A. Quality Control Testing during Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

#### 3.15 EROSION CONTROL

A. Provide erosion control methods in accordance with details shown on Drawings and/or requirements of authorities having jurisdiction.

## 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 to Designated Areas on OWNER's Property: Transport acceptable excess excavated material to designated soil storage areas on OWNER's property. Stockpile soil or spread as directed by ENGINEER.
  - 1. Transport waste material, including unacceptable excavated material, trash, and debris to designated spoil areas on OWNER's property and dispose of as directed.
- B. Removal from OWNER's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off OWNER's property.
  - 1. Remove excess excavated material, trash, debris, and waste materials and dispose of it off OWNER's property.

END OF SECTION

## SECTION 312300 - EXCAVATION AND BACKFILL

## PART 1 - GENERAL

#### 1.01 SUMMARY

A. Section Includes: Excavation, trenching, complete and continual dewatering of excavation, sheeting, bracing and shoring of sides of excavation, backfilling around structures and over pipelines, and disposal of excess excavated material.

#### 1.02 REFERENCES

- A. Reference Standards:
  - 1. ASTM D 1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) Modified Proctor Test.
  - 2. ASTM D 2487 Classification of Soils for Engineering Purposes.
  - 3. MDOT Michigan Department of Transportation.
  - 4. MDOT 6A Stone Refill.

#### 1.03 DEFINITIONS

- A. Earth: Earth, as a name for excavated material, shall include all glacial deposit whether cemented or not, except solid boulders 1/2 cubic yard or more in volume. It shall include all alluvial deposits and material of every kind that can be excavated with equal facility by the equipment and means used for other earth excavation in Work.
- B. Rock: Rock, as a name for excavated material, shall include pre-glacial solid ledge rock that can be removed most practically by blasting, barring, or wedging, or by some other standard method of quarrying solid rock. It shall include solid boulders of 1/2 cubic yard or more in volume, existing concrete, masonry with mortar joints, or other existing structural work that can be excavated practically only by methods of quarrying solid rock. It shall not include fragile, friable, or disintegrated materials of any kind that can be excavated with equal facility by equipment and means used for earth excavation.
- C. Site-excavated Backfill: Site-excavated backfill shall be defined as site-excavated material, free from frozen earth, boulders, rocks, stones larger than 6 inches in size, debris, and organic material.
- D. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, drainage fill, or topsoil materials.
- E. Subbase: The layer of specified materials of designed thickness placed on the subgrade as part of the pavement structure.
- F. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

#### 1.04 SUBMITTALS

- A. Test and Inspection Reports: Written reports shall be submitted to ENGINEER, with copy to CONTRACTOR, documenting testing and/or inspection results. The reports shall be prepared as noted under Section 01450. Tests shall include:
  - 1. Test reports on borrow material.
  - 2. Gradation analysis for granular backfill and subbase materials.
  - 3. Field reports; in-place soil density tests will be performed by a representative of OWNER.

#### 1.05 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction. Construct subbase in accordance MDOT Standard Specifications for Construction.

#### 1.06 PROJECT CONDITIONS

- A. 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.
- B. CONTRACTOR shall notify MISS-DIG, Utility Communications System, 811, three working days prior to starting any excavation with power equipment.
  - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Cooperate with OWNER and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.
  - 2. Do not interrupt existing utilities serving facilities occupied by OWNER or others during occupied hours except when permitted in writing by ENGINEER, and then only after acceptable temporary utility services have been provided.
  - 3. Provide minimum of 2 working days notice to ENGINEER and receive written notice to proceed before interrupting any utility.
  - 4. 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.
- C. Use of Explosives: Use of explosives is not permitted.
- D. Protection of Persons and Property: Barricade open excavations occurring as part of this Work and post with warning lights.
  - 1. Operate warning lights as recommended by authorities having jurisdiction.
  - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
  - 3. Perform excavation by hand within drip line 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

## 2.01 SOIL MATERIALS

- A. Satisfactory soil materials are defined as those complying with ASTM D 2487 soil classification Groups GW, GP, GM, SM, SW, and SP.
- B. Unsatisfactory soil materials are defined as those complying with ASTM D 2487 soil classification Groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.
- C. Bedding: MDOT Specification Granular Material 6A or Class I, except 100 percent must pass 1-1/2-inch sieve.
- D. Bedding for Thermoplastic Pipe, 6-inch Diameter or Less: Granular material with 100 percent passing the 1/2-inch sieve and less than 50 percent passing the No. 200 sieve.
- E. Granular Backfill: MDOT Specifications Granular Materials Class III.
- F. Stone Refill: MDOT 6A Coarse Aggregate.
- G. Subbase Material: MDOT Specifications Granular Materials Class II.
- H. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve and not more than 5 percent passing a No. 4 sieve.
- I. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock, or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

# PART 3 - EXECUTION

## 3.01 LIMITS OF EXCAVATION

- A. Trenches for pipes shall be excavated so that there shall be a minimum clearance of 6 inches on each side of the pipe barrel, and a maximum width at the level on the top of the pipe of not more than O.D. of the pipe, plus 12 inches on each side. Trenches shall be at all times of sufficient width to permit the pipe to be laid by first-class construction methods. Sufficient space shall be provided in the trench to permit the joints to be properly made. Before excavation is started in either bituminous or concrete paved streets, the paving shall be cut by means specified under this Section.
- B. The bottom of the trench in granular material shall be loosened to a depth of 4 inches below bottom of the pipe. Where the trench excavation for pipe is in rock, the trench bottom shall be undercut a minimum of 6 inches below the final location of the pipe and bedding material, herein specified, shall be placed and compacted along the haunch of the pipe.
- C. Excavation for structures shall be made to the outside lines and surfaces of such structures wherever it is practicable to build directly against the sides or bottoms of excavations. In such cases, care shall be taken not to disturb the original foundation or backing, with the final excavation or trimming being done by hand work just before the construction Work. If excess excavation is made, or the material becomes disturbed so as to require removal beyond the prescribed limits, the resulting space

shall be refilled with bedding, as specified in this Section, solidly machine tamped into place, to the required compaction, before construction work proceeds.

D. Excavation for structures shall be extended sufficiently beyond the limits of the structure to provide ample room for form construction and other construction methods to be followed, wherever necessary.

## 3.02 METHOD OF EXCAVATION IN EARTH

A. All excavation shall be by open cut from the surface, except in special cases where tunneling under pavement or structures may be required or where tunneling under the root system shall be required for tree root protection. All excavation shall be made in such a manner and to such depth, length, and width as shall give ample room for building the structures, for bracing, sheeting, and supporting the sides of the excavation, for pumping and drainage of groundwater and sewage which may be encountered, and for the removal of all materials excavated. Special care shall be taken so that the soil below the bottom of structures to be built shall be left undisturbed to provide a firm bed for construction.

# 3.03 STABILITY OF EXCAVATIONS

- A. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- 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.

## 3.04 STORAGE OF EXCAVATED MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
  - 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 use as backfill or fill.

## 3.05 BEDDING

A. Place specified bedding materials under the pipe, in the haunches along the sides of the pipe, and over the pipe to a level 1 foot above the pipe. The material directly below the pipe shall be compacted. The material in the haunch area shall be placed in layers not to exceed 6 inches in depth, and shall be compacted to 95 percent of its maximum unit weight. The material placed above the haunch area shall be compacted to percentage maximum unit weight as specified in this Section under "Compaction."

## 3.06 BACKFILLING TRENCHES

A. All trenches in paved streets, shoulders, traveled roadways, parking areas, and driveways shall be backfilled with site-excavated backfill or granular fill, as shown on Drawings, from the level 1 foot above the top of the pipe to the specified road surface subgrade. The site-excavated backfill or granular fill shall be placed in not more than 6-inch layers and thoroughly and uniformly compacted

by machine tamping to required compaction. With the approval of ENGINEER, water jetting on granular fill may be accepted in lieu of tamping in 6-inch layers.

- B. Trenches under concrete sidewalks shall be backfilled from a level 1 foot above the top of the pipe to a level 4 inches below the finished grade of the sidewalk with site-excavated backfill or granular fill and compacted to the required density.
- C. Trenches not in paved streets, shoulders, traveled roadways, parking areas, driveways, and under sidewalks shall be backfilled from a level 1 foot above the top of the pipe to the ground surface with site-excavated backfill and tamped as required to prevent trench settlement.
- D. Any depression resulting from settlement of the trench backfill previous to the date of total acceptance of all Work under this Contract shall be brought to proper grade and surface and made to match the adjacent surface.
- E. Wherever gas mains, water mains, sewers, etc., are located in the trench area, granular fill shall be used for backfill from the bottom of the trench up to the spring line of these pipes. Granular fill shall be placed full trench width with two horizontal to one vertical side slopes, and compacted in 6-inch layers to 95 percent of its maximum unit weight so as to thoroughly support the pipe within the trench area. Granular fill so required shall be considered included in the unit prices bid for other items of the Work. When directed by ENGINEER, dry mix Class "C" concrete shall be substituted for granular fill. The installation of any dry mix Class "C" concrete will be considered a Change in Work.

# 3.07 STONE REFILL

A. In locations where the soil at the bottom of the trench is unstable, when ordered by ENGINEER, CONTRACTOR shall excavate below the trench bottom and replace excavated material with stone refill.

## 3.08 BACKFILLING AROUND STRUCTURES

A. As soon as practical after concrete structures have set, forms and debris shall be removed and the surface of the concrete pointed. After the structure has been inspected and approved, the excavated area around the structure shall be backfilled up to the specified subgrade with granular fill or site-excavated backfill, as called for on Drawings for the adjacent trench. The fill shall be made in layers not to exceed 6 inches in depth and thoroughly compacted by machine tamping. No large boulders or masonry shall be placed in backfilling. No backfilling will be placed against manhole walls within 24 hours after the plaster coat has been applied to the outside of the walls, nor shall backfilling be placed about concrete structures until the concrete has attained at least 75 percent of its design strength and approval of ENGINEER has been obtained.

## 3.09 CROSSING EXISTING STRUCTURES

A. During construction, it may be necessary to cross under certain sewers, drains, culverts, water lines, gas lines, electric conduits, and other underground structures. Every effort shall be made to prevent damage to such underground structures. Wherever such structures are disturbed or broken, they shall be restored to good condition by CONTRACTOR unless otherwise noted on Drawings.

## 3.10 COMPACTION

- A. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
  - 1. Under pavements, structures, and slabs, compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum unit weight.
  - 2. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum unit weight.
  - 3. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum unit weight.
- B. 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.
  - 1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

## 3.11 DISPOSAL OF EXCAVATED MATERIAL

A. Excavated material, where suitable, shall be used in backfilling around pipelines and structures. All material in excess of the quantity required for backfilling or unsuitable material shall be disposed of by CONTRACTOR. CONTRACTOR shall obtain such spoil sites as may be required, except that ENGINEER may direct CONTRACTOR to dump materials at any site designated by OWNER within a 2-mile radius of Work area. CONTRACTOR shall provide all labor and equipment for spreading such material at the place of dumping, and shall leave the area in a neat condition satisfactory to ENGINEER.

## 3.12 TREE ROOT PROTECTION

A. Machines shall freely excavate no closer to the base of a tree than the radius of the tree in inches converted to feet for trees less than 24 inches in diameter, and no closer than 12 feet if the tree is more than 24 inches in diameter. Tunneling under the root system will be required between the points so determined. Approaches closer than the previously stated distance, or tree removal, may be authorized by ENGINEER. Trees removed shall be disposed of at CONTRACTOR's expense.

## 3.13 ROADSIDE DITCHES AND CULVERTS

A. All roadside ditches and driveway culverts shall be cleaned, repaired, and replaced to the same condition, or better, as existed before trenching operations commenced. Repair and/or replacement costs shall be included in other portions of the Work unless otherwise noted on Drawings.

## 3.14 FIELD QUALITY CONTROL

A. Quality Control Testing during Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

## 3.15 EROSION CONTROL

A. Provide erosion control methods in accordance with details shown on Drawings and/or requirements of authorities having jurisdiction.

#### City of Owosso

# 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.

# END OF SECTION

#### SECTION 333100 - SEWERS

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for furnishing, fabrication, production, installation, or erection of the items specified in this Section as shown on Drawings or listed on Schedule.
- B. Excavation, trenching, and complete and continual dewatering of excavation; sheeting, bracing, or shoring of sides of excavation; furnishing and installing of the pipe and bedding; backfilling; placing, and maintaining temporary roadway surfaces over trenches in streets, drives, and parking areas; testing; and disposal of excess excavated materials are to be done under Division 31 Sections of the Specifications.

## 1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013300, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
  - 1. Design details of the joint before ordering any pipe.
- B. Quality Control Submittals: All pipe delivered to Site shall be accompanied by certification papers showing that the pipe has been tested in accordance with applicable Specifications and that the pipe meets these Specifications.
- C. Warranty: Submit in accordance with requirements of Section 017700, warranties covering the items included under this Section.

# PART 2 - PRODUCTS

## 2.01 SEWER PIPE

- A. Locations of various types of pipe are shown on Drawings. Sanitary sewer pipe shall be designed for air testing.
- B. Sewer pipe and fittings used in this Work shall meet requirements of referenced standard specifications. Sewer piping shall be of following types as noted on Drawings.
  - 1. Polyvinyl Chloride Gravity Pipe (PVC): ASTM D 3034 or ASTM F 679, SDR 35 or SDR 26; PVC compounds to meet ASTM D 1784, Cell Class 12454B or C.
  - Polyvinyl Chloride Pressure Pipe (PVCP): ASTM D 2241, SDR 26; ASTM D 2672; AWWA C900; AWWA C905; UNI-B-11. PVC compounds, ASTM D 1784 with Cell Class 12454 B or C.
  - 3. Polyvinyl Chloride Pipe (PVC) and Fittings: ASTM D 1785, Schedules 40, 80, and 120; ASTM D 2466; ASTM D 2467; ASTM D 3036; PVC compounds to meet ASTM D 1784, Cell Class 12454B or C.
  - 4. Solid Wall High-Density Polyethylene Pipe (HDPE): ASTM F 714 with minimum SDR of 32.5. Cell Classification shall be PE 345434C per ASTM D 3350.

## 2.02 PIPE JOINTS

- A. Polyvinyl Chloride Pipe:
  - 1. Joints in polyvinyl chloride pipe shall be bell and spigot type unless solvent weld joints are specified. Bell and spigot joints shall consist of spigot and formed bell complete with a factory installed flexible elastomeric gasket meeting ASTM F 477.
  - 2. Joints for pressure pipe (PVCP) shall conform to ASTM D 3139. Joints for nonpressure pipe (PVC) shall conform to ASTM D 3212. Solvent weld joints shall conform to ASTM D 2855.
  - 3. Joints in tee branches, wyes, fittings, riser pipes, and service laterals shall be similar to (including pressure rating) and compatible with joints furnished for sewer pipe. Joints shall be made using lubricant as recommended by pipe manufacturer. When necessary to field cut standard length of pipe, the new spigot end shall be prepared as recommended by pipe manufacturer.
  - 4. Joints in Schedule 40, 80, or 120 pipe shall be solvent weld according to ASTM D 2564 and D 2855.
- B. High-Density Polyethylene Pipe: Provide thermally butt-fused joints. Butt fusion equipment and the service of a qualified equipment operator shall be provided by pipe manufacturer to connect pipe segments, or manufacturer shall certify installer in the butt fusion process.

## PART 3 - EXECUTION

# 3.01 STORING FLEXIBLE PIPE

A. After delivery, flexible pipe shall be stored on flat surface so that barrel is evenly supported. Pipe shall not be stored in piles higher than 4 feet. If pipe is to be stored for over 1 month, it shall be covered with opaque material so that it is protected from sun's rays; and bells shall be inverted in alternate rows so they are not supporting direct load. Deflection of pipe shall not exceed 5 percent. Follow manufacturer's instructions in storing and handling pipe during periods of temperature extremes.

## 3.02 DISPOSAL OF WATER AND SEWAGE

- A. CONTRACTOR shall remove by well points, pumping, bailing, or other acceptable method any water which may accumulate or be found in the trenches or other excavations to be made. CONTRACTOR shall make all necessary provisions to keep the trenches and other excavations entirely free of water during construction of pipelines and structures. Newly laid concrete shall be adequately protected from injury resulting from groundwater or sewage or from the handling or disposal of water or sewage. No drainage ditches shall be placed within the area to be occupied by any structure except as permitted by ENGINEER.
- B. CONTRACTOR shall at all times have upon the Site sufficient pumping equipment ready for immediate use to carry out the intent of this Section. All cost for dewatering trenches shall be incidental to the Contract.

## 3.03 CROSSING EXISTING STRUCTURES

A. During construction, it may be necessary to cross under certain sewers, drains, culverts, water lines, gas lines, electric conduits, and other underground structures. Every effort shall be made to prevent damage to such underground structures. Wherever such structures are disturbed or broken, they shall be restored to good condition by CONTRACTOR unless otherwise noted on Drawings.

# 3.04 LAYING PIPE

- A. Inspect each pipe for defects prior to being lowered into trench. Clean inside of pipe and outside of tongue and grooves of dirt or foreign matter. Place joint materials as recommended by manufacturer.
- B. After pipe is laid, carefully compact bedding under the haunches of pipe, and backfill trench to 12 inches above pipe. Place sufficient backfill after each joint is made along sides of pipe to offset conditions that might tend to move pipe off line and grade. Relay pipe found off grade or out of line.
- C. Allowable Tolerances in Sewer Grade: Construct and lay sewers to alignment and grade shown on Drawings or designated by ENGINEER. A variation greater than 1/4 inch from plan or designated grade is sufficient reason for rejection of sewer; and sewer shall be re-laid to proper grade if so directed by ENGINEER, at no cost to OWNER.

# 3.05 CONCRETE CRADLE FOR PIPE

- A. Where called for on Drawings, install pipe with concrete cradle of Class "C" concrete.
- B. Rest each pipe on 6-inch-minimum thickness bed of dry mix concrete, shaped to fit bottom of pipe. Dry mix concrete shall be machine mixed Class "C" concrete described in Specification Section 033150. After setting pipe, fill space between outside of pipe and undisturbed trench bank to a level equal to a point 1/3 of diameter above pipe invert with Class "C" concrete, having a 2-inch slump. Mechanically vibrate concrete to ensure complete filling of annular space between excavated face of original ground and outside face of pipe.
- C. All concrete Work shall be in accordance with Section 033150.

# 3.06 STUBS, BULKHEADS, AND MISCELLANEOUS WORK

- A. Furnish material and labor required to construct stubs, bulkheads, and miscellaneous Work shown on Drawings or called for in the Specifications. The cost of this Work shall be included in Unit Prices Bid for manholes, structures, catch basins, inlets, and/or sewers, if applicable.
- B. Where shown on Drawings, set stubs with bulkheads in manholes or structures for connections to future sewers. Stubs shall consist of 1 length of sewer pipe with watertight plug or brick and cement bulkhead. Stubs shall have size, material, and class shown on Drawings and/or specified herein under this Section.

## 3.07 CONNECTIONS TO EXISTING MANHOLES

A. Provide labor and materials required for connection of sewers and catch basin leads under this Contract to existing manholes, structures, and catch basins as called for on Drawings. Wherever possible, core holes in manhole walls for new pipe connections and install resilient boots or NPC contour seal, if approved by ENGINEER. If coring is not possible, star-drill the opening and provide

a smooth hand-troweled mortar finish in opening to allow installation of boot or seal. When making holes, take care to prevent debris from entering existing sewers or leads.

- B. After installation of pipe, seal manhole or catch basin around pipe, both on inside and outside of the manhole or catch basin, so that it is restored to a watertight condition. Install new flow channels in existing manholes where called for on Drawings.
- C. Install pipes made of plastic or other nonporous materials with ENGINEER-approved waterstop at manhole entry and exit points to provide watertight seal. Receive ENGINEER approval on waterstop prior to laying pipe.

## 3.08 WYE BRANCH CONNECTIONS

A. Provide wye branch connections at such points as are shown on Drawings or as directed by ENGINEER. Provide size and character indicated on Drawings. Form branch connections with standard wye branches. Close by stoppers branches which will not have pipes connected to them. Stopper shall be adequate for air testing requirements. Immediately set and joint stopper bell or groove of branch outlet by same type jointing material as used for sewer pipe.

# 3.09 FIELD QUALITY CONTROL

# A. General:

- 1. Conduct acceptance tests for tightness on sanitary sewers and laterals. In areas where live leads have to be connected as Work progresses, only television inspection shall be required.
- 2. Test sewers 24 inches in diameter and smaller using low-pressure air. Also test sewers for infiltration where groundwater is above sewer invert. In areas where groundwater is more than 2 feet above the sewer crown at upstream end, air test with dewatering system in operation or use infiltration test after dewatering system is turned off and groundwater has returned to its normal level.
- 3. Make provisions for determining groundwater level prior to testing. ENGINEER shall be able to confirm level by visual inspection. Water level holes in manholes shall be sealed watertight after sewer has passed test.
- 4. CONTRACTOR may, at CONTRACTOR'S option, test any or all of the sewer lines prior to backfilling. However, such tests shall be in addition to required test following backfilling of trench.
- 5. Following completion of first section of sewer, if ENGINEER determines that there is some question as to installation of sewer, ENGINEER may direct CONTRACTOR to conduct a presumptive test to check installation for defective pipe or faulty joints before it is completely covered with backfill material.
- 6. Provide necessary materials, equipment, and personnel to conduct tests.
- 7. Acceptance test sections include entire length of sewer under Contract, including laterals.
- 8. Clean and flush pipe prior to conducting acceptance tests.
- 9. Make tests under supervision of ENGINEER. Submit testing schedule and procedures for CONTRACTOR and approval by ENGINEER prior to start of Work.
- 10. For those sections of sewer that cannot pass the acceptance test, make segmented TV testing or visual inspection to examine length of sewer being tested to locate possible cracks, breaks, bad joints, or misaligned pipe sections. Remove cracks and breaks, and replace bad joints or misaligned pipe sections located by inspection. Any sewers found with defects as listed above shall be repaired to like-new condition. ENGINEER may order reconstruction of defective portion of sewer. After all repair Work has been completed, repeat test. Final acceptance of the sewer being tested will not be made until satisfactory tests have been passed.

#### City of Owosso

- 11. Repair visible leakage in sewers or manholes even though acceptance tests have been satisfactory.
- B. Air Testing:
  - 1. Except for test times, air test concrete pipe sewers in accordance with ASTM C 924, vitrified clay pipe, in accordance with ASTM C 828, and all other sewers in accordance with ASTM F 1417. After pipe section to be checked is plugged, supply air to pipe section at a rate sufficient to maintain internal pressure of 4.0 psig. If the reach of pipe has not been backfilled, spray exposed surface of the pipe, fittings and plugs with foamable soap solution to detect by foam abnormal leakage due to cracks, holes, or improperly sealed joints. Correct sources of 4.0 psig is obtained. Then allow pressure to decrease to 3.5 psig, at which time a stopwatch shall be started to determine total time required for internal pressure to decrease to 2.5 psig.
  - 2. Test equipment shall include source of compressed air, air hose, plugs, hose connections, shutoff valve, throttling valve, cage cock, monitoring pressure gauge, delicate 0.1 psi graduations pressure gauge, and stopwatch.
  - 3. In all test pressures noted, add pressure adjustment of 0.433 psi pressure for each foot of groundwater level above invert of pipe being tested.
  - 4. If section of sewer to be tested includes more than one pipe size, calculate test time for each size and add test times to arrive at total time for section.
  - 5. Carefully observe safety precautions during air testing, recognizing the danger from plugs blowing out. Do not allow persons in manholes during testing.
  - 6. Isolate pipe to be tested; plug section of pipe to be tested at each end. Plug ends of branches, laterals, and wyes which are included in test. Carefully brace plugs to prevent slippage and blowout due to the internal pressure.
  - 7. Supply air to pipe section. Monitor air pressure so that pressure inside pipe does not exceed 5.0 psig, plus adjustment for groundwater.
  - 8. Stabilize: When pressure reaches 4.0 psig, throttle air supply so that internal pressure is maintained between 4.0 and 3.5 psig, plus adjustment for groundwater, for at least 2 minutes. If plugs are found to leak, bleed off air, tighten plugs, and supply air again.
  - 9. Determine rate of air loss. The control equipment consists of pressure gauges, valves, and pocket stopwatch. After allowing pressure to stabilize for 2-minute period, disconnect air supply and allow pressure to decrease to 3.5 psig. At 3.5 psig, start stopwatch to determine time required for pressure to drop to 2.5 psig. (NOTE: Make proper pressure adjustment for groundwater, where applicable, in determining beginning and end of period for 1.0 psig pressure drop). Pipeline shall be considered acceptable if time interval for 1.0 psi pressure drop is greater than holding time listed in Low Pressure Air Test Tables included in this Section. If CONTRACTOR's pressure gauge has minor graduation marks for 0.25 psi or greater, a pressure drop of only 0.5 psi will be permitted for all pipes but VCP or concrete pipe. Times for 0.5 psi drop are same as those given in this Section for VCP and concrete pipe at 1 psi drop.

## Low Pressure Air Test Tables Time Required for 1.0 psig Pressure Drop When Testing One Pipe Diameter Only for Size and Length of Pipe Indicated.

		3	4								
1	2	Length for	Time for								
Pipe	Minimum	Minimum	Longer	Test Time for Length (L) Shown (min:sec)							
Diameter	Time	Time	Length								
(in.)	(min:sec)	(ft.)	(sec.)	100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

#### TABLE FOR PVC, PVCP, ABS and DI $\ensuremath{\mathsf{PIPE}}$

Note: When testing two sizes of pipe simultaneously, time shall be computed by ratio of lengths involved.

Example: 400 feet of 8-inch PVC pipe and 150 feet of 6-inch VCP pipe.

$$Time = \frac{Time = Length_1 x Time_1 + Length_2 x Time_2}{Length_1 + Length_2}$$

 $= \frac{400 \times 10:08 + 150 \times 2:50}{400 + 150} = \frac{400 \times 608 + 150 \times 170}{400 + 150} = 489 \text{ seconds} = 8:09 \text{ (min:sec)}.$ 

END OF SECTION

## SECTION 333216 - PACKAGED PUMP STATIONS

## PART 1 - GENERAL

#### 1.01 SUMMARY

- A. Section specifies Work required for packaged pump stations. Work shall include all required excavation and backfill, the disposal of any excavated material, dewatering, Site improvements, construction of the concrete foundation and top slabs, valve vault, wet well, entrance hatches, pumps, valves, piping, painting, ventilation equipment, instrumentation, electrical power wiring, station testing, and all other appurtenances shown on Drawings or specified in this Section.
- B. The following type of packaged pump stations are specified:
  - 1. Submersible wastewater grinder pump station.

#### 1.02 SYSTEM DESCRIPTION

- A. Contractor shall furnish and install one complete factory-built and tested duplex grinder pump station, consisting of a pair of grinder pump cores suitably mounted on an integral stand of stainless steel, tank, electrical quick disconnect (NEMA 6P), pump removal harness, discharge assembly/shutoff valve, anti-siphon valve/check valve assembly, electrical alarm assembly and all necessary internal wiring and controls. For ease of serviceability, all pump motor/grinder units shall be of like type and horsepower throughout the system.
- B. The station shall be complete with all equipment specified herein, including an inground fiberglass reinforced polyester resin wet well.
- C. Station shall be provided with one (1) spare Extreme Series explosion-proof grinder pump core.
- D. Factory-built pump station design, including materials of construction, pump features, valves and piping, and motor controls, and alarm panel shall be in accordance with requirements listed under PART 2 PRODUCTS of this section.
- E. Pump Station and components shall comply with NFPA 820 and NEC requirements. Equipment located in the wet well shall be rated for Class 1 Division 1 Group D.

## 1.03 PERFORMANCE CRITERIA

- A. Pumps must be designed to handle raw, unscreened, domestic sanitary sewage. Each pump shall be selected to perform under following operating conditions:
  - 1. Capacity (minimum)14 gpm2. Total Dynamic Head10 ft
- B. Site power furnished to pump station shall be single phase, 60 hertz, 240 volts, maintained within industry standards. Voltage tolerance shall be plus or minus 10 percent.

#### 1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013300, Shop Drawings and Guarantees covering the items included under this Section.
- B. Test and Inspection Reports: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 016000.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 016000, operation and maintenance manuals for items included under this Section. The station manufacturer shall submit to ENGINEER, through CONTRACTOR, 4 copies of the manual.
- D. Warranty: Submit in accordance with requirements of Section 017700, warranties covering the items included under this Section.

#### 1.05 QUALITY ASSURANCE

- A. Reference Standards: Performance and material requirements shall meet specific Reference Standards referred to herein under individual items.
- B. Factory System Test
  - 1. All internal components including the pumps, motors, valves, piping, and controls will be tested as a complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed, and horsepower. Factory operational test shall simulate actual performance anticipated for the complete station.
- C. The manufacturer's technical representative shall inspect the completed installation, correct, or supervise the correction of any defect or malfunction, and instruct operating personnel in the proper operation and maintenance of the equipment as described in Part 3 of this section.

## 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading: Fabricated assemblies shall be shop assembled and properly match-marked for ease of field erection and shipped in the largest sections permitted by carrier regulations. All components must be erected immediately upon receipt from the manufacturer or stored in strict conformance with storage recommendations, including lubrication, furnished by equipment manufacturer.
- B. The basin may not be dropped, rolled, or laid on its side for any reason.

# 1.07 MANUFACTURER'S WARRANTY

A. The grinder pump manufacturer shall provide a part(s) and labor warranty on the complete station and accessories, including, but not limited to, the panel for a period of 24 months after notice of OWNER'S acceptance, but no greater than 27 months after receipt of shipment. Any manufacturing defects found during the warranty period will be reported to the manufacturer by the OWNER and will be corrected by the manufacturer at no cost to the OWNER.

## PART 2 - PRODUCTS

## 2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
  - 1. Submersible Wastewater Grinder Pump Station:
    - a. Environment One Corporation

# 2.02 PUMP DESIGN

A. The pump shall be a custom designed, integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. Double radial O-ring seals are required at all casting joints to minimize corrosion and create a protective barrier. All pump castings shall be cast iron, fully epoxy coated to 8-10 mil Nominal dry thickness, wet applied. The rotor shall be through-hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specifically compounded ethylene propylene synthetic elastomer. This material shall be suitable for domestic wastewater service. Its physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, excellent aging properties, and outstanding wear resistance. Buna-N is not acceptable as a stator material because it does not exhibit the properties as outlined above and required for wastewater service.

# 2.03 GRINDER

- A. The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller (cutter wheel) assembly shall be securely fastened to the pump motor shaft by means of a threaded connection attaching the grinder impeller to the motor shaft. Attachment by means of pins or keys will not be acceptable. The grinder impeller shall be a one-piece, 4140 cutter wheel of the rotating type with inductively hardened cutter teeth. The cutter teeth shall be inductively hardened to Rockwell 50 60c for abrasion resistance. The shredder ring shall be of the stationary type and the material shall be white cast iron. The teeth shall be ground into the material to achieve effective grinding. The shredder ring shall have a staggered tooth pattern with only one edge engaged at a time, maximizing the cutting torque. These materials have been chosen for their capacity to perform in the intended environment as they are materials with wear and corrosive resistant properties.
- B. This assembly shall be dynamically balanced and operate without objectionable noise or vibration over the entire range of recommended operating pressures. The grinder shall be constructed so as to minimize clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour the tank free of deposits or sludge banks which would impair the operation of the pump. These requirements shall be accomplished by the following, in conjunction with the pump:
  - 1. The grinder shall be positioned in such a way that solids are fed in an upward flow direction.
  - 2. The maximum flow rate through the cutting mechanism must not exceed 4 feet per second. This is a critical design element to minimize jamming and as such must be adhered to.
  - 3. The inlet shroud shall have a diameter of no less than 5 inches. Inlet shrouds that are less than 5 inches in diameter will not be accepted due to their inability to maintain the specified 4 feet per second maximum inlet velocity which by design prevents unnecessary jamming of the cutter mechanism and minimizes blinding of the pump by large objects that block the inlet shroud.
  - 4. The impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.

C. The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects," such as paper, wood, plastic, glass, wipes, rubber, and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4" diameter stainless steel discharge piping.

## 2.04 ELECTRIC MOTOR

A. As a maximum, the motor shall be a 1 HP, 1725 RPM, 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with Class F insulation, low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds. The motor shall be press-fit into the casting for better heat transfer and longer winding life. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. The motor protector shall be specifically investigated and listed by Underwriters Laboratories Inc. for the application. Non-capacitor start motors or permanent split capacitor motors will not be accepted because of their reduced starting torque and consequent diminished grinding capability. The wet portion of the motor armature must be 300 Series stainless steel. To reduce the potential of environmental concerns, the expense of handling and disposing of oil, and the associated maintenance costs, oil-filled motors will not be accepted. Pump operation during instances of potentially damaging high current or low voltage conditions shall be inhibited by an in-pump electrical monitoring system that has been investigated and listed by Underwriters Laboratories Inc. for the application. Motor start shall be controlled by a DC driven electromechanical relay integrated within the control compartment of the pump. Electrical monitoring shall ensure the relay operates reliably. AC Mechanical contactors for motor start are susceptible to damage from short cycling and will not be accepted.

## 2.05 MECHANICAL SEAL

A. The pump/core shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring.

## 2.06 WET WELL

- A. The wet well shall have an inside diameter and height as shown on Drawings. Wet well shall be furnished complete with access opening, vent, inlet, and outlet sleeved piping connections, and electrical connections.
- B. The wet well shall consist of a single wall, laminated fiberglass construction. The resin used shall be of a commercial grade suitable for the environment. The reinforcing material shall be a commercial grade of glass fiber capable of bonding with the selected resin. The inner surface shall have a smooth finish and be free of cracks and crazing. The exterior tank surface shall be relatively smooth with no exposed fiber or sharp projections present.
- C. The wet well wall and bottom shall be of sufficient thickness and construction to withstand the imposed loading due to saturated soil at the specified burial depth for each available tank height. All station components must function normally when exposed to the external soil and hydrostatic pressures developed at the specified burial depth. The wet well bottom shall be reinforced with a fiberglass plate extending beyond the wet well walls to support concrete anchoring, as required, to prevent flotation.
- D. The fiberglass wet well shall have a stainless steel discharge bulkhead which terminates outside the wet well wall with a 1-1/4" female pipe thread. The discharge bulkhead shall be factory installed and warranted by the manufacturer to be watertight.

E. The power and control cable shall connect to the pump by means of the provided NEMA 6P Electrical Quick Disconnect (EQD) and shall enter the tank through a field installed watertight strain relief connector supplied by the manufacturer. An electrical junction box shall not be permitted in the tank. Installation of the inlet grommet and cable strain relief shall require field penetration of the tank wall by the installing party. The tank shall also be vented to prevent sewage gases from accumulating inside the tank by means of a factory-provided, field-installed mushroom vent. The station cover shall be factory drilled to accept the mushroom vent. The tank and stainless steel discharge bulkhead shall be factory-tested to be watertight.

# 2.07 STAINLESS STEEL CURB STOP/CHECK VALVE ASSEMBLY

- A. The curb stop shall be pressure-tight in both directions. The ball valve actuator shall include position stop features at the fully opened and closed positions. The curb stop/check valve assembly shall be designed to withstand a working pressure of 235 psi.
- B. The stainless steel check valve shall be integral with the curb stop valve. The check valve will provide a full-ported 1-1/4" passageway and shall introduce minimal friction loss at maximum rated flow. The flapper hinge design shall provide a maximum degree of freedom and ensure seating at low back pressure.
- C. The stainless steel, combination curb stop/check valve component shall be 100 percent hydrostatically tested to 150 psi in the factory.

# 2.08 ALARM PANEL

- A. Each grinder pump station shall include a NEMA 4X, UL-listed alarm panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of thermoplastic to ensure corrosion resistance. The enclosure shall include a hinged, lockable cover with padlock, preventing access to electrical components, and creating a secured safety front to allow access only to authorized personnel. The standard enclosure shall not exceed 12.5" W x 16" H x 7.5" D.
- B. The panel shall contain one 15-amp single pole circuit breaker for the alarm circuit and one 15-amp double pole circuit breaker per core for the power circuit. The panel shall contain a push-to-run feature, an internal run indicator, and a complete alarm circuit. All circuit boards in the alarm panel are to be protected with a conformal coating on both sides and the AC power circuit shall include an auto resetting fuse.
- C. The visual alarm lamp shall be inside a red, oblong lens at least 3.75" L x 2.38" W x 1.5" H. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating. The audible alarm shall be externally mounted on the bottom of the enclosure, capable of 93 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch that is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure (push-to-silence button).
- D. The high-level alarm system shall operate as follows:
  - 1. The panel will go into alarm mode if either pump's alarm switch closes. During the initial alarm mode both pumps will run and the alarm light and buzzer will be delayed for a period of time based on user settings (default is 3-1/2 minutes). If the station is still in high-level alarm after the delay, the light and buzzer will be activated.
  - 2. The audible alarm may be silenced by means of the externally mounted push-to-silence button.

- 3. The visual alarm remains illuminated until the sewage level in the wet well drops below the "off" setting of the alarm switch for both pumps.
- E. The entire alarm panel, as manufactured and including any of the following options shall be listed by Underwriters Laboratories, Inc.
- F. The Alarm Panel shall contain the following features:
  - 1. Alarm Activated Dry Contacts Normally open relay contact closes upon alarm activation.
  - 2. Alarm Activated Contacts for Remote Indoor Alarm Module Will work with or without power to the alarm panel and is designed to work with E/One's Remote Sentry.
  - 3. Includes Inner Door Dead Front
  - 4. Separate LED's for each condition
- G. The Alarm Panel shall provide protection from the following operating conditions:
  - 1. Low Voltage (Brownout) Protection A lockout cycle will prevent the motor from operating and will illuminate the Trouble LED if:
    - a. the incoming AC Mains voltage drops below a predetermined minimum, typically 12% of nameplate (211 volts for a 240 volt system) for 2 to 3 seconds, regardless of whether the motor is running
    - b. the lockout cycle will end if the incoming AC Mains voltage returns to a predetermined value, typically 10% of nameplate (216 volts for a 240 volt system).
  - 2. The system continues to retest the voltage every second indefinitely. If the lockout cycle has been initiated and the voltage comes back above the predetermined starting voltage, the system will function normally. The Trouble LED remains illuminated during a Brownout condition and a corresponding Brownout message will be displayed on the LCD screen. The LED will turn off when the Brownout condition ends and the LCD message remains latched until the panel is reset. The audible and visual alarm will not be activated unless there is a high wastewater level in the tank.
  - 3. Run Dry Protection A 20-minute lockout cycle will prevent the motor from operating and will illuminate the Trouble LED when the wastewater level in the tank is below the pump inlet shroud. A corresponding Run Dry message will be displayed on the LCD screen. The condition is rechecked every 20 minutes and the LCD message remains latched. If the condition is satisfied, the pump is allowed to cycle normally and the Trouble LED will go out, but the LCD message remains latched. The LCD message will remain latched until the panel is reset. If the condition is not satisfied after 3 consecutive attempts, the visual alarm will be activated until the panel is reset or until there is one cycle of normal operation. If a high level condition is presented at any time, a pump run cycle will be activated.
  - 4. High System Pressure Protection A 20-minute lockout cycle will prevent the motor from operating and will illuminate the Trouble LED when the pressure in the discharge line is atypically high (closed valve or abnormal line plug). A corresponding Overpressure message will be displayed on the LCD screen. The condition is rechecked every 20 minutes. If the condition is satisfied, the pump is allowed to cycle normally and the Trouble LED will turn off, but the LCD message remains latched. The LCD message will remain latched until the panel is reset. If the condition is not satisfied after 3 consecutive attempts, the pump is locked out indefinitely and the audible and visual alarm will be activated. The LCD message and alarms will remain latched until the condition is removed and the panel is reset.
- H. In all of the above cases, if more than one error condition is presented, the LCD message depicting the most recent error condition will be displayed.

- I. The Alarm Panel shall include the following features:
  - 1. High/Low Voltage monitoring with Trouble indication
  - 2. High/Low Wattage (wattage is used instead of current because it is a better indicator of pump performance) monitoring with Trouble indication
  - 3. Extended Run Time monitoring with Trouble indication
  - 4. Cycle/Event Counter
  - 5. Run Time Counter (Hour Meter)
  - 6. Run Time Limit time adjustable, user-selected options: 10 minutes (default) to 120 minutes in 1-minute intervals
  - 7. Power-up Delay time adjustable, user-selected options: None (default), to 300 minutes in 1minute intervals
  - 8. Alarm Delay time adjustable, user-selected options: zero to 10 minutes in 30-second increments; 4 minutes is default
  - 9. System self-test diagnostic
  - 10. User-selectable Alarm latch
  - 11. User-selectable Protect Mode disable
  - 12. User-selectable buzzer timer
- J. Specific Duplex Protect PLUS indicators and programming features shall include:
  - 1. Ready LED to indicate AC power to the station is satisfactory
  - 2. Pump Run LED to indicate pump is operating (LCD indicates which pump is running)
  - 3. Trouble LED indicator and predictive Visual Alarm notification ("blinking" alarm lamp; clears on Normal cycle)
  - 4. High Level Alarm LED indicator (LCD indicates which pump is in alarm)
  - 5. Manual Run switch to manually activate pumps
  - 6. Lead/Lag indication (LCD indicates which pump is lead)
  - 7. Menu-driven programmable controller with navigation overlay-type buttons (Enter, Scroll, Up, Down)
  - 8. Normal Operation LED and Mode button for Mode status
  - 9. Pump Performance menu LED with LCD display of the following pump performance statistics:
    - a. Real-time Voltage
    - b. Real-time Amperage
    - c. Real-time Wattage
    - d. Minimum/Maximum/Average Voltage
    - e. Minimum/Maximum/Average Amperage
    - f. Minimum/Maximum/Average Wattage
    - g. Minimum/Maximum Run-time
    - h. Average Run-time
    - i. Last Run-time
    - j. Cycle/Event Counter
    - k. Run Time Counter (Hour Meter)
  - 10. Diagnostics Menu LED
  - 11. Initialize System Menu LED
  - 12. Run Limit Menu LED
  - 13. Alarm Delay Menu LED
  - 14. Power Delay Menu LED
  - 15. Pump alternating options (no alternation, adjustable time based and test)
  - 16. Pump alternating time options 24 hours to 72 hours in 12-hour increments

## PART 3 - EXECUTION

## 3.01 INSTALLATION

- A. Earth excavation and backfill are specified under Section 312000, but are also to be done as a part of the work under this section, including any necessary sheeting and bracing.
- B. The CONTRACTOR shall be responsible for handling ground water to provide a firm, dry subgrade for the structure, and shall guard against flotation or other damage resulting from general water or flooding. Dewatering requirements are specified under Section 015000.
- C. Installation shall be accomplished so that 1 inch to 4 inches of accessway, below the bottom of the lid, extends above the finished grade line. The finished grade shall slope away from the unit. The diameter of the excavated hole must be large enough to allow for the concrete anchor.
- D. A 6" inch (minimum) layer of naturally rounded aggregate, clean and free flowing, with particle size of not less than 1/8" or more than 3/4" shall be used as bedding material under each unit.
- E. A concrete anti-flotation collar, as detailed on the drawings, and sized according to the manufacturer's instructions, shall be required and shall be pre-cast to the grinder pump or poured in place. Each grinder pump station with its pre-cast anti-flotation collar shall have a minimum of three lifting eyes for loading and unloading purposes.
- F. If the concrete is poured in place, the unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured.
- G. The Contractor shall mount the alarm device as indicated in the contract drawings and per national and local codes. The alarm panel will be connected to the grinder pump station by a length of 6-conductor type TC cable as shown on the contract drawings. The power and alarm circuits must be on separate power circuits. The grinder pump stations shall be provided with 32 feet, 25 feet of useable, electrical supply cable to connect the station to the alarm panel. This cable shall be supplied with a factory installed EQD half to connect to the mating EQD half on the core.
- H. Backfill of clean, native earth, free of rocks, roots, and foreign objects, shall be thoroughly compacted in lifts not exceeding 12" to a final Proctor Density of not less than 85%. Improper backfilling may result in damaged accessways. The grinder pump station shall be installed at a minimum depth from grade to the top of the 1 1/4" discharge line, to assure maximum frost protection. The finish grade line shall be 1" to 4" below the bottom of the lid, and final grade shall slope away from the grinder pump station.

## 3.02 FIELD QUALITY CONTROL

A. Installation Check: In addition to the installation check outlined in Section 016000, a qualified factory representative shall place the station in operation, make necessary adjustments, conduct a complete functional check, including pump performance tests, and, upon completion of this final installation check, furnish ENGINEER and OWNER the information listed on the Installation Checkout and Testing Report.

- B. Performance Test: After the pump station has been completed, performance tests shall be conducted. The purpose of these performance tests shall be to demonstrate that the units have been properly installed and that they and their appurtenant equipment will operate satisfactorily and meet the specified conditions and guarantees of CONTRACTOR. For the purpose of these tests OWNER will furnish the electricity and the water for a test load when these items are available.
  - 1. The measurement of the quantity of water pumped may or may not be included in the performance test. The performance tests shall be conducted under the supervision of ENGINEER with the cooperation of CONTRACTOR's factory representative. Results of this test will be listed on the Installation Checkout and Testing Report.

# PACKAGED PUMP STATIONS SCHEDULE

No. of Units:	1
Service:	Raw Sewage
Type:	Submersible
Location:	Washington Park Development
Capacity (gpm):	14
Remarks:	EOne Duplex Grinder Station

# PACKAGED PUMP STATIONS INSTALLATION AND CHECKOUT AND TESTING REPORT

Contract	Station No.	Date

The station manufacturer shall, upon completion of this final installation check, furnish ENGINEER and OWNER the following information. Representatives of ENGINEER and OWNER will be present at this final installation check.

People Present:

PUMPS:

Design Conditions: \_\_\_\_\_ gpm at \_\_\_\_\_ ft. TDH

ACTUAL OPERATING CONDITIONS

Pump 1: Run Time \_\_\_\_\_ gpm \_\_\_\_\_

Pump 2: Run Time \_\_\_\_\_ gpm \_\_\_\_\_

END OF SECTION