Red Rocks Community College

Replace/Upgrade Emergency Generator
Lakewood Campus
2024-082M23

100% Construction Document Submittal
Issued For Bid

October 20, 2025

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STATE REQUIRED FORMS

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 23 – HVAC

DIVISION 26 – ELECTRICAL

DIVISION 31 – EARTHWORK

PART 1 - GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. Work to take place at the Red Rocks Community College (RRCC) Lakewood Campus, Main Building. The scope includes a new standby generator to be installed to serve the data center and loads as indicated on the construction documents.

1.2 CONSTRUCTION STAGING

A. The following describes the proposed staging of the Work and the coordination required for the work done by separate contractors. This information is only provided to give the contractor an idea of the complexity of the job. The final construction staging plan will be developed by the contractor and the project sub-contractors, with input from RRCC and the design Engineers.
   1. Coordinate with RRCC project manager and design engineers for all outages. Outages must be kept to a minimum. Submit a Method of Procedure (MOP) a minimum of two weeks prior to all outages.

B. Temporary offices for the Contractor and Sub-contractors shall be located as directed by RRCC.

1.3 PLANS AND SPECIFICATIONS

A. RRCC will provide one (1) set of plans and specifications to the Contractor, if required, as well as electronic files with all the contract documents in PDF form. The Contractor may have additional sets printed at his expense from the Compact Disk or request them from the Design Professional

B. The Design Professional will provide drawings in PDF and AutoCAD for use by sub-contractors in the preparation of shop drawings and submittals. Design specifications will be provided in PDF.

END OF SECTION 01 01 00

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and supervisory requirements necessary for Project coordination including, but not necessarily limited to:
   1. Coordination as hereinafter specified.
   2. Layout drawings.
   3. General installation provisions.
   4. Cleaning and protection.

1.2 COORDINATION

A. Coordination: Coordinate construction activities included under various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections of the Specifications that are dependent upon each other for proper installation, connection, and operation.
   1. Where installation of one part of the Work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results and avoid progress delays.
   2. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair.
   3. Transmit to the trades doing the work of other Divisions all the information required for Work to be provided under their respective Sections (such as foundations, concrete work, etc.) in ample time for their installation.
   4. Prior to the installation and connection of Electrical Work to Work of other Divisions:
      a. Verify the requirements indicated with the requirements and characteristics of the other crafts.
      b. Before installation, make provisions to avoid interference’s with existing and proposed concealed conditions and exposed finishes that may affect the work.
   5. Site civil, structural, architectural, mechanical, electrical, and building automation and control systems drawings show the general arrangement of raceways, equipment and appurtenances, but shall be followed as closely as actual building construction and the work of other trades permit.
      a. Electrical drawings are diagrammatic and do not show all offsets, fittings and accessories which may be required.
      b. Investigate the structural and finish conditions affecting the work and arrange the work accordingly.
      c. Provide fittings and accessories as may be required to fit project conditions.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of schedules.
   2. Delivery and processing of submittals.
   3. Progress meetings and pre-installation conferences.
   4. Project Close-out activities.

C. Where necessary, prepare memoranda for distribution to each party involved outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings. Prepare similar memoranda for the Owner and separate Contractors where coordination of their Work is required.

D. Coordination with Red Rocks Community College (RRCC) Lakewood Campus: Close coordination will be required of the Contractor, any work performed under separate contracts to assure that Work on the Project site, access to and from the Project site and operations are maintained in a safe and efficient manner. Disruption and inconvenience to existing property should be minimized.
   1. Submit daily construction status. Report is to be submitted to the Project Inspector no later than the following workday.

1.3 COORDINATION OF SPACE

A. Coordinate use of Project space and sequence of installation of other trades and electrical Work. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with building lines. Utilize space efficiency to maximize accessibility for other installations, for maintenance, and for repairs.

B. Layout of electrical systems, equipment, conduit, specialty items, and accessories indicated on Drawings is diagrammatic. Variations in alignment, elevation, and details required to avoid interference and satisfy architectural and structural limitations are not necessarily shown.

C. Prior to installation of material and equipment, review existing spece and coordinate Work with Architectural and Structural Drawings to establish exact space conditions. Where available space is inadequate or where reasonable modifications are not possible, request information from RRCC before proceeding.

D. Coordinate installation to prevent conflicts and cooperate in making, without extra charge, reasonable modifications in layout as needed.

E. Provide clear access to control points, valves, strainers, control devices, and specialty items of every nature related to such systems and equipment to obtain maximum head room. Provide adequate clearances as necessary for operation and maintenance.

PART 2 - PRODUCTS (Not Applicable).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION PROVISIONS

A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. Manufacturer's Instructions: Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.

C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items.

D. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion, new concrete work, and building movement.

E. Install each outdoor component and related components and connections during weather conditions and Project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.

F. Recheck measurements and dimensions, before starting each fabrication and installation.

G. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Engineer for final decision.

H. Include all items necessary for a complete installation whether or not shown or described.

I. Relocate installed work that does not provide adequate accessibility.

J. Changes required in the Work of this Contract, caused by the Contractor's failure to coordinate the work with others shall be made at the Contractor's expense.

3.2 CLEANING AND PROTECTION

A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from the incursion of dust, dirt, and debris or damage or deterioration at Substantial Completion.

B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:
1. Excessive static or dynamic loading.
2. Excessively high or low temperatures.
3. Excessively high or low humidity.
4. Water or ice.
5. Soiling, staining, and corrosion.
6. Unusual wear or other misuse.
7. Excessive weathering.
8. Unprotected storage.
9. Improper shipping or handling.
10. Theft.

11. Vandalism.

END OF SECTION 01 04 00

PART 1 - GENERAL

1.1 Not used

PART 2 - SURVEY REFERENCE POINTS

2.1 Not Used

PART 3 - EXISTING UTILITIES

3.1 Preserve in operating condition all active utilities within and about the site. Promptly repair any damage to such utility or work due to work under this contract to the satisfaction of Red Rocks Community College (RRCC), Lakewood Campus.

3.2 Existing appurtenances and improvements that are to remain shall be protected from damage due to work under this section. Such damaged facilities shall be promptly repaired and/or replaced in kind.

END OF SECTION 01 05 00

PART 1 - GENERAL

1.1 HAZARDOUS MATERIALS PROCEDURES

A. Except as otherwise specified, in the event the Contractor encounters on the Project site material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), or other hazardous materials which have not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to Red Rocks Community College (RRCC) Lakewood Campus in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of RRCC and Contractor if in fact the material is asbestos, PCB, or other hazardous materials and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos, PCB, or other hazardous materials, or when such materials have been rendered harmless.

B. RRCC will contract with a certified asbestos removal contractor and monitoring agency for all removal of asbestos.
   1. Contractor shall locate and mark all suspected asbestos material and notify the University in writing a minimum of fifteen (15) days before the contractor is scheduled to begin work in each area.
   2. RRCC's asbestos contractor shall have unrestricted access and use of each area for fifteen (15) days to remove the asbestos.
   3. Failure of the contractor to provide the fifteen (15) day minimum notice will relieve the University of any delay that occurs due to asbestos removal.

1.2 ALTERATION PROJECT PROCEDURES

A. During the construction period contemplated for the Work described herein, the University will use the building and Project site areas adjacent to the work under this Contract.

B. The Contractor shall have the access to the Project site only as indicated in the Drawings and designated by the University. Elevator usage shall be only as authorized by the University, and shall be scheduled to minimize disruption of normal activities.

C. The occupied facilities shall be off limits to all construction personnel without prior approval of the University. Only those areas of occupied space that require Work to be installed shall be used by the Contractor, in a manner that will minimize disruption.

D. Noise controls shall be maintained by the Contractor in all areas of construction, guarding against any undue noise that may disrupt activities in adjacent occupied areas. Work requiring high levels of noise or vibration shall be coordinated with RRCC prior to commencement.

E. Dust control measures shall be implemented and maintained by the Contractor as required to guard against health or safety risk, discomfort, or disruption of activities of existing facilities.

F. Materials and equipment removed during demolition shall be disposed as of follows: Reserved items that are to remain property of RRCC shall be stored as noted on the Drawings or in the Specifications. Additionally, the Contractor is responsible for reviewing with RRCC existing electrical equipment, and components and the like which RRCC may wish to retain. Items that are to remain the property of the University shall be removed or dislodged from present locations in such a manner as to prevent damage. Store such items where directed by RRCC.

END OF SECTION 01 11 00

PART 1 - GENERAL

1.1 PRECONSTRUCTION CONFERENCE

A. Prior to commencement of Work, a preconstruction conference will be conducted by Red Rocks Community College (RRCC) Lakewood Campus to discuss procedures that are to be followed during performance of the Work.

B. Location: As designated by RRCC.
   1. Time: As agreed to by all parties

C. Attending shall be:
   1. RRCC.
   2. RRCC's designated Inspector
   3. RRCC's Consultants, as appropriate.
   4. Contractor's Project Manager and Project Executive
   5. Contractor's Superintendent
   6. Others, as appropriate.

1.2 PROGRESS MEETING

A. During the course of construction, progress meetings will be held weekly to discuss and resolve field problems.

B. Location: Teleconference or Contractor's job Office
   1. Time: Day and time to be agreed to by all parties.

C. Attending shall be:
   1. RRCC.
   2. RRCC's Facilities Management
   3. RRCC's Consultants, as appropriate.
   4. Contractor's Project Manager or Superintendent
   5. Others, as appropriate.

D. No other attendees will be permitted at the Progress Meetings without pre-approval by the RRCC.

E. Meeting Minutes:
   1. The Contractor shall be responsible for preparing and distributing meeting minutes for each progress meeting. Meeting minutes shall be distributed no later than 24 hours after the time of the meeting. Meeting minutes shall include:
      a. Meeting Number and Date
      b. Meeting Attendees and Individuals who are to be copied.
      c. Project Completion Status
      d. Schedule Summary
      e. Old Business Status
      f. New Business Status
      g. RFI Status
      h. Submittal Status
      i. Copy of three week look a-head schedule
      j. Progress Photos

2. The Contractors PM or their designee shall conduct the meeting.

END OF SECTION 01 20 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate. Complete all information in Form SBP-6.18 “alternates” provided with these specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. Add Alternate Number 01 : Replace existing pump CHWP-2.
   1. Base Bid: Replace chiller, chilled water pump CHWP-1, and associated mechanical and electrical equipment, materials, piping, controls, etc. as indicated in the construction documents .

2. Alternate: Replace existing chilled water pump CHWP-2 with new pump, piping, controls and associated mechanical and electrical equipment, materials, piping, controls, etc. as indicated in the construction documents.

END OF SECTION 01 23 00

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Submit Shop Drawings and Product Data, for the Work to be performed under this contract.

B. Submit Shop Drawings and Product Data, for proposed substitutions and Alternates.

1.2 SCHEDULE OF SUBMITTALS

A. Review General Conditions Article 3.9

B. Prepare a Schedule of Submittals in coordination with the Contract Schedule for the Red Rocks Community College System (RRCC) Lakewood Campus review. Submittal Schedule shall conform to the requirements of Phase 1 as described Section 01011 – Phasing.

C. Submittal Schedule shall include:
1. Submittal Number, Description and Specification Section
2. Date Submitted to RRCC and Design Professional
3. Scheduled Date for Return from Design Professional/RRCC
4. Status of Returned Submittal
5. Date of Re-Submittal
6. Date of Return from Design Professional/RRCC
7. Number of days outstanding
8. Number of days late.

D. A minimum of fourteen calendar (14) days shall be allotted in the schedule for the Design Professional/ RRCC to review each submittal. It is understood that the Design Professional will expedite the review of submittals in a timely manner in an effort to shorten the review period.

E. Do not submit any submittals until the Submittal Schedule is accepted by RRCC.

1.3 SUBMITTALS

A. DEFINITIONS
1. "Shop Drawings" and "Product Data" include fabrication, erection, layout and setting drawings, survey notes, standard drawings of manufacturers, descriptive literature, catalogues, brochures, performance and test data, calculations, wiring and control diagrams, material certifications, and any other representations used to control or coordinate the Work or used to show conformance with the Contract Documents. Products of same type or category shall be of single manufacturer.
2. "Manufactured" Work includes standard units that are usually mass-produced. "Fabricated" Work includes Work assembled out of manufactured Work.

B. SPECIFIED ITEMS, ALTERNATES, SUBSTITUTIONS
1. BASIS OF DESIGN AND ALTERNATES
a. The basis of design is the manufacturer, product, catalogue number, or method named as the specified item in a paragraph or subparagraph. If more than one is named, the first one listed is the "specified item"; and the others are "alternates". The specified item establishes the standard of quality, utility, and appearance.

1) If specified items are discontinued by the manufacturer the Contractor shall provide alternate items from the same manufacturer with similar features, functions and characteristics at no additional cost to RRCC.

2. SUBSTITUTIONS
   a. Items proposed by the Contractor but not named in the Specifications are substitutions. The Contractor may propose substitutions where the Specification notes "or equal" or "no known equal"; however, do not propose substitutions where the Drawings indicate to match existing materials.
3. CHANGES REQUIRED BY ALTERNATES AND SUBSTITUTIONS
   a. Use of alternate items or substitutions may require modification of the project design or construction such as changes in details, connections, interfaces, design calculations, lead times, etc. Provide and pay for design work and construction changes as required, and at no change in Contract Sum or Contract time and any additional plan check fees.
4. PROPOSALS AND REVIEW
   a. RRCC will review proposed substitutions and evaluate substantiating data within 30 days after receipt. If there is no response from RRCC within the 30 day time period, the request for substitution is denied.
   b. Submit complete data including drawings, performance specifications, and test reports of the proposed substitution for review by RRCC. The data shall contain directly comparable information to allow feature by feature evaluation of equality between specified item and proposed substitution.
   c. Submit a breakdown of cost showing any costs incurred and any savings gained by use of the substitution. Include the amount to be deducted from the Contract Sum, if any.
   d. List other trades that may be affected by the substitution.
   e. If the proposed substitution requires design, submit design calculations by a design consultant having the appropriate license.
5. JUDGEMENT
   a. RRCC's review is the final judgment of equality. If the substitution is rejected, resubmit using the specified item or alternate.

C. SUBMISSION
1. SCOPE
   a. Provide Shop Drawings and Product Data, to establish the actual detail of manufactured and fabricated Work as required by Division 2 through 16.
      1) Shop Drawings shall be specific to the work of this project and shall depict all surrounding construction. Manufacturer’s standard shop drawings and installation details that have not been adapted to the specific conditions of the work are not acceptable and will be rejected. The preparation and submission of Coordination Drawings does not substitute for shop drawings required by other section of this document.
      2) Clearly delineate work and materials to be provided by others and coordinate the provision of that work and materials through the Contractor. Submit only one product/manufacturer per submitted item.
      3) Shop drawings shall identify all materials, components and/or equipment that are required to provide a complete, functional and code conforming installation.
      4) Where conditions shown on shop drawings vary from those shown or specified in the Contract Documents, the proposed deviations shall be clearly identified and explained within the submittal.

2. QUANTITY AND MEDIA
   a. Provide electronic copy of each submittal Send to the RRCC Project Manager Design & Construction and Design Professional.
   b. Complete a transmittal form for each submittal as follows:
      1) Submittal #1: "Submittal Schedule" listing all the items required to be submitted for review and approval, submittal date and return date, per Section 01300.
      2) Submittal #2: Schedule of Values
      3) Submittal #3: "Preliminary Contract Schedule" (Interim Diagram) per Section 01310.3.1.
      4) Submittal #4: List with names, addresses, telephone numbers on each Subcontractor per Article 5, General Conditions.
      5) Submittal #5: Quality Control Plan, Section 01400, Optional.
      6) Thereafter number each submittal consecutively including the CSI division number except for re-submittals. Re-submittals are to be numbered with the same submittal number adding an R1, R2, etc. Be sure to write the submittal number on each item.
      7) All substitutions shall be in accordance with Section 01300.3.2 and on the proper form.
      8) Provide two additional copies of submittals requiring Fire Marshall review, i.e. fire sprinklers, fire alarm, fire caulking, etc. shall be submitted to RRCC at RRCC-Facilities Design & Construction to be forwarded to Campus Fire Marshal.
3. COVER LETTER
   a. Provide a cover letter for each submittal. Address it to RRCC and show the Project's title, the RRCC's Project number, the Contract number and, the dates of previous submittals if it is a resubmittal. Reference the Specification section and submittal number from the Schedule of Submittals.
4. ORGANIZATION
   a. Limit the content of a submittal to those items listed in a single Specification section. A single section may be divided into two or more submittals in order to expedite critical lead time items.
   b. Provide an index for each submittal; number and list the submitted items in order of their Specification Sections and paragraph.
   c. List in the index any proposed alternates, deviations, or substitutions and name the items clearly as such.
   d. List names of the contributing Subcontractors. For submittals in booklet format, bind this information in the front of the booklet.
5. APPROVAL
   a. Mark each set of the submittal to show that it has the Contractor's review and approval in accordance with General Conditions.
      1) In addition to the requirements of the General Conditions, provide documentation for the Contractor’s review, such as written coordination comments, conference reports (including names of participants, matters discussed and actions taken), or an affidavit of the Contractor’s Superintendent or the Project Quality Control Manager indicating that the submittal is complete and fully coordinated with that of other trades.
6. STAMP SPACE
   a. Provide a 3" by 8" blank space for review stamp on the cover sheet or page of each set of the submittal.
7. START OF WORK

a. Manufacture and fabricate based on the review comments from the Engineer of Record. Do not begin without the review comments on that portion of the Work.

D. SHOP DRAWINGS
1. FUNCTION OF DRAWINGS
a. Use Shop Drawings to show spatial and functional relationships between parts of work such as equipment, piping, ducting, conduit systems; and to coordinate Work between different trades.
2. FORMAT
a. Present information required on Shop Drawings in a clear and thorough manner. Reference individual drawings to the details, schedules, room numbers, and sheet numbers of the Drawings.

E. PRODUCT DATA
1. FORMAT
a. Provide Product Data in a bound booklet. Provide the index, at the front of the booklet.
1) When the paragraph indicates instruction only, the word "Noted" may be used to indicate the Contractor's acknowledgement.
2) When the paragraph calls for manufactured materials, the phrase "Specified Item" may be used when the Contractor's intent is to provide the specified manufactured item.
3) When the paragraph calls for equipment or other fabricated Work, the Contractor shall submit complete physical description, and when appropriate, performance data, even when the Contractor proposes to furnish the specified item.
4) When an alternate, substitution, or a deviation from the contract documents is proposed, type "ALTERNATE", "DEVIATION", or "SUBSTITUTION" and state what is proposed.
2. MARK-UPS
a. Clearly mark each page of the Product Data to show which item is submitted and which features apply to the item such as: performance characteristics and capacities; physical dimensions and clearances; and diagrams for wiring, piping, and controls. Mark the standard data of manufacturers' to delete information not a part the Work and add information to show application to the Work.
3. INSTRUCTIONS
a. Provide manufacturer's instructions when a part of the Work is required to be furnished, installed, or performed according to such instructions.

F. RESPONSE TO SUBMITTALS
1. FORM OF RESPONSE
a. The architect of record will respond to the submittals by marking them with one or more of the following:
1) No exceptions taken.
2) Make corrections noted.
3) Revise and resubmit.
4) Rejected.
5) Submit specified item.
6) Resubmittal not required.
b. When the submittal is marked with "no exceptions taken", "resubmittal not required" or "make corrections noted", proceed with the Work covered by the submittal except for

deviations or substitutions. Proceed with alternates, deviations, or substitutions only when RRCC has explicitly acknowledged that part of the Work as such, and has marked it "no exceptions taken".

c. When the submittal is marked with 3 through 5 above, make the noted changes and resubmit. Review resubmission requirements below.

2. COMPLIANCE
   a. Comply with any notes from RRCC marked on or attached to the submittal. Such notes are for conforming the Contractor's proposed work to the Contract Documents. Comply with the claims procedures if the notes call for work beyond that required by the Contract Documents.
3. LIMITATIONS OF REVIEW
   a. The review of RRCC is for the limited purpose of checking for compliance with the concepts and intent of the Contract Documents. The review is not for determining the accuracy or completeness of the Work such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems; the Work remains the responsibility of the Contractor as required by the Contract Documents.
4. RE-USE OF SUBMITTAL
   a. RRCC will cooperate in returning submittals that are not easily reproduced for re-use in a resubmittal.

G. RESUBMISSIONS
1. CHANGES
   a. Identify any changes not required by the previous review comments. Identify any departures from the Contract Documents and any changes from previous submittals not resulting from comments by RRCC.

END OF SECTION 01 30 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
   1. General coordination procedures.
   2. RFIs.
   3. Digital project management procedures.
   4. Project meetings.

B. Each contractor shall participate in coordination requirements.

C. Related Requirements:
   1. Other sections within the Division 01 Specifications.
   2. Section 017000 "Project Closeout " for coordinating closeout of the Contract.

1.3 DEFINITIONS

A. RFI: Request for Information. Request from Owner; Red Rocks Community College (RRCC) Lakewood Campus, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for RRCC and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
2. Delivery and processing of submittals.
3. Progress meetings.
4. Preinstallation conferences.
5. Project closeout activities.
6. Startup and adjustment of systems.

1.6 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
2. Owner name.
3. Owner's Project number.
4. Name of Engineer**.**
5. Engineer's Project number.
6. Date.
7. Name of Contractor.
8. RFI number, numbered sequentially.
9. RFI subject.
10. Specification Section number and title and related paragraphs, as appropriate.
11. Drawing number and detail references, as appropriate.
12. Field dimensions and conditions, as appropriate.
13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
14. Contractor's signature.

15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as indicated above, acceptable to Engineer.
1. Attachments shall be electronic files in PDF format.

D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI.
1. The following Contractor-generated RFIs will be returned without action:
    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of Engineer's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.
3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within **5** days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project management software. Software log with not less than the following:
1. Project name.
2. Name and address of Contractor.
3. Name and address of Engineer**.**
4. RFI number, including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer **a** within three days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Use of Engineer's Digital Data Files: Digital data files of Engineer's CAD drawings will be provided by Engineer for Contractor's use during construction.
   1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
   2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
   3. Digital Drawing Software Program: Contract Drawings are available in AutoCAD.
   4. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to RRCC and Engineer.
      a. Subcontractors and other parties granted access by Contractor to Engineer's digital data files shall execute a data licensing agreement in the form of Agreement acceptable to RRCC and Engineer.
   5. Data files shall not be used, distributed, or copied in part or whole except for the purpose of construction of this project only.
   6. The following digital data files will be furnished for each appropriate discipline:
      a. Floor plans.
      b. HVAC engineering drawings.

B. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare as follows:
   1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
   2. Name file with submittal number or other unique identifier, including revision identifier.
   3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.8 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
   1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify RRCC and Engineer of scheduled meeting dates and times a minimum of seven days prior to meeting.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
   3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including RRCC, and Engineer, within days of the meeting.

B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to RRCC and Engineer, but no later than **15** days after execution of the Agreement.
   1. Attendees: Authorized representatives of RRCC , Construction Manager, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   2. Agenda: Discuss items of significance that could affect progress, including the following:
      a. Responsibilities and personnel assignments.
      b. Tentative construction schedule.

c. Phasing.
d. Critical work sequencing and long lead items.
e. Designation of key personnel and their duties.
f. Lines of communications.
g. Use of web-based Project software.
h. Procedures for processing field decisions and Change Orders.
i. Procedures for RFIs.
j. Procedures for testing and inspecting.
k. Procedures for processing Applications for Payment.
l. Distribution of the Contract Documents.
m. Submittal procedures.
n. Preparation of Record Documents.
o. Use of the premises and existing building.
p. Work restrictions.
q. Working hours.
r. RRCC's occupancy requirements.
s. Responsibility for temporary facilities and controls.
t. Procedures for moisture and mold control.
u. Procedures for disruptions and shutdowns.
v. Construction waste management and recycling.
w. Parking availability.
x. Office, work, and storage areas.
y. Equipment deliveries and priorities.
z. First aid.
aa. Security.
bb. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before construction activity when required by other Sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer and RRCC's Project Manager of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Possible conflicts.
i. Compatibility requirements.
j. Time schedules.
k. Weather limitations.
l. Manufacturer's written instructions.
m. Warranty requirements.

n. Compatibility of materials.
o. Space and access limitations.
p. Regulations of authorities having jurisdiction.
q. Testing and inspecting requirements.
r. Installation procedures.
s. Coordination with other work.
t. Required performance results.
u. Protection of adjacent work.
v. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of RRCC, RRCC's Construction Manager, and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
1) Review schedule for next period.
b. Review present and future needs of each entity present, including the following:
1) Interface requirements.
2) Sequence of operations.
3) Deliveries.
4) Access.
5) Site use.
6) Quality and work standards.
7) Status of correction of deficient items.
8) Field observations.
9) Status of RFIs.
10) Status of Proposal Requests.
11) Pending changes.
12) Status of Change Orders.
13) Pending claims and disputes.
14) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

PART 1 - GENEREAL

1.1 GENERAL REQUIREMENTS

A. The Work shall be prosecuted at such rate as will ensure meeting the Substantial Completion and Final Completion dates within Contract Time. By execution of the Contract, the Contractor represents it has analyzed the Work, the materials and methods involved, the systems of the building, availability of qualified mechanics and skilled and unskilled labor, restrictions of the Project site, constraints imposed, its own Work load and capacity to perform the Work, and agrees that the specified times are reasonable considering the existing conditions prevailing in the locality of the Work, including weather conditions, and other factors, with reasonable allowance for variations from average or ideal conditions.

B. Failure of the Contract Schedule to include any element of the Work or any inaccuracy in the Contract Schedule will not relieve the Contractor from responsibility for accomplishing all the Work in accordance with the Contract Documents and within the Contract Time.

C. Following is a list of Red Rocks Community College (RRCC) Lakewood Campus holidays. No work requiring inspection should be scheduled on these dates. It is the responsibility of the Contractor to verify with RRCC holidays for each calendar year.

New Year's Day (January)
Memorial Day (May)
Independence Day (July)
Thanksgiving (2 days, November)
Christmas Day

1.2 PRELIMINARY CONTRACT SCHEDULE

A. Submission
1. Submit electronic Preliminary Contract Schedule to RRCC within fourteen (14) days after the date of award of the Contract.
2. Within seven (7) days after receipt of the Preliminary Contract Schedule, RRCC will notify Contractor of its acceptance of or its review comments about the schedule so that Contractor may make appropriate adjustments in the development of the Contract Schedule.

B. Form
1. Prepare the Preliminary Contract Schedule as a Critical Path Method (CPM), time-scaled network diagram showing continuous flow from left to right.

C. Prepare the Preliminary Contract Schedule in sufficient detail to demonstrate adequate planning for the Work, and represent a practical plan to complete the Work within the Contract Time.
1. Identify the following milestone events on the Preliminary Contract Schedule:
a. Notice to Proceed
b. Contract Completion Date
c. Site Demolition complete
d. Underground Construction Compete
e. Punch List
f. Back Check

g. Final Completion

D. Activities
1. Identify all Work activities that constitute the critical path.
2. Identify all other major Work activities.
3. Indicate planned mobilization of facilities, equipment and work force.
4. Indicate sequence of any early operations or procurement required.

1.3 CONTRACT SCHEDULE

A. Submission
1. Submit electronic copy of the Contract Schedule, in the form and having general content acceptable to RRCC, with a preliminary draft of the Application for Payment, seven (7) days prior to submitting the first Application for Payment.
2. RRCC will determine acceptability of the Contract Schedule within seven (7) days after its receipt.
3. No Application for Payment will be processed nor shall any progress payment become due until the Contract Schedule is properly submitted and accepted by RRCC.

B. Form
1. The Contract Schedule shall be a CPM, time-scaled network diagram showing continuous flow from left to right. The Contract Schedule shall be computer generated with a software program equal to the Primavera Project Planner. RRCC will determine the acceptability of the Contract Schedule format. The specified format and content shall be provided at the Contractors cost if independent scheduling consultants are required to meet the specified requirements.
2. The Contract Schedule shall be suitable for monitoring progress of the Work, in sufficient detail to demonstrate adequate planning for the Work, and represent a practical plan to complete the Work within the Contract Time.
3. Identify the following milestone events on the Contract Schedule:
a. Notice to Proceed
b. Contract Completion Date
c. Site Demolition complete
d. Underground Construction Complete
e. Finished Site Work Complete.
f. Punch List
g. Back Check
h. Final Completion
4. If the Contract Schedule is shown on more than one (1) sheet, provide a summary sheet.

C. Activities
1. Identify all Work activities in proper sequence for the completion of the Work. Work activities shall include the following:
a. Major Contractor-furnished equipment, materials, building elements, and scheduled activities requiring submittals or RRCC's prior approval.
b. Show dates for the submittal phase. Include a copy of the Submittal Schedule. Dates shall be shown for the procurement, fabrication, delivery, and installation of major equipment, materials, building elements, and scheduled activities designated by RRCC. Activity durations shall be the total of actual days required to perform that activity including consideration of any weather impact on completion of the Work. No activity

other than material delivery or agency review shall be shown with a duration greater than one (1) month.

c. A minimum of fourteen (14) calendar days shall be allotted in the schedule for RRCC to review each submittal.
d. System test dates.
e. Scheduled overtime Work.
f. Dates Contractor requests designated working spaces, storage areas, access, and other facilities to be provided by RRCC.
g. Dates Contractor requests orders and decisions from RRCC on designated items.
h. Dates Contractor requests RRCC-furnished equipment and materials.
i. Dates Contractor requests RRCC-furnished utilities.
j. Connection and relocation of existing utilities.
k. Holidays as indicated in 1.3.
l. Date for all required inspections

2. Identify all Work activities that constitute critical path by separate color and connecting arrows. Indicate dependencies and logic between activities.
3. Critical Work activities are defined as Work activities that, if delayed or extended, will delay the scheduled completion of one or more of the milestones specified in this Section or the scheduled completion of the Work or both. All other Work activities are defined as non-critical Work activities and are considered to have float.
4. The presentation of each Work activity on the Contract Schedule shall include a brief description of the Work activity, the duration of the Work activity in days and a responsibility code identifying the organization or trades performing the Work activity.
5. Float is defined as the time that a non-critical Work activity can be delayed or extended without delaying the scheduled completion of milestones specified in Paragraphs 2.2.3 and 3.2.3 or the scheduled completion of the Work. Neither Contractor nor RRCC shall have an exclusive right to the use of float. Use of float shall only be by mutual written acceptance of Contractor and RRCC. The party requesting the use of float shall document the effect on the updated Contract Schedule. If mutual acceptance of the use of float cannot be reached, the use float shall not be allowed.
6. Delays of any non-critical Work activity shall not be the basis for an extension of Contract Time until the delays consume the float associated with the non-critical Work activity and cause the Work to become critical.

END OF SECTION 01 31 50

PART 1 - GENERAL

1.1 GENERAL

A. The Quality Control Plan
   1. Submit the Quality Control Plan for the Red Rocks Community College System (RRCC) Lakewood Campus approval in accordance with Specification Section 013000.
   2. The Quality Control Plan shall include, as a minimum, the following:
      a. The Schedule of Submittals per Specification Section 013000.
      b. A list of all pre-construction meetings including, the primary work activity covered, related work activities affected and proposed attendees. Conduct pre-construction meetings in accordance with Specification Section 012000 – Project Meetings.
      c. A Quality Control Team Organizational Chart indicating the duties, responsibilities and authority of the team members.
      d. Methods of communication and documentation including inspection/test request forms, Contractor's Deficiency Log with the schedule for repair/replacement and Quality Control Team meetings and job walks. Team spirit, cooperation and good communications are essential for a successful Quality Control Plan.
      e. A list of utility outages required – Utility Outages indicating the work activity, the utility, and the follow on work activity.
      f. An outline of start-up schedules, commissioning requirements, spare parts requirements, punch list procedures, as-built drawings and warranty provisions.
      g. Sections for recording and filing the various pre-construction meeting minutes, inspection & test reports, mock-up and sample approvals, outage requests and Quality Control Team meeting minutes.
   3. After RRCC's review, a meeting will be held with the Contractor to discuss and finalize the Quality Control Plan that will then be revised by the Contractor and resubmitted for record purposes.
   4. The Quality Control Plan is to be updated at least monthly and be reviewed for completeness by RRCC's inspector as a requirement for approval of progress payments.

1.2 RESPONSIBILITY FOR TESTING AND INSPECTION

A. When the Contract Documents require testing, inspections, and approval of portions of the Work by RRCC, refer to General Conditions Article 3.2.3

B. Contractor shall not be relieved of its obligation to perform the Work in accordance with the Contract Documents either by acts or omissions of RRCC in the administration of the Contract, or by tests, inspections, or approvals required or performed by persons or firms other than Contractor."

C. The Contractor shall perform his own testing and inspections on all the work to fulfill both General Conditions Article 3.2.3 above and Article 3.2.4.

D. "3.2.4 Contractor shall be responsible for inspection of all portions of the Work, including those portions already performed under this Contract, to determine that such portions already conform to the requirements of the Contract Documents and are ready to receive subsequent Work."

1.3 DEFINITIONS

A. The term "RRCC's Testing Laboratory" means a testing laboratory retained and paid for by RRCC for the purpose of reviewing material and product reports and performing other services as determined by RRCC.

B. The term "Contractor's Testing Laboratory" means a testing laboratory retained and paid for by the Contractor to perform the testing services required by the Contract Documents. The Contractor's Testing Laboratory shall be an organization other than RRCC's Testing Laboratory and shall be acceptable to RRCC. It may be a commercial testing organization, the testing laboratory of a trade association, the certified laboratory of a supplier, the Contractor's own forces, or other organization. The Contractor's Testing Laboratory shall have performed testing of the type specified for at least five (5) years.

C. Tests, inspections, and approvals of portions of the Work required by the Contract Documents or by Applicable Code Requirements shall be made at appropriate times. Except as otherwise provided, the Contractor shall arrange for such tests, inspections, and approvals with the Contractor's Testing Laboratory. The Contractor shall give RRCC timely notice of when and where tests and inspections are to be made.

D. If such procedures for testing, inspection, or approval reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, the Contractor shall bear all costs made necessary by such failure including those of repeated procedures and compensation for RRCC's services and expenses.

E. If RRCC is to observe tests, inspections, or make approvals required by the Contract Documents, RRCC will do so promptly and, where practicable, at the normal place of testing.

F. Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

1.4 CONTRACTOR'S RESPONSIBILITIES REGARDING RRCC'S TESTING LABORATORY

A. Submit copies of product test reports as specified.

B. Furnish incidental labor and facilities:
   1. To provide RRCC's Testing Laboratory access to Work to be tested.
   2. To obtain and handle samples at the Project site or at the source of the product to be tested.
   3. To facilitate inspections and tests.
   4. For storage and curing of test samples.
   5. Provide notice to RRCC sufficiently in advance of operations to allow for RRCC's Testing Laboratory assignment of personnel and scheduling of tests.

1.5 TESTS AND INSPECTIONS

A. Certain portions of the Work will be tested and/or inspected at various stages. Nothing in any prior acceptance or satisfactory test result shall govern, if at any subsequent time the Work or portion thereof, is found not to conform to the requirements of the Contract Documents.

1.6 REINSPECTIONS

A. A reinspection fee may be assessed for each inspection or reinspection when such portion of work for which inspection is called is not complete or when corrections called for are not made.

B. This section is not to be interpreted as requiring reinspection fees the first time a job is rejected for failure to comply with the requirements of this specification, but as controlling the practice of calling for inspections before the job is ready for such inspection or reinspection.

C. Reinspection fee will be assessed at the current Recharge Rate per hour. A one-hour minimum will be charged for all inspections.

1.7 ADDITIONAL TESTING AND INSPECTION

A. If initial tests or inspections made by RRCC's Testing Laboratory or the Engineer reveal that any portion of the Work does not comply with Contract Documents, or if RRCC determines that any portion of the Work requires additional testing or inspection, additional tests and inspections shall be made as directed.
   1. If such additional tests or inspections establish that such portion of the Work complies with the Contract Documents, all costs of such additional tests or inspections shall be paid by RRCC.
   2. If such additional tests or inspections establish that such portion of the Work fails to comply with the Contract Documents, all costs of such additional tests and inspections, and all other costs resulting from such failure, including compensation for RRCC and RRCC's consultants shall be deducted from the Contract Sum.

1.8 TEST REPORTS

A. RRCC's Testing Laboratory and the Contractor's Testing Laboratory shall electronically distribute all reports as follows:
   1. RRCC
   2. RRCC's Consultants
   3. Contractor

1.9 NOT USED

1.10 CERTIFICATIONS

A. Certification Requirements For High Voltage (Hv) Cable Splicers/Terminators
   1. To be submitted within 15 days of Notice to Proceed.

1.11 CABLE

A. American made cable is acceptable to RRCC. If non-domestic cabling is submitted, notice is hereby given that extensive testing shall be required to insure quality and conformance to the Specifications. All of the testing procedures and results shall be satisfactory to RRCC.

END OF SECTION 01 40 00

PART 1 - GENERAL

1.1 TEMPORARY UTILITIES:

A. OWNER TO PAY FOR ALL UTILITIES USAGE.
1. The following utilities will be paid directly by the Owner; Red Rocks Community College (RRCC) Lakewood Campus and such costs shall be excluded from the Bid Price:
a. Electrical power

B. TEMPORARY SANITARY FACILITIES
1. Contractors may use the restrooms as specifically directed by RRCC provided the rooms remain relatively clean.

C. TEMPORARY FIRE PROTECTION
1. The Contractor will provide adequate fire extinguishers on the premises during the construction period, of the type and size as recommended by the National Fire Protection Association, to control fires resulting from the particular work being performed, ready for instant use.
2. Use and store hazardous or flammable substances as directed and dispose of in a legal manner after removal from the premises.

1.2 TEMPORARY BARRIERS AND ENCLOSURES:

A. The contractor shall provide all temporary barriers, fencing, platforms, safety lights, etc. as required to make excavations and installations safe for pedestrians and motor vehicles. Provide access to all existing facilities as required.

1.3 SECURITY:

A. PROTECTION OF WORK AND PROPERTY
1. The Contractor shall maintain security as required to protect the construction area, staging areas and any trailer areas.
2. The Contractor may use only RRCC designated Work location for storage and assembling of materials areas. Storage and assembling materials will not be permitted in parking lots outside the Project site. The Contractor shall provide all necessary enclosures, locks, etc. for the protection of materials and equipment and shall be responsible for their safety.
3. During construction, protect structural or finish surfaces exposed to view and protect all items of equipment. Turn over the Project entirely free from scratches, abrasions, dents, drips, gouges, stains, watermarks, paint or oil runs, or any other types of damage.
4. Protective methods shall be subject to approval by the RRCC and shall be maintained until each element so protected is ready for the next phase of Work or until final cleaning is directed. Remove all protection without causing damage to the protected element.
5. Wherever such damage does occur, completely remove and replace all damaged Work as directed by RRCC.

1.4 USE OF PUBLIC THOROUGHFARES, ROADS, AND PARKING

A. PARKING AREAS
1. Coordinate with the project manager.

1.5 TEMPORARY CONTROLS:

A. INTERRUPTIONS TO UTILITIES, SERVICES, AND ACCESSES
1. No existing utility services shall be interrupted at any time by the Contractor. Required shutdowns shall be scheduled two weeks prior to actual shutdown. The operation of valves, switches, etc. will be performed and paid for by RRCC. Indicate required utility shut downs on 3-week short-term schedules. A minimum of seventy-two hour notice is required for minor and 2 weeks for major shutdowns. Provide a Method of Procedure for approval by the consultants and Owner
2. Prior to the outage, all possible Work shall have been completed which will minimize the length of the required outage. During the outage, the Work will be proceed with diligence by an adequate number of skilled personnel.
3. The Contractor shall provide for all personnel required to maintain safe conditions during the outage including but not limited to fire watch, safety monitors and/or traffic control.

B. NOISE CONTROL
1. Noise shall be kept to a minimum at all times. Music, radios or boom-boxes shall not be permitted.

C. WORK HOURS
1. The earliest that construction noise can commence is 7:00 am on weekdays and 8:00 am on weekends. This applies at all times of the year. Occasional earlier or later times for starting construction noise that are agreed to by RRCC are allowed on a case by case basis and are not to be construed as establishing a new start time policy.

D. CONSTRUCTION CLEANING
1. Allow no accumulation of waste, or surplus construction materials at the Project Site, except at a specific debris collection area as designated by the Contractor, approved by RRCC, and maintained in an orderly and safe condition at all times. Contractor shall remove daily all debris to the satisfaction of RRCC. Ensure that, because of the work, no debris is deposited or blown on any portion of RRCC's adjoining property or on the public way. If any debris is deposited on RRCC's property or on the public way, remove it immediately.
   a. Dumpsters shall be covered to protect from high winds.
2. During construction, all interior spaces shall be cleaned to a debris/dust free condition at the end of each construction day. Remove temporary protection material, clean finishes free of dust, stains, films and other foreign substances.

E. MISCELLANEOUS CONTROLS
1. OSHA safety requirements are to be enforced at all times.
2. POWER ACTUATED ANCHORS AND BLASTING
   a. Power actuated anchors and fasteners may be used as approved in advance by RRCC Facility Staff and must be "silent" gun type only. Blasting of any description is strictly prohibited on any portion of the Work of this Contract.
3. SMOKING
   a. Smoking will not be permitted in any indoor area or within 20 feet from building entrances.

1.6 REMOVAL OF TEMPORARY CONSTRUCTION:

A. At the completion of the Work, the Contractor shall remove from the site all temporary construction and shall leave the Project site clean and free from debris, materials, or equipment. This includes under the computer access flooring

END OF SECTION 01 50 00

PART 1 - GENERAL

1.1 PREREQUISITE TO FINAL PAYMENT

A. The Contractor shall satisfactorily fulfill all of the following requirements of the Contract before making request for final payment:

B. Complete and receive Colorado Community College System (RRCC) Lowry Campus approval of all phases of the construction.

C. Deliver to RRCC and receive its written approval of: written guarantees, as-built Drawings, mechanics lien guarantee, record of all inspection and tests, and file of all operations and maintenance manuals.

D. Conduct operational tests of all equipment and instruct RRCC's personnel in the use of the equipment.

1.2 PUNCHLIST

A. The Contractor shall give notice to RRCC that the work is substantially complete

B. The RRCC Consultants and RRCC will inspect the work and prepare and give to the Contractor various lists of items to be completed or corrected before establishing completion. Failure to include an item on such list does not alter the responsibility of Contractor to complete all Work in accordance with the Contract Documents.

C. The Contractor shall correlate the various lists into one master punchlist. Subsequently, the Contractor will maintain, update and revise this master list as additional inspections are done.

D. Contractor shall proceed promptly to complete and correct items on the list. Upon completion, the Contractor shall submit a request for inspection by RRCC to determine if work is complete and acceptable.

E. RRCC will make an inspection to determine whether the Work or such designated portion thereof is complete. For all items completed and accepted, the Contractor shall note the data and name of the agency accepting the work. If the inspection discloses any item not included on the punchlist the Contractor shall add these items to the punchlist.

F. The Contractor shall proceed immediately to complete all items found incomplete all items found incomplete and all new items. Contractor shall then submit a request for another inspection by RRCC to determine Final Completion.

G. Another inspection will be made per 2.5. For all items that fail the second inspection, all costs of such additional inspections, and all other costs resulting from such failure, including compensation for RRCC and RRCC's consultants, shall be deducted from the Contract Sum.

1.3 FINAL CLEANUP

A. At the completion of the Work, the Contractor shall remove from the Project site all remaining debris, tools, scaffolding and surplus materials and shall leave all areas "broom clean", unless

specified otherwise elsewhere herein. Finish surfaces shall be left free from foreign matter of any kind whatsoever. Wash and clean all windows in the project area and any affected by construction. Where more specific cleaning and/or finishing procedures are required, they are called out in the separate sections of the Specifications.

1.4 AS-BUILT DRAWINGS

A. The Contractor shall be responsible for the maintenance and completion of as-built Drawings, and the following procedure shall be strictly adhered to:

B. Contractor shall maintain one complete set of Construction Documents as the record set at the jobsite. It shall be kept in good condition until the completion of the Project.

C. As the Work progresses, a complete and accurate notation of all RFI's, ASI's, changes or deviations from the Drawings and Specifications shall be recorded on the as-built indicating all sheet and detail locations where the specific RFI, ASI, etc. impact the design documents. Such indications shall be neatly made and kept current. Where exact locations are critical, such as in the case of buried piping or conduit, such locations - both horizontal and vertical - shall be dimensioned.

D. The Contractor shall not request that inspection be made of any Work which has been installed in locations contrary to the Drawings until such changes or deviations are properly noted on the record set of documents by the Contractor.

E. At the completion of the Project, and before the request for final payment is made and RRCC's approval obtained, the record set shall be completed by the Contractor, and submitted to the Engineer.

F. All as-built indications shall be made on the record set legibly.

1.5 OPERATION AND MAINTENANCE MANUALS & INSTRUCTIONS:

A. Assemble and furnish a minimum of 2 complete sets of all data, except those noted to be mounted in frames, in three-ring loose-leaf binders, complete with index, with indexed dividers permanently attached and exterior labels on cover and back of binders. Submit one electronic copy of the set.

B. Data Required:
   1. Manufacturers' Manuals: Provide complete installation, operation, maintenance, and service manuals and printed instructions and parts lists for all materials and equipment, where such printed matter is regularly available from the manufacturer. This includes but is not limited to such service manuals as may be sold by the manufacturer covering the operation and maintenance of items and complete replacement parts lists sufficiently detailed for parts replacement ordering to manufacturer. Bound publications need not be assembled in binders.
   2. Equipment Nameplate Data: A typewritten list of all mechanical and electrical equipment showing all equipment nameplate data exactly. Identify equipment by means of names, symbols, and numbers used in the Contract Documents.
   3. System Operating Instructions: Typewritten instructions covering operation of the entire Include schematic flow and control diagrams as appropriate and show, locate, or list system valves, control-elements, and equipment components using identification symbols and numbers. List rooms, area of equipment served, and show proper settings for valves, controls, and switches.

4. System Maintenance Instructions: Typewritten instructions covering routine maintenance of systems. List each item of equipment requiring inspection, lubrication, or service and briefly describe such maintenance, including types of lubricants and frequency of service. It is not intended that these instructions duplicate manufacturers' detailed instructions. Give name, address, and phone number of nearest firm authorized or qualified to service equipment or provide parts.
5. Warranty, Bonds, and Service Contracts: Provide a copy of each warranty, bond, and service contract issued. These should be accompanied by a sheet that outlines procedures to take in the event of failure and the circumstances that might affect the validity of warranties or bonds.

C. INSTRUCTIONS AND TRAINING
1. Make all arrangements and notices for operation and instruction periods through RRCC.
2. This instruction period is in addition and subsequent to any period of operation, testing and adjustment called for elsewhere in these Specifications.

1.6 GUARANTEE, BONDS AND MAINTENANCE CONTRACTS

A. Refer to the General Conditions for the minimum requirements and the specifications for any additional requirements

B. Guarantees from Subcontractors shall not limit the Contractor's warranties and guarantees to RRCC. Whenever possible, the Contractor shall cause warranties of Subcontractors to be made to the Contractor, the Contractor shall assign such warranties to RRCC prior to final payment.

C. Submit the Guarantees in the format contained in this Section, typed on the Subcontractor's letterhead, when required by a Specification section.

D. Submit Guarantees, Bonds and Maintenance Contracts executed by each of the respective manufacturers, suppliers and subcontractors in duplicate packages. Bind packets together and provide cover sheet and table of contents to identify contents. Size shall be standard 8 1/2" x 11". Provide PDF electronic files.

E. All submittals shall be transferred to RRCC within ten (10) days after date of Substantial Completion, prior to request for final payment. For items of Work where Final Completion is delayed materially beyond the date of Substantial Completion, provide updated submittal within ten (10) days after Final Completion, listing the date of completion as the start of the "Guarantee to Repair Period".

F. Submit all guarantees, bonds, and service and maintenance contracts specified in the individual sections.

1.7 GUARANTEE TO REPAIR PERIOD

A. Upon acceptance of the project or a portion thereof from the Contractor, the "Guarantee to Repair Period" of one year or more will begin as described in Article 9 of the General Conditions. Official notice will be given to RRCC Facilities Management by RRCC Facilities Design & Construction. At this point Facilities Management will act as the owner. Facilities Management will become responsible for receiving notices of Defective Work from building occupants and securing Contractor compliance where applicable. Facilities Management shall have prime responsibility for follow-up & monitoring of Contractor activities. (Refer to Article 12 of General Conditions).

B. If the Contractor must "Shut-down" the fire and security alarms in an occupied building, then the Contractor shall be responsible to provide a fire and security watch until the system is reconnected, at no additional cost to RRCC.

END OF SECTION 01 70 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All electrical work installed under Division 23 shall be in compliance with Division 26.

1.2 DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic in character indicating design concept and do not indicate every required piping offset, valve, fitting, etc.

B. All drawings relating to this structure, together with these specifications, shall be considered in bidding and construction. The drawings and specifications are complementary, and what is called for in either of these shall be as binding as though called for by both. Should any conflict or omissions arise between the drawings and specifications, such conflict shall be brought to the attention of the Architect/ Engineer for resolution.

C. Unless otherwise indicated, all equipment and performance data listed is for job site conditions (elevation 5,500 feet).

D. Drawings are not to be scaled.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic
   2. PE: Polyethylene plastic
   3. PVC: Polyvinyl chloride plastic

G. The following are industry abbreviations for rubber materials:
   1. EPDM – Ethylene propylene diene terpolymer rubber

2. NBR – Acrylonitrile-butadiene rubber

1.4 SUBMITTALS – GENERAL REQUIREMENTS FOR ALL DIV 23 SECTIONS

A. Submittal Data and Shop Drawings:
   1. Refer to Division 01, for general submittal requirements.
   2. Contractor agrees that Shop Drawings and Submittals processed by the Engineer are not Change Orders; that the purpose of shop drawings and submittals by the Contractor is to inform the Engineer which equipment and materials he intends to furnish and install.
   3. Submittals and shop drawings are to be edited to show specific data and all options for the products and systems that the Contractor intends to provide.
   4. Submittals and shop drawings are to be identified with numbers or letters identical to those listed on the drawings and specifications.
   5. All submittals shall be transmitted electronically in .pdf format. Engineer will review electronic files and return as .pdf files with comments as required. Hardcopies will not be processed unless special arrangements are made prior to submittal.
   6. Approved Manufacturers and Substitutions:
      a. Equipment and materials manufactured by any one of the manufacturers listed in this specification or on the drawings shall be acceptable if the equipment and material is equivalent in performance, capacity, weight, utility requirements, and configuration to the Basis of Design identified on the drawings or these specifications.
      b. Substitution Requests prior to bid: Refer to Division 01. No prior approvals will be given by the Engineer unless specifically mentioned in these specifications.
      c. Substitution Requests after Execution of Contract: If Contractor wishes to furnish or use a substitute item of material and equipment, he must submit a change order request to the Engineer. The request for change order shall itemize each of the proposed substitutions identified by applicable specification section, paragraph number, and drawing number. A price change (increase or decrease) shall be listed for each item along with complete data showing performance over entire range, physical dimensions, electrical characteristics, material construction, operating weight, and other applicable data. Justification of substitution must be more than just cost justification. The Engineer will review the change order request for equality, suitability, and reasonableness of price differential. A single substitution change order listing the approved items will be issued with the net cost of the change order being the sum of the approved item costs. No subsequent substitution change orders will be considered. The Engineer's decision will be final.
      d. It shall be the responsibility of the Contractor to assure that the substitute material and equipment fits into the space provided, system connections and building penetrations are compatible with the contract document layout, utility requirements are equal, venting and intake openings are similar, and weight is equal or less than the basis of design. The Contractor shall pay all extra costs incurred by other trades for any and all changes necessitated by these substitutions. No time extension will be allowed due to substitution on equipment.
   7. Organization: Submittals shall be organized by spec section. All product of one section shall be submitted together, unless identified in the submittal schedule or otherwise approved prior to submittal. Where partial section submittals are allowed, each portion shall have a unique designation.
   8. Submittals Schedule: Comply with Division 01 construction progress documentation and submittal requirements and the additional submittal requirements specified below. Unless otherwise specified in Division 01, comply with the submittal periods specified below. Engineer will schedule submittal reviews based on the submittal schedule. Failure to submit the schedule

may result in inability to review submittals within the periods stated in the submittal schedule. These delays shall not be cause for extension of Contact completion date.

a. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
b. Submit schedule within 14 days of commencement of work. Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
c. Allow 15 days for review of each resubmittal.
d. Arrange the following information in a tabular format:
    1) Scheduled date for first submittal.
    2) Specification Section number and title.
    3) Submittal category (action or informational).
    4) Name of subcontractor.
    5) Description of the Work covered.
    6) Scheduled date for Architect's final release of reviewed submittal.

9. Deviations: Equipment and material submittals of approved manufacturers, including Basis of Design manufacturer, shall be provided with a written itemization of exceptions to the specification and deviations from the Basis of Design for all features, design, configuration, physical dimension, performance, and operation of the submitted product. Those elements not identified and itemized as exceptions in the submittal shall not be reviewed by the Engineer and shall be provided as specified.
10. Non-Responsive Submittals: Submittals are intended to be reviewed in an initial submittal with comments corrected and submitted in a resubmittal. Non-responsiveness to the initial submittal comments in the resubmittal will result in return of the documents for correction and additional resubmittals. Any time charged by the Engineer in review of additional resubmittals due to non-responsiveness shall be deducted from the Contractor's billings

B. Close-Out Submittals:
1. Operating and Maintenance (O&M) Manual:
    a. Provide O&M manuals in accordance with Division 01 and the following.
    b. Format shall be as agreed to between Contractor and Owner. Follow Owner’s standards where available.
    c. Contractor shall prepare an Operating & Maintenance (O&M) manual that shall cover all systems and equipment installed under Division 23. Incorporate the standard technical literature into system-specific formats for this facility as designed and actually installed. The resulting manual shall also serve as the training manual and shall be specific, concise, to the point, and tailored specifically for this facility.
    d. Provide manufacturers’ literature for the actual products and systems provided for this project. The manual shall be adequately indexed and contain the following information:
        1) Contractors' names, addresses, and telephone numbers
        2) Alphabetical list of all system components with the name and address and 24-hour phone number of the company responsible for servicing each item during the first year of operation
        3) Guarantees and warranties of all equipment whenever applicable.

4) All manufacturers' data that is applicable to the installed equipment, with appropriate highlighting, such as the following:
   a) Shop drawings (latest copy)
   b) Installation and Operating instructions
   c) Lubrication instructions
   d) Wiring diagrams
5) A simplified description of the operation of all systems including the function of each piece of equipment within each system, including both normal and emergency operations. These descriptions shall be supported with a schematic flow diagram when applicable.

2. Record Drawings:
   a. Comply with record drawing requirements in Division 01 and the following.
   b. Maintain a Field Record Set of documents, showing all approved changes as well as field coordinated deviations from the Contract Documents.
   c. At the time of Project Close-out, Contractor may request an updated set of Contract Documents in .pdf format from the Engineer, if available. All RFIs, Change Orders, and other directives, if not recorded on the updated Contract Drawings and Amendments, shall be red-lined on the Record Drawings. Record Drawings simply tabulating the amendments onto the drawings shall be returned for clarification of installed conditions and red-line mark-up. Deviations in dimensions, size, layout ,or location between Contract Documents and actual installed conditions shall be red-lined on the .pdf record documents.

1.5 SUBMITTAL – FOR WORK OF THIS SECTION

A. Product Data: Provide for all products of this specification.
   1. Identification: Submit schedule of identification nomenclature for each system and equipment.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code – Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.7 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 plastic pipes protected from direct sunlight. Support piping to prevent sagging and bending.

1.8 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Identification:
   1. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   2. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Coordinate with all trades to maintain clearances to access panels, equipment, control and electrical panels. Intrusions into access space shall be brought to the attention of other trades. Notify Engineer of conflicts shown on drawings prior to installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles throughout Divisions 23 where subparagraph titles introduce lists of manufacturers, the following requirements apply for product selection:
   1. Subject to compliance with requirements, provide products by one of the manufacturers listed.
   2. Manufacturers other than the ones listed may be proposed under the provisions for Substitutions in this Part 1 and the provisions of Division 01.

2.2 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. PSI/Thunderline/Link-Seal
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Zinc dichloromate or glass reinforced plastic. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.610 mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.4 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
   1. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass.
      a. Finish: Polished chrome-plated.
   2. One-Piece, Cast-Brass Type: With set screw.
      a. Finish: Polished chrome plated.
   3. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
      a. Finish: Polished chrome plated.
   4. One-Piece, Floor-Plate Type: Cast-iron floor plate.
   5. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.5 IDENTIFICATION

A. Pipe Labels:
   1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
   2. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
   3. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
   4. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
   5. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
      a. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
      b. Lettering Size: At least 1-1/2 inches high.

B. Valve Tags:
   1. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
      a. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
      b. Fasteners: Brass wire-link or beaded chain; or S-hook.
   2. Valve Schedules: For each piping system, on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
      a. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Divisions 01 for general demolition requirements and procedures.

B. Disconnect and remove mechanical systems, equipment, and components indicated to be removed.
   1. Piping To Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying Mechanical piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: Split, cast-brass type with spring clips.
      d. Bare Piping at Wall, Floor, and Ceiling Penetrations in Finished Spaces, Unfinished Service Spaces, and Equipment Rooms: One-piece or split, cast-brass type with polished chrome-plated finish.

L. Sleeves are not required for core-drilled holes except for vertical penetrations exposed to weather.

M. Install sleeves for pipes passing through concrete floors.
   1. Cut sleeves to 6” above surfaces exposed to weather.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials, seismic installation may require additional clearance:
   Steel Pipe Sleeves: For pipes smaller than NPS 6 Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Verify final equipment locations for roughing-in.

O. Refer to equipment specifications in other sections of these specifications for roughing-in requirements.

3.3 IDENTIFICATION COMMON REQUIREMENTS

A. Preparation: Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Pipe Label Installation:
   1. Piping Color-Coding: Painting of gas piping shall be yellow per ANSI A13.1.
   2. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      a. Near each valve and control device.
      b. Near each valve and control device.
      c. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      d. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
      e. At access doors, manholes, and similar access points that permit view of concealed piping.
      f. Near major equipment items and other points of origination and termination.
      g. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

C. Valve Tag Installation: Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
   1. Valve Tag Application: Tag all valves with indicating service and number. Tags 1-1/2 inches in diameter, brass, with 1/4-inch-high letters. Securely fasten with chain and hook. Match service abbreviations given on drawings.

3.4 CLEANING

A. Cleaning and Flushing:
   1. Extreme care shall be exercised during construction to prevent all dirt and other foreign matter from entering the pipe or other parts of the system. Pipe stored on the project shall have the open ends capped, and equipment shall have all openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and all dirt removed.

2. After the system (or portion thereof) has been leak tested, thoroughly flush with clean water. During the clean water flush, all valves shall be full open, the flow rate for flush shall be at least 4 ft./sec., and the total flow shall equal at least five times the total piping system volume. Flushing shall continue until water runs clear.
3. After clear water flushing is complete, a chemical flushing solution, shall be utilized to remove oil, grease, piping compounds, etc. After the system is filled with this solution, the system shall be brought up to temperature and allowed to circulate for at least eight hours. The system shall then be drained completely and reflushed with fresh water.
4. After the system has been completely cleaned as specified herein, it shall be dried completely with compressed air blow through.
5. The Owner's representative shall be given notice of this cleaning operation. If the Owner's representative deems it necessary, the cleaning operation shall be repeated.
6. Clean exterior of piping prior to application of coatings.

B. Cleanup:
1. Clean under, in and around equipment.
2. Clean exposed surfaces of piping and equipment.
3. Clean equipment cabinets and enclosures.

END OF SECTION 23 05 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Contractor shall design and select supports and upper attachments for all suspended mechanical systems. Contractor shall design and select trapeze pipe hangers and equipment supports using performance requirements and design criteria indicated. Trapeze hangars and equipment supports may be designed using recognized, catalogued, pre-engineered methods. Follow all means and methods identified on the support system product data. Comply with all requirements of the structural drawings and specifications.

B. Hangers and supports for equipment and distribution systems shall withstand the effects of gravity loads and stresses within limits and under conditions indicated.
   1. Supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: Provide sufficient information to show the hangars and supports are suitable for the intended purpose, including design loads and actual loads. Provide submittal data for:
   1. Mechanical systems, pipe and equipment hangers and supports
   2. Devices for attachment to the structure
   3. Recognized, catalogued, pre-engineered hangar and support systems.
      a. Identify typical assemblies used for this project

B. Shop Drawings:
   1. Provide fabrication and installation details, and calculations for the following systems:
      a. Pipe and equipment supports not addressed by recognized, catalogued, pre-engineered methods.
      b. Architect/Engineer Responsibilities: The Architect/Engineer shall review delegated design submittals for compliance with specification requirements. Design and analysis performed for the delegated design submittal will not be reviewed.

C. Welding Certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code.

PART 2 - PRODUCTS

2.1 PIPE HANGERS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
1. Anvil International
2. B-Line Systems, Inc.; a division of Cooper Industries
3. nVent Caddy
4. PHD Manufacturing, Inc.
5. Tolco/Eaton

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

2.2 METAL FRAMING SYSTEMS

A. Description: Shop- or field-fabricated, support assembly made of steel channels, accessories, fittings, and other components for supporting equipment, duct, or multiple parallel pipes. Manufacturer’s data shall include selection and load support information for standard, pre-engineered installations.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channels: Continuous slotted carbon-steel, channel with inturned lips.
3. Channel Width: Selected for applicable load criteria.
4. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel stainless steel
6. Paint Coating for indoor, standard applications: Rust inhibiting thermoset acrylic enamel paint applied by electrodeposition after cleaning and phosphating, and thoroughly baked. Manufacturer’s standard color
7. Metallic Coating for outdoor or mild corrosion resistance: hot-dipped galvanized per ASTM A123 or A153. Zinc coated after all manufacturing operations are complete Zinc coating thickness shall be G65.

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries
2. nVent Caddy
3. PHD Manufacturing, Inc
4. Power-Strut Div.; Tyco International, Ltd.
5. Tolco/Eaton
6. Unistrut

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners are not allowed.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC
      e. Powers Fasteners
      f. PHD Manufacturing, Inc.

2.4 PRE-ENGINEERED SUPPORTS

A. General: Pre-engineered, manufactured assemblies made of corrosion-resistant components to support piping, where it is acceptable to rest by gravity on the surface ballast. Provide additional lateral support as required for wind resistance.
   1. Contractor shall select product appropriate to the type of items being supported.

B. Manufacturers:
   1. Erico/Michigan Hanger Co.
   2. Miro Industries
   3. Dura-Blok
   4. Cooper B-Line

C. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe.

D. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller.

E. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support.
   1. Bases: Plastic.
   2. Vertical Members: Two or more cadmium-plated-steel or stainless steel, continuous-thread rods.
   3. Horizontal Member: Cadmium-plated-steel or stainless steel rod with plastic or stainless steel, roller-type pipe support.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
   1. Properties: Non-staining, non-corrosive, and non-gaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-58 and MSS SP-89 for the installation of hangers, supports, clamps, and attachments to properly support piping from building structure.

B. Hanger Spacing:
1. Hanger spacing and sizing shall per MSS SP-58 or applicable codes, whichever is more stringent.
2. Hanger spacing must be reduced to compensate for any valves and/or fittings installed in the pipe run.
3. Alternate span calculations may be used with a maximum deflection of 0.1 inch between hangers.
4. Hanger spacing must be reduced if thermal hanger shield insert cannot support full span.

C. Hanger and Support Installation:
1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
2. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31 is not exceeded.
4. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install any of the following types:
   a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   b. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   c. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   d. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 3.
   e. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 3.
   f. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

g. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
h. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
i. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
j. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

5. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
a. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).

3.3 INSTALLATION OF PRE-FABRICATED SUPPORTS

A. Install as per the manufacturer instructions, project specific submittals, and as indicated below.
1. Install an additional sheet of roofing material, a support pad, or traffic pad beneath the base of each stand.
2. Place the supports:
a. Center each stand beneath the component so supports are aligned.
3. Adjustable Supports: Adjust height of each support to achieve proper height and level before installing supported item.
a. Level hangers, rollers or struts before installing component.
b. Make final height adjustments to provide even distribution of load on all supports.

3.4 PAINTING

A. Touching Up: 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.

B. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.3.1.

END OF SECTION 23 05 29

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

A. Product Data: Submit product data for the following items:
   1. Valves, manual and automatic
   2. Pressure-reducing stations

B. Close-Out Submittals: Submit operating and maintenance instructions on the following items.
   1. Valves, manual and automatic
   2. Pressure-reducing stations

1.3 QUALITY ASSURANCE

A. Certifications: All fittings, valves, PRVs, etc., shall be UL recognized or AGA/API certified for fuel gas service.

1.4 SEQUENCING/SCHEDULING

A. Coordinate all work with all other trades and utility companies for elimination of interference; utilization of combined hanger support systems; timely routing and installation of systems; verifications of existing utilities, locations, depths, and connection regulations; and proper valving and junction structures or fittings. Location and furnishing of pressure-reducing stations and/or meters as applicable and appropriate.

1.5 GAS SERVICE

A. Existing gas service is to be utilized to serve the new equipment. Notify the local gas utility as to new connected loads.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Interior Exposed and Concealed, with Operating Pressures from 15-inch w.c. to 5 psig:
   1. Size NPS 3/4 through NPS 2:
      a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
      b. Wrought Steel Fittings: ASTM A 234, seamless or welded; ASME B 16.9, butt welding type; and ASME B16.11, socket-welding type.
      c. Unions: ASME B16.39, Class 150, malleable-iron, with brass to iron seat, ground joint.
   2. Size NPS 2-1/2 and Over:
      a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.

b. Wrought Steel Fittings: ASTM A 234, seamless or welded; ASME B 16.9, butt welding type.
c. 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:
1) Material Group: 1.1.
2) End Connections: Threaded or butt welding to match pipe.
3) Lapped Face: Not permitted underground.
4) Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel gas.
5) Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.

B. Exterior Aboveground with Operating Pressures to 5 psig:
1. Size NPS 1/2 through NPS 2:
a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
b. Malleable Iron Fittings: ASME B16.3, Classes 150, standard pattern.
c. Unions: ASME B16.39, Class 150, malleable-iron, with brass to iron seat, ground joint.
d. Joint Seal: Teflon.
2. Size NPS 2-1/2and Over:
a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
b. Wrought Steel Fittings: ASTM A 234, seamless or welded; ASME B 16.9, butt welding type.
c. 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:
1) Material Group: 1.1.
2) End Connections: Threaded or butt welding to match pipe.
3) Lapped Face: Not permitted underground.
4) Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel gas.
5) Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.

C. For interior piping with Operating Pressures above 5 psig:
1. Size NPS 3/4 through NPS 2:
a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
b. Wrought Steel Fittings: ASTM A 234, seamless or welded; ASME B 16.9, butt welding type; and ASME B16.11, socket-welding type.
2. Size NPS 2-1/2 and Over:
a. Pipe: Schedule 40, ASTM A 53, Grade B black steel, Type E or ASTM A 106, Grade B carbon steel, Type S.
b. Wrought Steel Fittings: ASTM A 234, seamless or welded; ASME B 16.9, butt welding type.
c. 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:
1) Material Group: 1.1.
2) End Connections: Threaded or butt welding to match pipe.

3) Lapped Face: Not permitted underground.
4) Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel gas.
5) Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.

3. All joints are welded or brazed.
4. Piping joints are flanged and pipe to flange connections are are made by welding or brazing.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
1. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
2. Corrugated stainless steel tubing with polymer coating.
3. Operating-Pressure Rating: 0.5 psig.
4. End Fittings: Zinc-coated steel.
5. Threaded Ends: Comply with ASME B1.20.1.
6. Maximum Length: 72 inches.

2.3 GAS VALVES

A. Manual Shutoff Valves:
1. Steel Pipe: Two –piece ball type forged brass body, 175 psig WOG, UL, AGA, or API recognized for fuel gas service. Threaded ends for NPS 3or smaller. Apollo 80-100-1 or Nibco 585.
2. Lubricated Plug Flanged ends for NPS 4and larger. SMG Key Port Fig. 425, Mueller “Luboseal” gas meter valve, Rockwell lubricated plug cocks, Resun Fig. D-125 through NPS 4, Fig. D-126 for NPS 5and larger, Walworth Series 1700 (screwed) and 1700 F (flanged).
3. PE Pipe: Plug type through NPS 1-1/4, ball type for NPS 2to NPS 4, ASTM D-2513, 80 psig minimum allowable pressure rating. Material and SDR to be same as PE pipe material. Rockwell “Polyvalve” or approved equal.

2.4 GAS PRESSURE REGULATORS (COMMERCIAL)

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 2and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
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. Actaris
b. Fisher Control Valves and Regulators; Division of Emerson Process Management
c. Maxitrol Company
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150% of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
12. Maximum Line Regulator Inlet Pressure: 10 psig

2.5 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

3.1 INSTALLATION

A. General: Provide all fuel gas piping from source to each connection point of all gas-fired equipment items. Provide a drip leg, gas shutoff valve, and union for each equipment item. Make final connections in compliance with equipment manufacturer's instructions. Flexible connections will not be allowed, except where explicitly specified or shown.

B. Piping:
   1. General:
      a. Install fuel gas distribution piping in accordance with jurisdiction codes, local utility company requirements, and NFPA 54.
      b. Install a "Tee" fitting with a drip leg at the bottom of pipe risers or drops, fitted with full size 6-inch-long nipples capped at the bottom.
      c. Use dielectric unions where dissimilar metals are joined together.
      d. Use Teflon joint seal on metal gas piping threads.
      e. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping or equipment connections are completed.
      f. Install gas shutoff valve and strainer ahead of gas pressure regulators.
      g. Gas pressure regulators shall be accessible and vented to the outside of the building.
      h. Paint exterior pipe per Section 23 05 00.
      i. Refer to Division 23 Section 23 05 29, "Hangers and Supports for Mechanical Systems," for additional installation requirements.
   2. Prohibited Locations:
      a. Gas piping shall not be installed in or on the ground under any building or structure, and exposed gas piping shall be kept at least 6 inches above grade or structure. The term “building or structure” shall include structures such as porches and steps (whether

covered or uncovered), breezeways, roofed porte-cocheres, roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances.

3. Protective Coating: When metallic piping and fittings will be in contact with material or atmosphere exerting a corrosive action or installed below grade, all pipe and fittings shall be factory or field wrapped with polyethylene tape having the following properties:
   a. Overall thickness: 20 mil (50% overlap)
   b. Synthetic adhesive
   c. Water vapor transmission rate: 0.10 gallon per 100 square inches, or less
   d. Water Absorption: 0.02% or less
   e. All fittings shall be double-wrapped 40 mil

C. Gas Valves:
   1. Provide at supply runout connection for each gas-fired equipment item, at building entry, and on risers and branches where indicated.
   2. Locate gas valves where easily accessible and where they will be protected from possible damage. Install per manufacturer's recommendations.
   3. Do not install gas valves in plenums or concealed locations. Use a valve ceiling enclosure when shutoff valves are to be located in accessible ceilings.

D. Unions, Flanges, and Strainers:
   1. Install unions in pipes NPS 2and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
   2. Install flanges on valves, apparatus, and equipment having NPS 2-1/2and larger connections.
   3. Install strainers on the supply side of each control valve, pressure-reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

E. Electrical Bonding and Grounding:
   1. Install aboveground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 of the National Electrical Code.
   2. Do not use gas piping as a grounding electrode for other systems.
   3. Conform to NFPA 70 - "National Electrical Code" for wiring and electrical connections to electrically operated control devices.

F. Equipment Gas Pressure Regulators:
   1. Install regulators per manufacturer's recommendations and comply with utility requirements. Pipe atmospheric vents full size to outdoors. Install gas shutoff valve upstream of each pressure-regulating valve.
      a. Install NPS 3/8plugged gauge tap both upstream and downstream (10 pipe diameters straight pipe where possible) of each regulator.
   2. Do not install regulators in concealed locations.

3.2 FIELD QUALITY CONTROL

A. Testing:
   1. All piping specified in this section shall be tested.
      a. All joints, fittings, and piping accessory items shall be exposed to view during tests whether pipe is above or below ground. "Closed-in" or "buried" piping shall be re-exposed during testing.
      b. Proper restraining of piping and test plugs shall be accomplished prior to test.

c. Test connections can be anywhere in the system. Use certified 6-inch gauge with 1 psi division.
d. In the event that tests fail, use a standard soap and brush inspection using "Trouble Bubble" liquid high density soap as manufactured by Jersey Meter Co., Patterson N.J. Formula ST-1. After source of failure is discovered, correct and retest system. Repeat procedure until system successfully sustains required testing.

2. Testing shall be of the complete piping system, before covering, or of individually separable larger portions of the system. Only the last connection to the appliance may be tested under operating conditions. This connection will be tested with soap and brush under line pressures. This connection must remain exposed.
3. Test Procedures: As required by Administrative Authority and NFPA 54.
   a. 15-inch w.c. to 5 psig Systems: 60 psig air pressure for a period of 2 hours with no drop in gauge pressure.
   b. 14-inch w.c. or Less: 10 psig air pressure for a period of 1 hour with no drop in gauge pressure.
4. Retesting: Retest any piping failing initial tests following correction of defective work. Requirements of initial tests shall apply.
5. Verification of tests shall be made by the plumbing inspector or Owner's Representative.
   a. Testing contractor shall arrange a time and date with the plumbing inspector or Owner's Representative so arrangements can be made for witnessing tests.
   b. Record pressure and ambient temperature at start and end of test. Submit written results of tests to the Owner's Representative.

END OF SECTION 23 11 23

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. The minimum requirements for this work are according to the currently adopted edition of the building codes listed on the plans, and local authorities having jurisdiction.

1.3 SUBMITTALS – GENERAL REQUIREMENTS FOR ALL DIV 26 SECTIONS

A. Submittal Data and Shop Drawings:
   1. Refer to Division 01, for general submittal requirements.
   2. Contractor agrees that Shop Drawings and Submittals processed by the Engineer are not Change Orders; that the purpose of shop drawings and submittals by the Contractor is to inform the Engineer which equipment and materials they intend to furnish and install.
   3. Submittals and shop drawings are to be edited to show specific data and all options for the products and systems that the Contractor intends to provide.
   4. Submittals and shop drawings are to be identified with numbers or letters identical to those listed on the drawings and specifications.
   5. All submittals shall be transmitted electronically in .pdf format. Engineer will review electronic files and return as .pdf files with comments as required. Hardcopies will not be processed unless special arrangements are made prior to submittal.
   6. Approved Manufacturers and Substitutions:
      a. Equipment and material manufactured by any one of the manufacturers listed in this specification or on the drawings will be acceptable if the equipment and material is equivalent in performance, capacity, weight, utility requirements, and configuration to the Basis of Design identified on the drawings or these specifications.
      b. Substitution Requests Prior to Bid: Refer to Division 01. No prior approvals will be given by the Engineer unless specifically mentioned in these specifications.
      c. Substitution Requests after Execution of Contract: If Contractor wishes to furnish or use a substitute item of material or equipment, they must submit a Change Order Request to the Engineer. The Change Order Request shall itemize each of the proposed substitutions identified by applicable specification section, paragraph number, and drawing number. A price change (increase or decrease) shall be listed for each item along with complete data showing performance over entire range, physical dimensions, electrical characteristics, material construction, operating weight, and other applicable data. Justification of substitution must be more than just cost justification. Engineer will review the Change Order Request for equality, suitability, and reasonableness of price differential. A single substitution change order listing the approved items will be issued with the net cost of the Change Order being the sum of the approved item costs. No subsequent substitution Change Orders will be considered. The Engineer's decision will be final.
      d. It shall be the responsibility of the Contractor to assure that the substitute material and equipment fits into the space provided, system connections and building penetrations are compatible with the contract document layout, utility requirements are equal, venting and intake openings are similar, and weight is equal or less than the basis of design.

e. The Contractor shall pay all extra costs incurred by other trades for any and all changes necessitated by these substitutions.
f. No time extension will be allowed due to substitution on equipment.

7. Organization: Submittals shall be organized by spec section. All products of one section shall be submitted together, unless identified in the submittal schedule or otherwise approved prior to submittal. Where partial section submittals are allowed, each portion shall have a unique designation.
8. Submittals Schedule: Comply with Division 01 construction progress documentation and submittal requirements and the additional submittal requirements specified below. Unless otherwise specified in Division 01, comply with the submittal periods specified below. Engineer will schedule submittal reviews based upon submittal schedule. Failure to submit schedule may result in inability to review submittals within the periods stated in the submittal schedule. These delays shall not be cause for extension of Contact completion date.
   a. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
   b. Submit schedule within 14 days of commencement of work. Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
   c. Allow 15 days for review of each resubmittal.
   d. Arrange the following information in a tabular format:
      1) Scheduled date for first submittal
      2) Specification Section number and title
      3) Submittal category (action or informational)
      4) Name of subcontractor
      5) Description of the Work covered
      6) Scheduled date for Architect or Engineer’s final release of reviewed submittal
9. Deviations: Equipment and material submittals of approved manufacturers, including Basis of Design manufacturer, shall be provided with a written itemization of exceptions to the specification and deviations from the Basis of Design for all features, design, configuration, physical dimension, performance, and operation of the submitted product. Those elements not identified and itemized as exceptions in the submittal will not be reviewed by the Engineer and shall be provided as specified.
10. Non-Responsive Submittals: Submittals are intended to be reviewed in an initial submittal with comments corrected and submitted in a resubmittal. Non-responsiveness to the initial submittal comments in the resubmittal will result in return of the documents for correction and additional resubmittals. Any time charged by the Engineer in review of additional resubmittals due to non-responsiveness will be deducted from the Contractor's billings.

B. Close-out Submittals:
1. Operating and Maintenance (O&M) Manual:
   a. Provide O&M manuals in accordance with Division 01 and the following
   b. Format shall be as agreed to between Contractor and Owner. Follow Owner’s standards where available.
   c. Contractor shall prepare an O&M manual that encompasses all systems and equipment installed under Division 26. Incorporate the standard technical literature into system-specific formats for this facility as designed and actually installed. The resulting manual

shall also serve as the training manual and shall be specific, concise, to the point, and tailored specifically for this facility.

d. Provide manufacturers' literature for the actual products and systems provided for this project. The manual shall be adequately indexed and contain the following information:
   1) Contractors' names, addresses, and telephone numbers
   2) Alphabetical list of all system components with the name and address and 24-hour phone number of the company responsible for servicing each item during the first year of operation
   3) Guarantees and warranties of all equipment whenever applicable
   4) All manufacturers' data that is applicable to the installed equipment, with appropriate highlighting, such as the following:
      a) Shop drawings (latest copy)
      b) Installation and Operating instructions
      c) Maintenance instructions
      d) Wiring diagrams
   5) Manufacturers' technical literature of installed equipment shall be highlighted indicating the configuration of the installed equipment. Options, and selections presented in the technical literature that are not part of the installed configuration shall be blocked out, or redacted in an unambiguous manner.
   6) A simplified description of the operation of all systems including the function of each piece of equipment within each system, including both normal and emergency operations. These descriptions shall be supported with a schematic diagram when applicable.

2. Record Drawings:
   a. Comply with record drawing requirements in Division 01 and the following.
   b. Maintain a Field Record Set of documents, showing all approved changes as well as field coordinated deviations from the Contract Documents.
   c. At the time of Project Close-out, Contractor may request from the Engineer an updated set of Contract Documents in .pdf format, if available. All ASIs, RFIs, Change Orders, and other directives, if not recorded on the updated Contract Drawings and Amendments, shall be red-lined on the record drawings. Record Drawings simply tabulating the amendments onto the drawings will be returned for clarification of installed conditions and red-line mark-up. Deviations in dimensions, size, layout or location between Contract Documents and actual installed conditions shall be red-lined on the .pdf record documents.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a nationally recognized testing agency acceptable to authorities having jurisdiction, and marked for the intended use.

B. All equipment and materials shall be new and unused and shall be in conformance with the current applicable industry standards. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of Architect or Engineer and at no additional cost to the Owner.

1.5 SEQUENCING

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installation.

B. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

C. Sequence, coordinate, and integrate the installation of electrical materials and equipment for efficient flow of the Work. Coordinate the installation of large equipment requiring positioning before closing in the building.

D. Coordinate electrical service connections to components furnished by utility companies.
   1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components, prior to commencement of any work.
   2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 08 "Openings."

F. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, provide all work required to expose and restore the concealed work in addition to all required modifications.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES FOR ELECTRICAL COMPONENTS

A. Provide hangers and supports to support raceways, fixtures, cabinets, boxes, etc. as manufactured by B-Line, Unistrut, Binkley or Kindorf.

B. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

C. Metal Items for Use Outdoors or in Damp Locations: Steel, hot-dip galvanized after fabrication.

D. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameterslotted holes at a maximum of 2 inches o.c., in webs.
   1. Channel Thickness: Selected to suit structural loading.
   2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Expansion Anchors: Carbon-steel wedge or sleeve type.

H. Toggle Bolts: All-steel springhead type.

2.2 CONCRETE EQUIPMENT BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 03.

B. Concrete: 3000-psi (20.7-MPa), 28-day compressive strength as specified in Division 03.

2.3 TOUCH-UP PAINT

A. Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.4 FIRESTOPPING

A. Unless noted otherwise, provide Hilti Firestop & Fire Protection Systems, 3M's Firestop Products and Systems, or equal, applied in accordance with manufacturer's recommendations. Products which are affected by water are not acceptable.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Adhere to clearances required by the NEC, NFPA 70. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb. design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25% minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 3/8-inch-diameter or larger threaded steel hanger rods, unless otherwise indicated. Trim off threaded rod supports at a maximum length equal to the rod diameter below the bottom nut.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
   1. Wood: Fasten with wood screws or screw-type nails.
   2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
   3. New Concrete: Concrete inserts with machine screws and bolts.
   4. Existing Concrete: Expansion bolts.
   5. Threaded studs driven by a powder charge and provided with lock washers in existing concrete are not allowed unless approved by the Architect.

6. Steel: Welded threaded studs or spring-tension clamps on steel. Provide field welding compliant with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25% of its proof-test load.

3.4 FIRESTOPPING

A. Firestopping materials and installation requirements are specified in Division 07. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Unless noted otherwise, provide firestops and seals for penetrations through fire-rated walls and floors applied in accordance with manufacturer's recommendations. Products which are affected by water are not acceptable.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow the supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated.

3.6 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site. Coordinate with the Owner for any materials to be salvaged.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work; repair or replace all components found to be damaged or faulty.

B. Test the Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.
   1. Connect a load of known kW rating (1.5 kW minimum) to a circuit supplied by the metered feeder.
   2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.
   3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.
   4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record the test results.
   5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of the entire system is verified.

3.9 REFINISHING AND TOUCH-UP PAINTING

A. Refinish and touch-up paint as required.
   1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
   2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
   3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   4. Repair damage to PVC or paint finishes with matching touch-up coating recommended by manufacturer.

3.10 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 26 05 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26 Section, "Common Work Results for Electrical Systems."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer's authorized service representative.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wires and cables according to NEMA WC 26 - *Binational Wire and Cable Packaging Standard*.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Wires and Cables:
      a. Alcan Aluminum Corporation; Alcan Cable Div.
      b. Alpha Wire
      c. American Bare Conductor
      d. Cerro Wire LLC
      e. Colonial Wire and Cable
      f. Encore Wire Corporation
      g. General Cable / Carol Brand Wire
      h. Leviton Manufacturing Company, Inc.
      i. Prysmian Group North America Construction & Infrastructure Group
      j. Senator Wire & Cable Company, by Southwire Company
      k. Service Wire Co.
      l. Southwire Company
      m. WESCO International, Inc.
   2. Connectors for Wires and Cables:
      a. 3M Company; Electrical Products Division

b. ABB - Thomas & Betts
c. AFC Cable Systems
d. AMP Incorporated
e. Emerson - Appleton and O-Z/Gedney Fittings
f. Hubbell Incorporated

2.2 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. 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."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 and ASTM B496 for stranded conductors.

D. Conductor Insulation:
1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type USE-2 and Type SE: Comply with UL 854.
3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type UF: Comply with UL 83 and UL 493.
7. Type XHHW-2: Comply with UL 44.

2.3 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. 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."

C. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.

D. Conductor Insulation:
1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type USE-2 and Type SE: Comply with UL 854.
3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type XHHW-2: Comply with UL 44.

2.4 METAL-CLAD CABLE, TYPE MC

A. The use of MC Cable is prohibited.

2.5 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Match conductor.
2. Type: Two hole with long barrels.
3. Termination: Crimp.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Provide solid conductors for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

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

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

B. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

C. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type MC.

E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

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 26 05 33 "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 26 05 29 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Division 26, Section "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each of the following visual and electrical tests:
   a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
   b. Test bolted connections for high resistance using one of the following:
      1) A low-resistance ohmmeter.
      2) Calibrated torque wrench.
   c. Inspect compression-applied connectors for correct cable match and indentation.
   d. Inspect for correct identification.
   e. Inspect cable jacket and condition.
   f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
   g. Continuity test on each conductor and cable.
   h. Uniform resistance of parallel conductors.
3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
   a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   b. 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.
4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 ACTION SUBMITTALS

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

1.3 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.

B. Signal Reference Grid Shop Drawings: Dimensioned plans and sections or elevations showing the layout of the signal reference grid, bonding connections to metal objects, bonding connections to the structure, and bonding connections to equipment. Include sizes for conductors, bonding equipment, and termination/connection details.
   1. Submit product data sheets showing application, dimensions, and material of each component to be utilized with the signal reference grid.
   2. Provide written 1 year (minimum) product warranty against defects in materials and workmanship.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field Test Reports: Submit written test reports to include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 CLOSE-OUT SUBMITTALS Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 01, Section "Operation and Maintenance Data," include the following:
      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 grounding connections for separately derived systems based on 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.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Comply with UL 467.

C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

E. Comply with NFPA 99 for performance criteria and testing in patient care rooms.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers/Suppliers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors, Cables, Connectors, and Rods:
      a. AFL
      b. Burndy
      c. Copperweld Corp.
      d. Eaton
      e. Emerson Electric Co. and subsidiaries
      f. Galvan Industries, Inc.
      g. Harger Lightning & Grounding
      h. Hastings Hot Line Tools & Equipment
      i. Heary Brothers Lightning Protection Co.
      j. Honeywell Salisbury
      k. Hubbell Electrical Systems
      l. Ideal Industries, Inc.
      m. ILSCO
      n. Lightning Master Corp.
      o. Lyncole XIT Grounding
      p. nVent Electrical & Fastening Solutions: CADDY, ERICO, ERIFLEX and LENTON brands

q. Robbins Lightning, Inc
r. Sankosha U.S.A., Inc.
s. Siemens Industry, Inc., Energy Management Division
t. Thomas & Betts Corporation; a member of the ABB Group
u. VFC Lightning Protection Inc.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B3.
2. Assembly of Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors:
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Mechanical Type Bolted Connectors: Bolted-pressure-type connectors

C. Compression connectors: Irreversible circumferential compression type connectors.

D. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

E. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

F. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

G. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

H. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

I. Conduit Hubs: Mechanical type, terminal with threaded hub.

J. Ground Rod Clamps: Unless indicated otherwise, mechanical type, copper or copper alloy, terminal with socket set screw.

K. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

L. Signal Reference Grid Clamp: Unless indicated otherwise, mechanical type, stamped-steel terminal with hex head screw.

M. Straps: Solid copper, cast-bronze clamp or copper lugs. Rated for 600 A.

N. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

O. Water Pipe Clamps:
   1. Mechanical type, two pieces with zinc-plated bolts.
      a. Material: high conductivity copper alloy Tin-plated aluminum.
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and copper ground connector.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

B. Test Wells: Provide handholes as specified in other Division 26 sections, as well as other specification Divisions.

C. Concrete encased electrode: Per NEC requirements.

PART 3 - EXECUTION

3.1 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. In raceways, use green-colored insulated equipment grounding conductors.

C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

D. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

E. Underground Grounding Conductors: Use tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 30 inches below grade.

F. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

G. Separately Derived Systems: Electrical equipment and standby generators creating separately derived distribution systems, such as dry-type transformers, shall utilize the equipment ground bars in the equipment enclosure for both secondary equipment ground and secondary neutral ground with separate grounding conductor extended to an approved ground electrode.

H. 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.

3.2 EQUIPMENT GROUNDING

A. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. In addition to the ground path provided by the continuously grounded metallic raceway system that encloses the phase and neutral conductors, provide equipment grounding conductors in all feeders and branch circuits. Where there are parallel feeders installed in more than one raceway, each raceway shall have a green insulated equipment ground conductor.

C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, telecommunication room, and central equipment location.
1. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
2. Central Equipment Locations and Telecommunication Equipment Rooms: Terminate grounding conductor on a grounding bus with insulated spacers.

3.3 INSTALLATION

A. Ground rods:
1. Drive ground rod until top is 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Grounding electrode conductors and bonding jumpers shall be insulated and installed in raceway.

C. Service Equipment: Install insulated equipment grounding conductor from the grounding bus in the switchgear to the wall mounted grounding bus. Terminate grounding conductor on grounding bus with insulated spacers.

D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches below grade.

E. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

F. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

G. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

H. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Where metallic piping and duct systems are rendered metallically non-continuous by non-conductive couplings, provide bonding jumpers to restore grounding continuity. Use braided-type bonding straps.

I. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact. Clean surfaces thoroughly before applying ground lugs or clamps. If surface is coated, the coating must be removed down to the bare metal. After the coating has been removed, apply a noncorrosive approved compound to clean surface and install lugs or clamps. Where galvanizing is removed from metal, it shall be painted or touched up with "Galvanox," or equal.
   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.

B. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

C. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

D. Connections at Test Wells: Use bolted- and clamped-type connections between conductors and ground rods.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

A. Tests: Perform the following field quality-control testing:
   1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests, by the fall-of-potential method according to IEEE 81.
   3. Provide drawings locating each 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.
      a. Equipment Rated 500 kVA and Less: 10 ohms.
      b. Equipment Rated 500 to 1000 kVA: 5 ohms.
      c. Equipment Rated More Than 1000 kVA: 3 ohms.
      d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
      e. Manhole Grounds: 10 ohms.
   4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
   5. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.6 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 05 26

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUMMARY

A. This section includes electrical conduits, tubing, surface raceways, and wireways as well as electrical outlet boxes, pull and junction boxes, conduit fittings, and hinged door assemblies.

1.3 REFERENCES

A. The latest edition of the following standards and codes, are the minimum requirements for this work:

ANSI C80.1	Rigid Steel Conduit, Zinc-coated
ANSI C80.6	Intermediate Metal Conduit, Zinc-coated
ANSI C80.3	Electrical Metallic Tubing, Zinc-coated
NEMA FB 1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
NEMA RN 1	Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC2	Rigid Nonmetallic Conduit (Schedule 40 and Schedule 80)
NEMA TC 3	PVC Fittings for Use with Rigid PVC Conduit and Tubing
NEMA TC 14	Reinforced Thermosetting Resin Conduit and Fittings Series
NFPA No. 70	National Electric Code (NEC)

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each type of conduit, fitting, wireway, box, and accessory provided.

PART 2 - PRODUCTS

2.1 RACEWAYS AND FITTINGS

A. Metallic Conduit Systems:
   1. Electrical Metallic Conduit (EMT): EMT shall comply with UL 797 and ANSI C80.3. EMT shall be zinc-coated steel, galvanized on the outside and coated on the inside with a hard smooth lacquer finish. EMT fittings shall be steel compression type with insulated throats. Die cast zinc fittings are prohibited.
   2. Flexible Metal Conduit (FMC): FMC shall be single strip, continuous, flexible interlocked double-wrapped steel, zinc-coated inside and out forming smooth internal wiring channel with steel compression fittings and shall comply with UL 1.

3. Liquid-tight Flexible Metal Conduit (LFMC): FLMC shall comply with UL 360 and be zinc-coated steel the same as FMC except with sunlight-resistant and mineral-oil-resistant plastic jacket. Fittings shall be cast malleable iron or steel body and gland nut, cadmium-plated with one-piece brass grounding bushings threaded to interior of conduit. Provide spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.
4. Rigid Steel Conduit (RSC): RSC shall be heavy wall, hot dipped galvanized steel inside and out with threaded ends, and shall comply with U.S. Standard UL6 and ANSI Standard C80.1. RSC fittings shall be steel, threaded type. Plastic-coated RSC shall be rigid galvanized steel conduit having a 0.030-inch-minimum thick, factory-bonded PVC jacket, using pre-jacketed couplings as manufactured by Pittsburgh Robroy, Plastic Applicator, Occidental, or approved equal.

B. Nonmetallic Conduit Systems:
1. Rigid Nonmetallic Conduit (RNC): RNC shall be polyvinyl chloride (PVC) Schedule 40 or 80 suitable for 90°C. Provide solvent cemented type fittings matched to conduit type and material.
2. Liquidtight Flexible Nonmetallic Conduit (LFNC): LFNC shall comply with UL 1660.
3. Fiberglass Conduit: Reinforced Thermosetting Resin Conduit (RTRC). Above ground RTRC shall be listed by UL, Underwriters Laboratories, to the UL 2515 Above Ground standard. Below ground RTRC shall be listed by UL, Underwriters Laboratories, to the UL 2420 Below Ground standard. All conduit sections and fittings shall contain UL labels.
4. Nonmetallic Conduit System manufacturers shall have a current Certificate, issued by an independent and accredited company, of compliance with an ISO 9001 Quality Management System.

C. Raceway Fittings: Specifically designed for the raceway type with which used.

D. Bushings: For rigid steel conduit larger than 1/2-inch size, provide insulated type bushings, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system. Grounding bushings shall be locking type and shall be provided with a feed-through compression lug for securing the ground cables. Unions shall be electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal.

E. Expansion Fittings: Each conduit that is buried in or secured to the building's construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings shall be rigid steel hot-dipped galvanized or malleable iron with factory-installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25 feet or less, and the long type in runs 26 to 80 feet. The short type shall be a one-piece, coupling with O ring, providing 2 inches of total movement range in 1/2-inch to 2 inch conduit sizes. The long type shall be a two-piece barrel and piston joint, providing 6 inches of the total movement range in 1/2 inch through 6 inch conduit sizes. Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4 inch movement in any direction.

F. Sealing Fittings: Provide threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

2.2 OUTLET, JUNCTION, AND PULL BOXES

A. Acceptable Manufacturers:
1. Boxes and Cabinets: Bowers, Raco, Steel City, Appleton, Hoffman, or approved equal.

2. Floor Boxes: Walker; Hubbell; Raceway Components, Inc.; MonoSystems, Inc.; or approved equal.

B. Outlet, Junction, and Pull Boxes:
1. Cast Type Boxes: Cast type boxes shall be ferrous alloy and have gasketed cast covers and inside threaded hubs with adapters as necessary. Cast-metal boxes shall comply with NEMA FB 1, Type FD.
2. Galvanized Pressed Steel Type Boxes: Boxes shall be pressed steel, galvanized or cadmium-plated, 4 inch minimum octagonal or square with galvanized cover or extension ring as required. Knockout type shall be used with knockouts removed only where necessary to accommodate the conduit entering. Boxes shall comply with NEMA OS 1. Provide a grounding terminal in each box containing a green equipment ground conductor, or serving motors, lighting fixtures, or receptacles. Grounding terminal shall be green-colored washer-in-head machine screw or grounding bushing.
3. Large Sheet Steel Boxes:
   a. 12-Gauge sheet steel for boxes with maximum side less than 40 inches, and maximum area not exceeding 1,000 square inches; riveted or welded 3/4 inch flanges at exterior corners.
   b. 10-Gauge sheet steel for boxes with maximum side 40 to 60 inches, and maximum area 1,000 to 1,500 square inches; riveted or welded 3/4-inch flanges at exterior corners.
   c. 10-Gauge sheet steel riveted or welded to 1-1/2" x 1-1/2" x 1/4" welded angle iron framework for boxes with maximum side exceeding 60 inches and more than 1,500 square inches in area.
   d. Covers:
      1) Same gauge steel as box. Provide lifting handles on covers with any dimension larger than 36 inches.
      2) Subdivided single covers so no section of cover exceeds 50 pounds.
      3) Machine bolts or machine screws threaded into tapped holes.
   e. Paint: Rust inhibiting primer, ANSI 61 gray enamel finish coat.
4. Floor Boxes and Fittings:
   a. General:
      1) Provide pedestal or flush floor boxes and fittings of the types, ratings, and configurations as shown on the Drawings.
      2) Floor boxes and fittings shall be suitable for the fire rating and thickness of the floor.
      3) Combination power/telecom outlets shall have barrier to separate power and telecom wiring.
      4) Provide carpet flange to match box cover, where carpet is installed; finish as selected by the Architect.
   b. Recessed Flush Floor Box:
      1) Cast-iron box, multiple gang, shallow depth, brass carpet flange, and coverplates. Walkerbox or equal by other approved manufacturer.
      2) Receptacles shall be 125V, 15A unless otherwise noted.
      3) Combination Duplex Receptacle/Telecom Outlet: Provide indicated power outlets with 828R coverplate and 829S telecom coverplate.
      4) Telecom Outlet: provide 829S coverplate.
      5) Power Connection to Electrified Furniture System: Walkertap RC 900 FF Series Poke-Thru with blank plate service fitting with factory cut hole for connection of furniture system wiring whip.
      6) Telecom Connection to Electrified Furniture System: Walkertap RC 900 FF.

c. Recessed Flush Floor Box:
   1) Cast-iron box, multiple gang, shallow depth, brass carpet flange, and coverplates. Walkerbox or equal by other approved manufacturer.
   2) Receptacles shall be 125V, 15A unless otherwise noted.
   3) Combination Duplex Receptacle/Telecom Outlet: Provide indicated power outlets and coverplate and 829S telecom coverplate.
   4) Telecom Outlet: provide 829S coverplate.

PART 3 - EXECUTION

3.1 GENERAL

A. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

B. Consult all other drawings. Verify all scales and report any dimensional discrepancies or other conflicts to Architect before submitting bid.

C. All home runs to panelboards are intended to be started from outlet nearest panel and continuing in general direction of that panel. Continue such circuits to panel as though routes were completely indicated. Terminate homeruns of signal, alarm, and communications systems in a similar manner.

D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Architect, and conform to all structural requirements when cutting or boring structure is necessary and permitted.

E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc. required for equipment specified under this section.

3.2 SLEEVES

A. Provide sleeves accurately set in place in forms for new concrete walls, floor slabs and partitions for passage of raceways. Waterproof all sleeved raceways.

B. The electrical contractor shall be present during the pouring of concrete to make sure the location of sleeves is not disturbed during the pour.

C. All sleeves through concrete floors shall be pipe sleeves with the top of sleeves a minimum of 1/2 inch above finished floor surfaces. Do not utilize more than one sleeve per pipe. Blockouts for multiple pipes or individual pipes will not be allowed except where approved by the structural engineer/Architect.

D. In cases where cast-in-place openings are not possible, appropriate size holes shall be bored through the concrete to accommodate the conduit passage. The size and location of the holes shall not impair the structure's integrity. After completion, grout or caulk around conduit and finish to match existing surroundings. Cut all openings for which sleeves are omitted with rotary type drill, or other method as approved by the Architect. Holes cut with pneumatic hammer will not be accepted.

3.3 RACEWAYS

A. Provide raceways for all power and special systems as indicated. 277/480V system wiring shall be kept independent of 120/208V system wiring wherever possible. Emergency system wiring shall be kept independent of other wiring systems. Provide insulated equipment grounding conductor in all raceways. Minimum conduit size shall be 3/4 inch. Wiring of each type and system shall be installed in separate raceways.

B. Locate raceways so that the integrity of structural members is not affected and they do not conflict with the services of other trades. Draw up couplings and fittings full and tight. Protect threads from corrosion after installation with zinc chromate or equivalent protection.

C. Install power raceways a minimum of 24 inches from telecommunications raceways, cross at 90° angle.

D. Protect all non-PVC coated metallic raceway in earth or fill from corrosion with two coats of corrosion resistant paint or tape wrap.

E. Elbows for conduit installed below grade or embedded within floor slabs shall be RTRC or rigid steel conduit with factory PVC coating or two coats of corrosion resistant paint or tape wrap. Tie the embedded raceways securely in place prior to concrete placement.

F. Raceways and elbows that stub-up above the slab shall extend a minimum of 4 inches above the finished slab or housekeeping pad to the first connector. Stub-ups shall be PVC coated rigid steel; RTRC and PVC shall not be used. Install capped bushings on conduit stub-ups.

G. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb. (90-kg) tensile strength. Leave at least 12 inches of slack at each end of the pull wire. Tag both ends noting destination.

H. Use temporary raceway caps to prevent foreign matter from entering conduits.

I. Make all bends using an approved bending tool. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated. Cut all conduits square and ream all cuts to remove burrs. Exercise all necessary precautions during the construction period to prevent entry or accumulation of moisture, dust, concrete, and all foreign matter into the raceway system. Pull a mandrel through each raceway to ensure that the raceway interior is clean and dry prior to pulling conductors or cable.

J. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.

K. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72 inch flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

L. Above grade - defined as areas above finished grade for a building exterior and above top surface of any slabs (or other concrete work on grade) for a building interior. Installation of and materials for above-grade raceways shall conform with the following:

1. Install all raceways concealed within finished walls, ceilings, and floors except at surface cabinets, for motor and equipment connections, and in building service equipment rooms unless otherwise indicated. Route exposed raceways and raceways above suspended ceilings parallel or perpendicular to building lines with right angle turns and symmetrical bends. Raceways below or within floor slabs shall be run in a direct line, and where possible, with long sweep bends and offsets.
2. Install raceways a minimum of 6 inches away from parallel runs of flues and steam pipes or other heated lines. Locate horizontal raceway runs above water and steam piping.
3. Provide for waterproofing of all raceways, outlets, fittings, etc. which penetrate exterior walls or the roof to preserve the weatherproof integrity of the building. Provide pockets for waterflashing and counterflashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. which penetrate roof. Wherever conduits penetrate concrete walls to outdoors, the Contractor shall provide a watertight seal as manufactured by O.Z. Gedney Company, Type CSMC; Thunderline Corporation, Link Seal, or equal.
4. Raceways between cabinets, fittings, or boxes shall not exceed 200 feet for straight runs or 100 feet for runs with the maximum number of bends.
5. Provide one empty 3/4 inch conduit for each set of three spare circuit breakers or spaces in flush-mounted panelboards into the overhead accessible ceiling space.
6. Raceways Embedded in Floor Slabs:
    a. Raceways shall not be installed in slab without the approval of the Structural Engineer.
    b. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Raceways shall not interfere with placement of floor slab reinforcement components.
    c. Install raceways between the upper and the lower layers of reinforcing steel.
    d. Space raceways not less than 8 inches on centers except where they converge at panels or junction boxes.
    e. Raceways running parallel to slab supports, such as beams, columns and structural walls, shall be installed not less than 12 inches from such supporting elements.
    f. Rigid steel conduit, or rigid nonmetallic conduit may be embedded in concrete providing the outside diameter does not exceed one-third the thickness of the concrete slab, wall, or beam and it is located entirely within the center third of the member with at least 1 inch concrete cover. Space the raceways laterally to prevent voids in the concrete.
7. Raceways Above Suspended Ceilings:
    a. Raceways shall not be supported from ceiling support wires. Provide independent support of raceways.
    b. Install conduit 1 foot minimum above top of ceiling.
8. Special occupancies as defined and classified in Chapter 5 of the National Electrical Code. Installation of raceway systems to include seal-offs, explosion-proof boxes and fittings, etc. shall be in accordance with applicable provisions of the NEC. Provide conduit seal-offs where portions of an interior raceway system pass through walls, ceiling or floors which separate adjacent rooms having substantially different maintained temperatures.
9. Rigid metallic steel conduit shall be installed in the following above-grade areas:
    a. Where exposed to mechanical injury.
    b. Where specifically required by the National Electrical Code.
10. Electrical Metallic Tubing (EMT): May be installed in dry areas only in:
    a. Concealed locations in furred or masonry walls or ceilings.
    b. Embedded in poured insulating fills.
    c. Exposed areas at least 8 feet above floor.
11. Flexible metal conduit shall be provided in sufficient lengths for makeup of motor, transformer or equipment, and/or raceway connections where isolation of sound and vibration transmission

is required. Provide liquid-tight flexible conduit in exterior, wet or damp locations and for connections to wet-pipe mechanical systems. Flexible metal conduit shall contain a separate equipment grounding conductor, sized per NEC requirements.

12. Flexible metallic 3/8 inch fixture whip connections to recessed lighting fixtures shall not exceed 6 feet in length.
13. Wireways, where indicated, shall be complete with elbows, tees, connectors, adaptors, etc., with all parts factory fabricated and of same manufacturer. Install wireways above suspended ceilings such that cover will hinge upward from side. Provide 12 inches clear from wireway cover when in open position.
14. Conduit Supports and Fasteners:
    a. Supports: Provide supports for horizontal steel conduits and EMT not more than 8 feet apart with one support near each elbow or bend, including runs above suspended ceilings.
    b. Straps: Install one-hole pipe straps on conduits 1-1/2 inch or smaller. Install individual pipe hangers for conduits larger than 1-1/2 inch. Spring steel fasteners with hanger rods may be used in dry locations in lieu of pipe straps.
    c. Trapezes: Install multiple (trapeze) pipe hangers where two or more horizontal conduits run parallel and at the same elevation. Secure each conduit to the horizontal hanger member by a U-bolt, one-hole strap or other specially designed and approved fastener.
    d. Hanger Rods: Install 3/8-inch diameter or larger steel rods for trapezes, spring steel fasteners, clips and clamps. Wire or perforated strapping shall not be used for the support of any conduit.
    e. Fastening: Fasten pipe straps and hanger rods to concrete by means of inserts or expansion bolts, to brickwork by means of expansion bolts, and to hollow masonry by means of toggle bolts. Wooden plugs and shields shall not be used. Power-driven fasteners may be used to attach pipe straps and hanger rods to concrete where approved by Architect. Install raceway on steel construction with approved clamps which do not depend on friction or set-screw pressure alone.
    f. All conduits not embedded in concrete shall be firmly secured by means of pipe clamps, hangers, etc., equal to Caddy Fasteners of ERICO Products, Inc. Wire wrapped around conduits and supporting members will not be acceptable.
15. Fittings: Use approved type couplings and connectors in all conduit runs, and make all joints tight. Provide insulated bushings or rain-tight connections with insulated throats for all terminations in pipe sizes 1-1/4 inch and larger. Provide waterproof fittings for all runs in wet locations, such as exposed to weather, buried in slabs, etc. Provide raceway expansion joints with necessary bonding conductor at building expansion joints, between structures, and where required to compensate for raceway or building thermal expansion and contraction.
16. Firestops and seals shall be provided for penetrations through fire-rated walls and floors. Firestops and seals shall be Dow Corning's Firestop Series 2000, 3M's fire barrier composite sheets CS195, or equal, and shall be applied in accordance with manufacturer's recommendations. Products which are affected by water are not acceptable.

M. Below Grade: Defined as area below finished grade for a building exterior and below bottom floor slab for a building interior. Installation of and materials for below-grade raceways shall conform with the following:
    1. Below-grade raceways shall project 4 inch minimum above floor or equipment foundation.
    2. Install exterior underground conduits 30 inch minimum below finished grade unless shown otherwise on the drawings.
    3. Do not penetrate waterproof membranes unless proper seals are provided.
    4. Conduits below building slab shall be 12 inch minimum below bottom of concrete.

5. Make all penetrations through concrete with plastic-coated rigid steel conduit and sleeves:
   a. At foundation and slab penetrations from below grade to interior, provide sleeves and link-seal for watertight seal; extend plastic-coated rigid steel conduit 5 feet beyond foundation wall.
   b. At foundation penetrations from below grade to below grade, provide sleeves for watertight seal; extend plastic-coated rigid steel conduit 5 feet beyond both sides of foundation wall.
6. Non-encased Raceways: For installation below slabs on grade or in earth or gravel, unless specifically noted on drawings for concrete encasement, provide either of the following raceway systems specified in sub-paragraphs a., b. or c.
   a. Rigid, heavy-wall, Schedule 40 or 80, polyvinyl chloride PVC plastic conduit, suitable for direct burial. If schedule 80 PVC is used, conductor fill recalculation is required and the raceway re-sized if necessary; in all recalculation situations the raceway size shall not be reduced. All offsets and 90-degree ells shall be plastic-coated rigid steel conduit or RTRC. Provide continuous ground wire for all non-metallic conduits.
   b. Rigid steel conduit that is not completely encased in concrete but is in contact with ground or on a vapor barrier shall be wrapped with Scotchrap 51 half-lapped, or shall be plastic-coated rigid steel conduit. Other PVC or Phenolic-resin-epoxy coating material which is equally flexible and chemically resistant may be used providing approval by the Engineer is obtained prior to installation. Provide pre-jacketed couplings to provide a substantially watertight jacketing system.
   c. Fiberglass conduit, also known as Reinforced Thermosetting Resin Conduit (RTRC) conduit, suitable for direct burial. Conductor fill recalculation is required and the raceway re-sized if necessary; in all recalculation situations the raceway size shall not be reduced. All offsets and 90-degree ells shall be RTRC. Provide continuous ground wire for all non-metallic conduits.
   d. Cut rigid steel conduit ends square, thread and ream to remove burrs and sharp edges. Make joints with standard couplings - no running threads permitted. Paint threads with "LPS Zinc Rich" where installed below grade or where threads are not galvanized.
   e. All underground conduits and ducts 2 inches and larger shall be proven clear by pulling through a ball mandrel (diameter approximately 85% of conduit inside diameter) followed by close fitting wire brush and wad of felt or similar material. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. Clean empty raceways similarly. Clear or replace any raceway which rejects ball mandrel.
   f. Provide seal-off fittings where conduits enter or leave hazardous wiring area or areas of widely different temperature and/or humidity.
   g. RTRC conduit shall be supplied with a bonded coupling or an integral wound bell on one end and a machined spigot on the other end. A two part adhesive, epoxy resin system, designed to permanently bond fittings and joints of conduit shall be properly mixed and applied to the spigot end before joining the conduits together. The adhesive shall be suitable for the ambient temperatures of the final installation. The adhesive shall be supplied from the same manufacturer of RTRC conduit and fittings.
7. Non-Metallic Raceway Installations:
   a. In locations permitted by the NEC, provide either PVC or RTRC conduit systems for non-metallic raceway installations.
   b. Joints shall be made using the material recommended by the raceway manufacturer. Components shall be cleaned prior to assembly.
   c. Raceway cutoffs shall be square and shall not deform conduit. Ream rough surfaces.
   d. Provide male box adapters to terminate raceways.

e. Where separable terminations are required, provide threaded adapters with locknuts or bushings. Provide "O" rings for watertight installations.
f. Bends shall be made by manufacturer's recommended methods that do not deform or damage the conduit.
g. Provide expansion fittings where required.
h. Raceway supports shall be installed to allow the non-metallic conduit to slide through the supports.

8. Conductors serving electric fire pumps shall be either in conduit encased in a minimum of 3 inches of concrete (concrete encasement is not required within fire pump room and electrical room where service originates), in conduit run beneath the slab on grade, or mineral insulated cable.

3.4 OUTLET, JUNCTION, AND PULL BOXES

A. Except where otherwise indicated, provide galvanized or zinc-coated, pressed steel outlet boxes for all locations. Provide cast metal boxes where required by the NEC. Pressed steel boxes are to be minimum 4-inch-square or octagonal, and of depth as required. Provide plaster or tile rings for all flush outlets installed where wood, drywall, tile, plaster, etc. types of finishes are applied. All outlets for exterior application shall be cast, weatherproof type, with gasket and cast coverplate. Tile boxes of extra depth may be used for interior, dry applications where masonry block or brick walls constitute the finished wall surface. Boxes installed in masonry walls shall be cast metal, installed as part of the original wall construction to correspond with consistent brick or block course (where new), and coordinated with both the masonry subcontractor and the architect for location. In any event, provide outlet boxes of proper type and design for the particular fixture or device to be installed. Boxes shall be installed such that they are accessible and with adequate working clearance. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc. with Architect and/or Engineer.

B. Provide a minimum 4-inch octagon box. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4-inch square box with tile ring in masonry walls which will not be plastered or furred, or where "drywall" type materials are applied.

C. Except as otherwise noted, locate outlet boxes as follows: Dimensions given are from finished floor to center line of outlets. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

1. Wall switch outlets ..... 44 inches
2. Convenience outlets, long axis vertical with grounding pole on bottom ..... 18 inches
3. Phone and data outlets ..... 18 inches
4. Wall-mounted phone outlet ..... 44 inches
5. Fire alarm horn/strobes outlets ..... 80 inches
6. Fire alarm pull station outlets ..... 44 inches
7. Clock outlets ..... as noted

D. Provide outlet boxes of proper type and design for the particular fixture or device to be installed. Boxes shall be installed such that they are accessible and with adequate working clearance. In stud walls, provide box supports that span two structural framing members to rigidly support boxes. Far side box supports that rely on the gypsum board for rigid support are not acceptable.

E. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes over 12 inches in any dimension shall be fabricated from sheet steel, sized according to code, and have screw-on covers. All junction boxes shall be accessible.

F. Surface-mounted devices are to be mounted in cast-type boxes with gasketed covers.

G. Floor Outlets: Provide surface- or flush-floor outlets in locations indicated on drawings. Provide service top in color as directed by Architect. Provide complete complement of parts needed for finished installation including floor box, carpet flange, fittings, and device covers. Set floor boxes level and trim after installation to fit flush to finished floor surface.

H. Removable covers must be accessible at all times. Mount per "Outlets" Section.

I. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with Architect.

J. All pull boxes shall be set rigidly in place with their front set straight and plumb.

K. For ease of identification during maintenance and remodeling, junction box covers shall be color coded according to the following schedule:
   1. Fire Alarm and Fire Pump boxes - Red
   2. Emergency Circuitry - Yellow
   3. Telephone - Green
   4. Television signal - Violet
   5. Computer Data - Blue
   6. 277/480V Systems – Orange

L. Install device plates in full contact with wall surface. Plates shall not project out from the wall.

M. Mark junction box covers in ceiling spaces or unfinished areas with permanent stencil identification of panelboard and circuit numbers of wiring contained within.

END OF SECTION 26 05 33

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26 Section, "Common Work Results for Electrical Systems."

1.2 ACTION SUBMITTALS

A. Product Data – For each type of product:
   1. Include duct-bank materials, including spacers and miscellaneous components.
   2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Include accessories for manholes, handholes, boxes, and other utility structures.
   4. Include underground-line warning tape.
   5. Include warning planks.

1.3 INFORMATIONAL SUBMITTALS

A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

D. Source quality-control reports.

E. Field quality-control reports.

1.4 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.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.6 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 the Engineer, Construction Manager, and Owner no fewer than 2 weeks in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without the Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on the drawings.

C. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on the drawings.

PART 2 - PRODUCTS

2.1 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, minimum.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type DB-60 PVC RNC, complying with NEMA TC 6 & 8 and ASTM F 512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

C. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling. Spacers shall be Snap-Loc type as manufactured by Carlon Electrical Products or approved equal.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

D. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   1. Cover Hinges: Concealed, with hold-open ratchet assembly.
   2. Cover Handle: Recessed.

F. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   1. Cover Hinges: Concealed, with hold-open ratchet assembly.
   2. Cover Handle: Recessed.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC."

I. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

J. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

K. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   1. Center window location.
   2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   5. Knockout panels shall be 1-1/2 to 2 inches thick.

L. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1. Type and size shall match fittings to duct to be terminated.

2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

M. Handholes 12" wide x 24" long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Standard: Comply with SCTE 77.

C. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have open ottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC."

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12" wide x 24" long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull Box Prototype Test: Test prototypes of manholes 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. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify the Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by the Architect.

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC or Type EPC-40-PVC.

B. Duct for Electrical Branch Circuits: Type EPC-80-PVC or Type EPC-40-PVC.

C. Stub-ups: Concrete-encased, PVC-coated GRC. Raceways and elbows that stub-up above the slab installed below floor slabs shall extend a minimum of 4 inches above the finished slab or housekeeping pad to the first connector. Unless indicated otherwise, stub-ups shall be PVC coated GRC; RTRC and PVC shall not be used. Install capped bushings on conduit stub ups.

D. Elbows for underground duct or embedded within floor slabs shall be RTRC or GRC conduit with factory PVC coating, two coats of corrosion-resistant paint, or tape wrap.

E. Underground duct penetrating structural footings and foundations shall be concrete encased RTRC or GRC conduit with factory PVC coating, two coats of corrosion-resistant paint, or tape wrap. Extend raceway and encasement minimum 10-feet beyond either side of structure or foundation. Where terminating in elbows that stub-up above the slab, extend concrete encasement to stub-up.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
   2. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 or Polymer concrete units, SCTE 77, Tier 8 structural load rating.
   3. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Division 31, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Restore area immediately after backfilling is completed or after 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.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32.

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to Division 01.

3.5 DUCT AND DUCT BANK INSTALLATION

A. Install duct, spacers, and accessories into the duct bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated. Provide RTRC or PVC-coated GRC conduit or two coats of corrosion-resistant paint or tape wrap.
   1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Building Wall Penetrations: Make a transition from underground duct to PVC-coated GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for non-metallic raceway-to-GRC transition.

G. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig hydrostatic pressure.

H. Pulling Cord: Install 200 lbf test nylon cord in empty ducts.

I. Direct-Buried Duct and Duct Bank:
   1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements of Division 31 for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
   2. Width: Excavate trench 12 inches wider than duct on each side.
   3. Width: Excavate trench 3 inches wider than duct on each side.
   4. Depth: Install top of duct at a maximum of 36 inches below finished grade unless otherwise indicated.

5. Burial depths can be increased in parts of an electrical duct run provided the total length of parts of the duct run increased in depth is less than 25 percent of the total run length.
6. Set elevation of bottom of duct bank below frost line.
7. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
8. Elbows: Use manufactured PVC-coated GRC elbows for stub-ups, at building entrances. Use manufactured PVC-coated GRC elbows at changes of direction in duct run. Encase elbows for stub-up ducts throughout length of elbow.
    a. Couple non-metallic conduit to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    a. Stub-ups to Outdoor Equipment: Extend concrete-encased PVC-coated GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
    b. Stub-ups to Indoor Equipment: Extend concrete-encased PVC-coated GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
9. After installing first tier of duct, backfill, and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Division 31 for installation of backfill materials.
    a. Place minimum 6 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
    b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

J. Underground-Line Warning Tape: Bury conducting underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Division 26, Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
    1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.

2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12 inch long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.
1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 26 05 43

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate color, lettering style, and graphic features of identification products.

1.3 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, a minimum of 1/16 inch thick for signs up to 20 square inches and 1/8 inch thick for larger sizes.
   1. Engraved legend with white letters on black face.
   2. Punched or drilled for mechanical fasteners.

2.2 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch
   2. Tensile Strength: 50 lb minimum
   3. Temperature Range: Minus 40 to plus 185°F
   4. Color: According to color-coding

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Install painted identification according to manufacturer's written instructions and as follows:
   1. Clean surfaces of dust, loose material, and oily films before painting.
   2. Prime surfaces using type of primer specified for surface.
   3. Apply one intermediate and one finish coat of enamel.

E. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

F. Circuit Identification Labels on Boxes: Install labels externally.
   1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover
   2. Concealed Boxes: Plasticized card-stock tags
   3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent

G. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.
   1. Color-code 208/120-volt system as follows:
      a. Phase A: Black
      b. Phase B: Red
      c. Phase C: Blue
      d. Neutral: White
      e. Ground: Green
   2. Color-code 480/277-volt system as follows:
      a. Phase A: Brown
      b. Phase B: Orange
      c. Phase C: Yellow
      d. Neutral: Gray or white with a colored stripe
      e. Ground: Green with a gray stripe
   3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
      a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.

b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

H. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

I. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

J. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch-high lettering on 1-1/2-inch -high label; where two lines of text are required, use labels 2 inches high. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures
2. Access doors and panels for concealed electrical items
3. Electrical switchgear and switchboards
4. Electrical substations
5. Emergency system boxes and enclosures
6. Motor-control centers
7. Disconnect switches
8. Enclosed circuit breakers
9. Motor starters
10. Pushbutton stations
11. Power transfer equipment
12. Contactors
13. Remote-controlled switches
14. Dimmers
15. Control devices
16. Transformers
17. Inverters
18. Rectifiers
19. Frequency converters
20. Battery racks
21. Power-generating units
22. Telephone switching equipment

23. Clock/program master equipment
24. Call system master station
25. TV/audio-monitoring master station
26. Fire alarm master station or control panel
27. Security-monitoring master station or control panel

K. Transformer Disconnecting Means Identification: where transformer disconnecting means is not in sight of transformer, or located in a remote location, the disconnecting means shall be lockable and its location shall be indicated on the transformer. Provide engraved-plastic labels to indicate location of transformer disconnecting means.

END OF SECTION 26 05 53

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26 Section, "Common Work Results for Electrical Systems."

1.2 TEST REPORT SUBMITTALS

A. Prior to testing, the Testing Firm shall develop and provide a detailed “Testing Submittal” for review and approval by the engineer four weeks before any testing is required to be performed. The submittal shall include a complete resume and statement of qualifications from the testing firm detailing the following:
   1. Company History
   2. Equipment Calibration Program
   3. List of Equipment to be tested
   4. List of Functional Tests to be performed to verify proper operation of systems.
   5. Specific Test Procedures to be utilized on this project, along with the applicable test values to determine pass or fail.
   6. Sample test data recording forms that are applicable to this project.
   7. NETA Certificate
   8. Submit a sample coordination study from a similar project. Submit sub-consultant qualifications if fault analysis and coordination study is not directly performed by Testing Firm.
   9. Submit a sample Arc Flash study from a similar project. Submit sub-consultant qualifications if Arc Flash study is not directly performed by Testing Firm.

B. Final Report:
   1. Submit results of testing for each system to the Engineer when complete in accordance with Division 01 and Section 5.4 of NETA ATS.
   2. Submit final coordination study and summary of dialed in settings of overcurrent protective devices. Final report, coordination curves and device settings summary to reflect “as installed” conditions.
   3. Submit Arc Flash Hazard study including flash hazard boundaries, incident energy and required PPE for all electrical equipment.
   4. Include Final Report in Operation & Maintenance Manuals
   5. Report shall conform to the requirements of NETA ATS Section 5.4

1.3 SCOPE/DIVISION OF RESPONSIBILITY

A. Contractor shall perform routine insulation resistance, continuity, phase rotation, motor rotation, and bolt/lug torque tests for all distribution and utilization equipment prior to any tests performed by a separate testing contractor.

B. Contractor shall test all lighting and utilization equipment, services, and all circuits for proper operating conditions prior to acceptance testing.

C. Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.

D. Contractor shall engage and pay for the services of a recognized corporately and financially independent Testing Firm for the purpose of performing inspections and tests as herein specified. The Testing Firm shall coordinate testing responsibilities and scheduling with equipment manufacturer's site test and startup field technicians where manufacturer's site presence is required in other specification sections.

E. Contractor and Testing Firm shall coordinate testing activities and scheduling with the Commissioning Contractor hired by the Owner to satisfy LEED sustainability requirements for this project. The Contractor and Testing Firm shall coordinate with Division 01 Section "General Commissioning Requirements."

F. Contractor shall supply a complete set of electrical plans, specifications, and any pertinent design changes to the Testing Firm prior to commencement of testing.

G. The Testing Firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

H. Contractor shall supply a suitable and stable source of power to each test site. The Testing Firm shall specify the specific power requirements.

I. Contractor shall notify the Testing Firm when equipment becomes available for testing. Work shall be coordinated to expedite project scheduling. Wherever possible multiple systems shall be made available to Testing Contractor at one time.

J. The Testing Firm shall notify the Contractor of any system, material, or workmanship which is found defective.

K. The tests and inspections shall determine suitability for energization. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications and manufacturer's requirements. Permanent power shall not be applied to equipment until completion of testing and review of final reports by Engineer of Record.

L. Contractor shall perform safe switching of service equipment, generators, UPS, etc., and scheduling of any required outages for testing. Contractor shall provide temporary power as required during outages to maintain continuity of power to Owner's facility.

M. The protective device coordination study shall be performed by the Testing Firm or their contracted agent. The studies shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage (120/208V, three-phase, four-wire) distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.

N. The Testing Firm shall be responsible for dialing in all final settings and adjustments on protective devices and transformer tap settings after review and acceptance of the coordination study by the Engineer and Owner.

O. The Testing Firm shall perform functional testing as required to demonstrate proper operation of systems including but not limited to generator startup and alarms, UPS operation from batteries, UPS

transfer to bypass, UPS alarms, transfer switch operation, Building Automation System interface, zone selective interlocks, tie breaker controls etc.

P. An itemized description of equipment to be inspected and tested by the Testing Firm is as follows:
1. Main distribution switchgear, and emergency/standby switchgear.
2. Distribution switchboards rated 800A and larger.
3. Distribution panelboards rated 400A and larger.
4. Transformers (225 kVA and larger).
5. Cables and Wiring: Test all cables and wiring rated to carry 200 amps and above at 480 volts, and 400 amps and above at 208 volts.
6. Grounding system.
7. Power generator system.
8. Automatic transfer switch.
9. Power transfer switchgear and controls.
10. Paralleling switchgear and controls.
11. Ground fault protection systems.
12. Motor control centers.
13. Instrument Transformers (CTs, PTs, CPTs)
14. LV Circuit Breakers (applies to all power breakers and molded case breakers 225A and above)
15. Metering
16. Protective Relays
17. Uninterruptible power supply systems
18. Thermographic survey of all equipment associated with this project.

1.4 TEST EQUIPMENT

A. Test equipment shall comply with Section 5.2 of NETA ATS.

B. Test instrument calibration shall comply with Section 5.3 of NETA ATS.

1.5 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:
1. Section 5.1 of NETA ATS.
2. Occupational Safety and Health Act.
3. Accident Prevention Manual for Industrial Operations, National Safety Council
4. Applicable state and local safety operating procedures
5. Owner's safety practices
6. National Fire Protection Association - NFPA 70E
7. American National Standards for Personnel Protection
8. ANSI/IEEE C2, National Electrical Safety Code

B. All pre-functional tests shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.

C. The Testing Firm shall coordinate with the Contractor's safety representative on the project to supervise the testing operations with respect to safety.

1.6 QUALIFICATIONS OF TESTING FIRM

A. The Testing Firm shall be a corporately and financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the Testing Firm.

B. The Testing Firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The Testing organization shall use technicians who are regularly employed for testing services.

D. An organization having a “Full Membership” classification issued by the International Electrical Testing Association meets the above criteria.

E. The testing organization shall submit appropriate documentation to demonstrate that it satisfactorily complies with these requirements.

F. Testing personnel shall comply with the requirements of Section 3.2 of NETA ATS.

1.7 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
   1. National Electrical Manufacturer's Association - NEMA
   2. American Society for Testing and Materials - ASTM
   3. Institute of Electrical and Electronic Engineers - IEEE
   4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - (ATS) current edition
   5. American National Standards Institute - ANSI C2: National Electrical Safety Code
   6. Codes and ordinances of the State, County, and City
   7. Insulated Cable Engineers Association - ICEA
   8. Association of Edison Illuminating Companies - AEIC
   9. Occupational Safety and Health Administration - OSHA
   10. National Fire Protection Association - NFPA
      a. ANSI/NFPA 70: National Electrical Code
      b. ANSI/NFPA 70B: Electrical Equipment Maintenance
      c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
      d. ANSI/NFPA 780: Lightning Protection Code
      e. ANSI/NFPA 101: Life Safety Code

B. All inspections and tests shall utilize the following references:
   1. Project design specifications
   2. Project design drawings
   3. Manufacturer's instruction manuals applicable to each particular apparatus

PART 2 - SHORT CIRCUIT AND PROJECTIVE DEVICE COORDINATION STUDY

2.1 SHORT-CIRCUIT STUDY

A. The study shall be in accordance with applicable ANSI and IEEE Standards and Section 6.1 of NETA ATS and be performed by the testing firm under the supervision of a professional electrical engineer. If possible, this study shall be performed on the latest version of SKM DAPPER software.

B. A short circuit study has been performed by the Engineer to determine the AIC ratings of equipment. A more detailed study shall be performed using ratings, data etc., of as installed equipment for verification of the preliminary study and for use in the coordination and other studies.

C. The study input data shall include the utility company's short-circuit single- and three-phase contribution, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters. The Utility contact representative for this project is Xcel Energy.

D. Short-circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear, switchboard, motor control center, distribution panelboard, critical bus branch circuit panelboards, and other significant locations through the system.

2.2 EQUIPMENT EVALUATION STUDY

A. An equipment evaluation study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the available fault currents. Any problem areas or inadequacies in the equipment shall be promptly brought to the Owner/Engineer's attention.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. A protective device coordination study shall be performed in accordance with Section 6.2 of NETA ATS to check the selections of low-voltage breaker trip characteristics and settings in relation to upstream and downstream circuit breaker characteristics and settings. If possible, this study shall be performed on the latest version of Captor software.

B. The coordination study shall include all voltage classes of equipment from the main distribution equipment down to and including each motor control center and/or panelboard main and branch. The phase and ground overcurrent protection shall be included, as well as settings for all other adjustable protective devices.

C. The time-current characteristics of the specified protective devices shall be plotted on appropriate log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low-voltage circuit breaker trip curves, and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, ANSI transformer magnetizing inrush and withstand curves per ANSI C37.91, cable damage curves, symmetrical and asymmetrical fault currents. All requirements of the current National Electrical Code shall be adhered to. Reasonable coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a

complete system basis. Sufficient curves shall be used to clearly indicate the coordination achieved to each main and feeder breaker, transformer secondary, panelboard main and branch devices. There shall be a maximum of four protective devices per plot.

D. The selection of settings for the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system. Discrepancies, problem areas, or inadequacies shall be promptly brought to the Owner/Engineer's attention.

2.4 ARC FLASH HAZARD ANALYSIS

A. Using the calculated available short circuit, determine the following:
   1. Calculate the flash protection boundary.
   2. Calculate the arc-flash incident energy.
   3. Provide necessary flash protection boundary signage and warning labels for switchgear compartments to comply with NFPA 70E.
   4. Determine the required personal protective equipment for personnel working on or near energized conductors or components.
   5. Generate Work Permits per the requirements of NFPA 70E for use by the Owner’s facility maintenance personnel.

PART 3 - COMPONENT INSPECTION AND TEST PROCEDURES

3.1 ELECTRICAL TESTS

A. The recommended electrical equipment tests and procedures specified in NETA ATS 2017 shall be performed on electrical equipment within the scope of this project including any exceptions or modifications noted below.
   1. Transformers, Dry Type, Air Cooled, Low Voltage, Small (225KVA to 500KVA): Per NETA ATS 2017 Section 7.2.1.1.
   2. Cables, Low Voltage, 600V Maximum: Per NETA ATS 2017 Section 7.3.2.
   3. Grounding Systems: Per NETA ATS 2017 Section 7.13.
   4. Surge Arrestors, Low Voltage Surge Protection Devices: Per NETA ATS 2017 Section 7.19.1.
   5. Emergency Systems, Engine Generator: Per NETA ATS 2017 Section 7.22.1.

END OF SECTION 26 08 01

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26 Section, "Common Work Results for Electrical Systems."

1.2 REFERENCES

A. Equipment, methods, materials and procedures applicable to low voltage transformers shall be governed by the latest edition of the following standards or publications:

NFPA 70:	National Electric Code, National Fire Protection Association
10 CFR	Part 431.192 - Code of Federal Regulations, Energy Conservation Standards for Low-Voltage Dry-Type Distribution Transformers
	Part 431, Subpart K, Appendix A. - DOE Test-Procedure
ANSI/NEMA ST 20:	Dry-Type Transformers for General Applications, National Electrical Manufacturers Association
UL 1561:	Dry-Type General Purpose and Power Transformers, Underwriters Laboratory, Inc.
IEEE C57.12.91:	Test Code for Dry-Type Distribution and Power Transformers.
ANSI/NEMA TP-1:	Guide for Determining Energy Efficiency for Distribution Transformers (2002)
IEEE C57.110-1998:	IEEE Recommended Practice for establishing transformer capability when feeding non-sinusoidal load currents
IEEE-1100:	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
IEEE-519-1992:	IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

1.3 SUBMITTALS

A. Shop Drawings: Provide shop drawings for each different model transformer in accordance with Division 01. Shop drawings shall consist of the following:
1. Dimensional plan and elevation views (show base dimensions with anchoring recommendations.)
2. Conduit entrance locations and dimensions
3. Incoming and outgoing conductor terminator positions
4. Wiring terminal lug locations, and all other terminal lug locations, number, and size of wire per lug.
5. Neutral, ground bus connections
6. Weight of equipment

7. Minimum clearances
8. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

B. Product Data: Provide data sheets for each different model transformer in accordance with Division 01. Product data shall include the following:
1. Complete nameplate data including:
   a. kVA
   b. Primary and secondary voltage
   c. Primary and secondary ampere rating at all tap connections.
   d. Windings material.
   e. Insulation class and winding temperature rise.
   f. Impedance percent.
   g. Basic impulse insulation level.
   h. Connection diagram showing tap configuration.
   i. Manufacturers Model Number and UL label.
2. Model performance data including losses and efficiency at 25, 50, 75, and 100% rated load; and sound level.
3. Certification of UL listing and compliance with NEMA standards.
4. Efficiency when feeding loads at 100% and 50% of nameplate rating.
5. Harmonic performance when feeding computer loads at 50% of nameplate rating.
6. Copy of Factory nonlinear load test of a representative 75kVA transformer per manufacturer’s factory nonlinear load test program.

C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Factory Test Reports: Certified copies of manufacturer's design and routine factory tests required by referenced standards.

F. Sound-Level Test Reports: Certified copies of manufacturer's sound-level tests applicable to equipment for this Project.

G. Field Test Reports: Indicate and interpret test results for tests specified in Part 3.

H. Maintenance Data: For transformers to include in the maintenance manuals specified in Division 01.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 01, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or shall be a full-member company of the International Electrical Testing Association.
1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

C. Comply with IEEE C2.

D. Comply with NFPA 70.

E. Provide description of manufacturer's factory nonlinear load test program.
1. The manufacturer must have a nonlinear Load Test Program operating in the production environment that is audited and documented per quality standard ISO9001.
2. As a minimum, the nonlinear load bank shall consist of three phases of 120V switch-mode power supplies typical of commercially supplied models capable of producing total harmonic current distortion up to at least 100%, with the capability of blending in other load profiles such as 3-phase rectifiers and resistive load.
3. Harmonic data including current and Voltage THD at the different load levels shall be included with the test report.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Division 01 and in accordance with manufacturer's instructions.

B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.

C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect Units against entrance of rain, sleet, or snow if handled in inclement weather.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.7 WARRANTY

A. Transformer shall carry a 10-year pro-rated warranty standard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide general purpose and power transformers by one the following:
1. Acme Electric Corp.; Transformer Division
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Controlled Power Company
4. Eaton Corp.; Cutler-Hammer Products
5. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.

6. General Electric Co.; Electrical Distribution & Control Div.
7. Hammond Co.; Matra Electric, Inc.
8. Magnetek Power Electronics Group
9. Micron Industries Corp.
10. Myers Power Products, Inc.
11. Sola/Hevi-Duty Electric
12. Square D Co.; Schneider Electric USA
13. Siemens Industry, Inc.

2.2 TRANSFORMERS, GENERAL

A. Description: Factory-assembled and -tested, air-cooled quiet-type units of types specified, designed for 60-Hz service. Transformers shall be of the size, rating, and mounting configurations as shown on the drawings. Unless otherwise specified, the design, manufacture, and testing of dry-type transformers and the methods of conducting tests and preparing reports shall be in accordance with ANSI, IEEE, UL, and NEMA Standards. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40°C maximum ambient, with a 30°C average over 24 hours. The terminal compartment temperature shall not exceed 75°C when the transformer is operating continuously at rated load with an ambient temperature of 40°C. Transformers shall be provided with factory installed ground lug. Provide lifting eyes on brackets. Lift and label as complying with UL 1561.

B. Cores: Grain-oriented, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses, one leg per phase.

C. Coils: Continuous aluminum or copper windings without splices, except for taps. One coil per phase in primary and secondary.

D. Internal Coil Connections: Brazed or pressure type.

E. Enclosure:
1. Class complies with NEMA 250 for the environment in which installed.
   a. Indoor ventilated, NEMA 250, Type 2.
   b. Outdoor ventilated, raintight, NEMA 250, Type 3R
2. The enclosure shall be made of heavy gauge steel and shall be finished utilizing a continuous process of degreasing, cleaning, and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking. The coating color shall be ANSI 61. The enclosure shall have lifting holes. All ventilation openings shall be protected against falling dirt.

F. Low-Sound-Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

G. Enclosure: Indoor, ventilated NEMA 250, Type 2

H. Insulation Class: For general purpose and power transformers, 185 or 220°C class for transformers smaller than 15 kVA; 220°C class for transformers 15 kVA and larger. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.
1. Rated Temperature Rise: 150°C maximum rise above 40°C, for 220°C class insulation. Maximum hot spot temperature of 30°C.

I. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:
   1. Taps, 25 to 500 kVA: Two 2.5% taps above and two 2.5% taps below normal full capacity.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with efficiency levels prescribed in 10 CFR 431.192.
   2. Tested according to DOE Test-Procedure. 10 CFR Part 431, Subpart K, Appendix A.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests comply with referenced standards.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project if specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air. Clearance from walls or other equipment shall be per manufacturer's recommendations, but not less than 6 inches.

C. Identification:
   1. Identify transformers and install warning signs according to Division 26 Section, "Identification for Electrical Systems."
   2. Where transformer disconnecting means is not in sight of transformer, or located in a remote location, the disconnecting means shall be lockable and its location shall be indicated on the transformer. Provide engraved-plastic labels to indicate location of transformer disconnecting means.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Transformers smaller than 15 kVA shall be wall-mounted using unistrut supports. Transformers 15 kVA and larger shall be floor-mounted unless otherwise shown on the drawings. Provide Korfund elasto-rib vibration isolations pads for all transformers, along with rubber washers for all mounting bolts. Where wall-mounted, provide factory mounting brackets. Where floor-mounted, install and anchor to 4-inch thick concrete pad. Set the transformer plumb and level.

F. Conduit connections to transformers shall be made with flexible metal conduit, not less than 18 inches or more than 36 inches in length. Where primary feeders come from the floor below, they shall terminate at the end of transformer enclosure with a metal grounding bushing with neoprene throat insert. Ground the bushing to the transformer enclosure.

G. Provide working space for all transformers.
   1. The depth of the working space in the direction of live parts shall not be less than 4 feet measured from the enclosure.

2. The width of the working space in front of transformers shall be the width of the equipment or 30-inches, whichever is greater. All enclosure removable panels shall be capable of opening a minimum of 90 degrees.
3. The work space shall be clear and extend from the grade, floor, or platform to a height of 6½ feet or the height of the equipment, whichever is greater. Within the height requirements of this section, other equipment or support structures, such as concrete pads, associated with the electrical installation and located above or below the electrical equipment shall be permitted to extend not more than 6-inches beyond the front of the electrical equipment.
4. Where transformers are located in a space with limited access, all of the following shall apply:
   a. Where equipment is installed above a lay-in ceiling, there shall be an opening not smaller than 22-inches × 22-inches, or in a crawl space, there shall be an accessible opening not smaller than 22-inches × 30-inches.
   b. The width of the working space shall be the width of the equipment enclosure or a minimum of 30- inches, whichever is greater.
   c. All enclosure removable panels shall be capable of opening a minimum of 90 degrees.
   d. The space in front of the transformer shall not be less than 4 feet measured from the enclosure. The maximum height of the working space shall be the height necessary to install the equipment in the limited space. A horizontal ceiling structural member or access panel shall be permitted in this space.

3.2 GROUNDING

A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

B. Comply with Division 26 Section, "Grounding and Bonding for Electrical Systems," for materials and installation requirements.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to supervise the field assembly and connection of components, and the testing and adjusting of transformer components and accessories.

B. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.

C. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

D. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed "Satisfactory Test" label to tested component.

E. Schedule tests and provide notification at least 7 days in advance of test commencement.

F. Report: Submit a written report of observations and tests. Report defective materials and installation.

G. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors. On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.
   a. Minimum Test Voltage: 1,000V, dc
   b. Minimum Insulation Resistance: 500 megohms
   c. Duration of Each Test: 10 minutes
   d. Temperature Correction: Correct results for test temperature deviation from 20°C standard

H. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean all ventilation openings. Clean components internally using methods and materials recommended by manufacturer. Do not use compressed air to assist in cleaning.

3.5 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

END OF SECTION 26 22 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26, Common Work Results for Electrical Systems.

1.2 SUBMITTALS

A. All exceptions to the specification shall be in written, detailed format with paragraphs referenced and presented with the shop drawing submittal. Refer to Division 01. Provide a written list with sections referenced of all the exceptions taken on this specification.

B. Product Data: For each type of panelboard, accessory item, and component specified.

C. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, available spaces, major features, and voltage rating. Include the following:
   1. Enclosure type with details for types other than NEMA 250, Type 1
   2. Bus configuration and current ratings
   3. Short-circuit current rating of panelboard
   4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components
   5. Wiring Diagrams: Details of schematic diagram where applicable (i.e., shunt trip devices, breaker monitoring, metering, etc.), including control wiring and differentiating between manufacturer-installed and field-installed wiring
   6. Quantity and wire range of lugs

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

G. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 01. Include manufacturer's written instructions for testing circuit breakers.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 01, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the InterNational Electrical Testing Association.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. 2.Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

C. Comply with NFPA 70.

D. Panelboards:
1. NEMA PB-1
2. Federal Specification W-P-115A Type II, Class 1
3. UL 50 and 67

E. Circuit Breakers:
1. NEMA AB-1
2. Federal Specification W-C-375a and W-C-375b
3. UL 489

1.4 MAINTENANCE

A. Extra Materials: Keys: Six spares of each type for panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following:
1. Eaton Corp.
2. General Electric Co.; Electrical Distribution & Control Div.
3. Square D Co.; by Schneider Electric USA

2.2 FABRICATION

A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location. Enclosures shall be corrosion resistant galvanized (zinc finished) sheet steel. Fronts shall be cold rolled steel, finish coated with ANSI 49 and 61 gray enamel over a rust inhibitor. Panel locks shall be keyed alike. Recessed flush-mounted panels shall have overlapping front. All sections of multi-section panelboards shall be the same size.
1. Outdoor Locations: NEMA 250, Type 4
2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4
3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C

B. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.

C. Directory Frame: Metal, mounted inside each panelboard door.

D. Bus System:
1. Bus bars shall be sequence phased, rigidly supported by high impact resistant, insulated supporting bus assemblies to prevent vibration and resulting damage when subjected to stress, vibration or short circuits. Solderless terminations shall be suitable for either copper or aluminum wire or cable.

2. Bus bars shall be tin-plated copper. Bus bars shall be of the ampere rating shown on the Drawings. Neutral bus shall be full size and of the same material as the phases buses. Neutral bus shall be 200% rated when supplied from a double neutral feeder. Provide copper equipment ground bus in each panelboard. In addition to the equipment ground bus, provide an isolated ground bus when supplied from a feeder which includes an isolated grounding conductor. Neutral and ground buses shall be capable of terminating one conductor per pole position minimum.

E. Main and Neutral Lugs: Compression type

F. Where a main breaker is indicated, it shall be factory mounted to the bus and shall be located in panel as indicated. Branch-mounted main breakers are prohibited.

G. Panelboards rated 240V ac or less shall have short-circuit ratings as shown on the drawings, but not less than 10,000 amperes RMS symmetrical.

H. Panelboards rated 480V ac shall have short-circuit ratings as shown on the drawings, but not less than 14,000 amperes RMS symmetrical.

I. Panelboards shall be labeled with a UL short-circuit rating. Provide "FULLY" rated panelboard unless noted otherwise. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings of installed frames. It shall state the conditions of the UL series ratings, including:
   1. Size and type of upstream device
   2. Branch devices that can be used
   3. UL series short-circuit rating

J. Molded-case as scheduled or required. Provide quick-make and quick-break toggle mechanism, inverse-time characteristics, and trip-free operation on overload or short-circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide a trip element for each pole, a common-trip bar for all poles and a single molded insulating material handle. Handle ties will not be accepted. Adjustable magnetic trip devices shall be set at the factory to the low trip setting unless otherwise noted. Provide breaker frame sizes as required to meet the continuous ampere rating and the interrupting capacity. Provide GFI, arc-fault, or shunt-trip type breakers/interrupters where indicated on drawings. Shunt-trip breakers shall be supplied with 120V ac coils, U.O.N.

K. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.

L. Special Features: Include the following features for panelboards:
   1. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
   2. Door-in-Hinged Front Cover (Hinged Trim): Entire front trim hinged to box with standard hinged door with combined latch and lock within the hinged front. The cover shall have a continuous hinge on one side and machine screws into threaded holes in the panelboard cabinet on the other three sides. When open, the cover shall provide full access to the wiring gutters on three sides, and a minimum of 2-3/4-inch access on the hinge side without exposing live conductors.

3. Skirt for Surface-Mounted Panelboards: Where indicated on the plans provide same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and floor.

M. Extra Gutter Space: Dimensions and arrangement as indicated.
1. Gutter Barrier: Arranged to isolate section of gutter as indicated.
2. Column-Type Panelboard Configuration: Narrow cabinet extended as wireway to overhead junction box equipped with ground and neutral terminal buses.
3. Subfeed: Overcurrent protective device or lug provision as indicated.

N. Feed-through Lugs: Sized to accommodate feeders indicated.

2.3 PANELBOARDS

A. Overcurrent Protective Devices: Fixed mains, bolt-on full-module circuit breakers.
1. Circuit Breakers for Equipment Marked Type HACR: Indicated as Type HACR.

B. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
2. Application Listing: Appropriate for application, including Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
6. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
7. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
8. Shunt Trip: Where indicated.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: Arranged to permit testing of functions of solid-state trip devices without removal from panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. The directory shall clearly identify circuit numbers corresponding to the installed circuit breakers, and loads shall be identified by room number/area, type of load (i.e., printer, GFI receptacles, etc.), quantities, and other relevant information. Obtain approval before installing.

E. Install filler plates in unused spaces.

F. Install plugs on open knockouts.

3.2 IDENTIFICATION

A. Panelboard Nameplates: Nameplates for identifying the panelboards shall be engraved laminated plastic strips black with white letters, attached by screws, or phenolic buttons or small window-frame type. Adhesive stick-on labels alone will not be acceptable unless specifically approved. Panelboard nameplates shall include name of panel and voltage.

3.3 GROUNDING

A. Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
   2. Make continuity tests of each circuit.

B. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing.

C. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
   1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

D. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
   1. Perform measurements during period of normal working load as advised by Owner.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

E. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of each panelboard. Remove fronts to make joints and connections accessible to a portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scanning of each panelboard 11 months after date of Substantial Completion.
   2. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
   3. Record of Infrared Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

B. Backboxes shall be clean, dry and free of construction debris and fireproofing overspray prior to installation of panelboard interior.

C. Vacuum backboxes clean of debris after installation and wiring of branch circuits.

END OF SECTION 26 24 16

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading: Deliver all materials to the Work site in original, new, and unopened containers bearing the manufacturer's name and label.

1.4 CLOSE-OUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Items of material furnished for the Work, subject to compliance with requirements, items listed or equal approved from manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Wiring Devices:
      a. GE Company
      b. Hubbell, Inc
      c. Leviton
      d. Pass & Seymour/Legrand
      e. Pyle National, Inc.; an Amphenol Co.
      f. Molex

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Receptacles: Provide 125V, 20 A unless otherwise noted for installation in a 2-3/4-inch-deep outlet box without an adapter.
   1. Description: Two pole, three wire, and self-grounding.

2. Configuration: NEMA WD 1 and WD 6, 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

F. Straight-Blade and Locking Receptacles: Heavy -Duty grade.

G. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

H. Devices for Owner-Furnished Equipment:
1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

I. Device Color:
1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.

J. Wall Plate Color: For plastic covers, match device color.

K. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.3 RECEPTACLES

A. Duplex Receptacles: All devices shall be duplex, configuration NEMA 5-20R, unless otherwise noted.

B. GFCI Duplex Receptacles: Feed-through type.
1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Provide an indicator light that turns on when the GFCI has malfunctioned and no longer provides proper GFCI protection.
2. Standards: Comply with UL 943 Class A, and FS W-C-596.

C. Tamper-Resistant Duplex Convenience Receptacles:
1. Description: Integral shutters that operate only when a plug is inserted in the receptacle.
2. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

D. Weather-Resistant GFCI Duplex Receptacle:
1. Description: Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.4 TOGGLE SWITCHES, 120/277 V, 15 A

A. Single-Pole Switches, 120/277 V, 15 A:
1. Standards: Comply with UL 20 and FS W-S-896.

2.5 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black -filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections :
1. Test Instruments: Use instruments that comply with UL 1436.

D. Tests for Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26, Common Work Results for Electrical Systems.

B. This Section includes packaged engine-generator sets for standby power supply with the following features:
1. Engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Battery charger
5. Muffler
6. Exhaust piping external to set
7. Outdoor enclosure
8. Remote annunciator
9. Remote stop switch
10. Starting battery
11. Performance requirements for sensitive loads.
12. Load banks.
13. Outdoor enclosure.

1.2 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include the following:
1. Manufacturer’s product literature including all features, rated capacities, operating characteristics, furnished specialties and accessories, components, and performance data, sufficient to verify compliance to specification requirements.
2. Manufacturer's certification of prototype testing.
3. Manufacturer's published warranty documents.
4. Shop drawings showing plan and elevation views with certified overall dimensions, weight, and dimensioned mounting bolt locations.
5. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
6. Manufacturer's installation instructions, including required clearances.
7. Thermal damage curve for generator.
8. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For manufacturer.

D. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces.

E. Source quality-control test reports.
1. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.
5. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

F. Field test report of tests specified in Part 3.

G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. The manuals shall include outline, interconnection, wiring, and control drawings accurately describing the equipment provided. Provide ladder logic for all programmable logic controllers in the system.
2. Detail operating instructions for both normal and abnormal conditions.
3. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions, including software, where applicable.

H. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain packaged engine generator and auxiliary components specified in this Section through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

C. Comply with NFPA 70.

D. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

E. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

F. Manufacturer Qualifications: Maintain a service center capable of emergency maintenance and repairs at the Project with eight hours' maximum response time of Project site. Service center shall be capable of providing training, parts, and emergency maintenance repairs.

G. Testing Agency: Refer to Section 26 08 01 “Electrical Testing.”

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

I. Comply with ASME B15.1, NFPA 37, and UL 2200.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

K. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.5 PROJECT CONDITIONS

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

B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: Minus 15 to plus 50°C.
2. Altitude: Sea level to 5,600 feet.

1.6 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators and load bank mounted on grade. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

C. Warranty Period: 1 year from date of Substantial Completion.

1.8 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar; Engine Div.
2. Cummins Power Generation; Industrial Business Group
3. Kohler Co.; Generator Division
4. MTU Onsite Energy Corporation
5. Generac Power Systems

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. 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.

D. Capacities and Characteristics:
1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: 3-phase, 4-wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

E. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth: 3% of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20% variation for 50% step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 3 seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5% 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% variation for 50% step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5% total and 3% for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50%.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250% of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

F. Generator-Set Performance for Sensitive Loads:
1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1% of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10% variation for 50% step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25% of rated frequency from no load to full load.
5. 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.
6. Transient Frequency Performance: Less than 2-Hz variation for 50% step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 3 seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2% total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50%.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300% of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

G. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

2.3 ENGINE

A. Fuel: Natural Gas.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90% of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Governor: Adjustable isochronous, with speed sensing.

F. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50% ethylene-glycol-based antifreeze and 50% 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% 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 the engine manufacturer.
   5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
      a. Rating: 50-psig maximum working pressure with coolant at 180°F, and non-collapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

G. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

H. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: 12V or 24V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least two times without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10°C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35A minimum continuous rating.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

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

2.4 CONTROL AND MONITORING

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

B. Configuration: 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 features shall include the following:
1. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
2. Panelboard Construction: Freestanding unit complying with Division 26 Section “Panelboards.”
3. Current and Potential Transformers: Instrument accuracy class.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system, and the following:
1. AC voltmeter
2. AC ammeter
3. AC frequency meter
4. DC voltmeter (alternator battery charging)
5. Engine-coolant temperature gage
6. Engine lubricating-oil pressure gage
7. Running-time meter
8. Ammeter-voltmeter, phase-selector switch(es)
9. Generator-voltage adjusting rheostat
10. Generator overload

D. 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.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

F. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown
2. Lube-oil, low-pressure shutdown
3. Overspeed shutdown
4. Remote emergency-stop shutdown
5. Engine high-temperature pre-alarm
6. Lube-oil, low-pressure pre-alarm
7. Low coolant level

G. Remote Emergency-Stop Switch: Flush, wall mounted, unless otherwise indicated, and labeled. Pushbutton shall be protected from accidental operation.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100% rated; complying with NEMA AB 1 and UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. 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 shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110% of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or 3-phase fault conditions, regulates generator to 300% of rated full-load 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 generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.6 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 or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125% of rating, and heat during operation at 110% of rated capacity.

F. Enclosure: Weather proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator:
1. Solid-state type, separate from exciter, providing performance as specified.
2. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5% adjustment of output-voltage operating band.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. 23% stand-alone generators, 14% for paralleling generators; 8.5% for critical maximum stability.

K. Sub-transient Reactance: Minimum 23%.

2.7 LOAD BANK

A. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100% rated-system capacity, at 80% power factor, lagging. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25% steps and with minimum step changes of approximately 5 and 10% available.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.

C. Reactive Load Elements: Epoxy-encapsulated reactor coils.

D. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50% of maximum continuous temperature rating of resistance elements.

E. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

G. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch-square (13-mm), galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge.

H. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be non-interchangeable fuses with 200,000-A interrupting capacity.

I. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110% 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.

C. Interior Lights with Switch: Factory-wired, vaporproof-type 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.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.9 MOTORS

A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.10 VIBRATION ISOLATION DEVICES

A. 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-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% of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50% of required deflection at rated load.
4. Lateral Stiffness: More than 80% of rated vertical stiffness.

5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.

2.11 FINISHES

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

2.12 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Equipment shall be installed in accordance with final submittals and contract documents.

B. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction.

C. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

D. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

E. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.

F. Equipment shall be initially started and operated by representatives of the manufacturer.

G. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

H. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

I. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section " Seismic Controls for Electrical Systems."

J. Install remote radiator with restrained spring isolators having a minimum deflection of 1 inch on concrete base on grade.

K. 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. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
   1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

L. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 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 set and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.""

3.4 IDENTIFICATION

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

3.5 FACTORY TESTS

A. Equipment supplied shall be fully tested at the factory for function and performance.

B. Generator set factory tests on the equipment shall be performed at rated load and rated PF. Generator sets that have not been factory tested at rated PF will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady state governing, single step load pickup, and function of safety shutdowns.

C. Transfer equipment factory tests: Each transfer switch supplied shall be factory tested before shipment. Factory tests shall include a complete functional test of the transfer switch controls, including calibration of the voltage sensors.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Refer to specification 26 08 01 “Electrical Testing.”

B. Tests and Inspections:
1. Refer to specification 26 08 01 “Electrical Testing.”

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 standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Remove and replace malfunctioning units and retest as specified above.

F. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

G. 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.

3.7 COMMISSIONING PLAN

A. Perform the approved commissioning plan; establish baseline test results to verify the proper operation and sequence of operation of electrical equipment.

3.8 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in

duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility Owner.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 32 13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Division 26 Section, "Common Work Results for Electrical Systems."

1.2 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 the 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, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
   4. Wiring Diagrams: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels. Differentiate between manufacture installed wiring and field installed wiring.
   5. Checklist: Submit a detailed checklist which documents compliance or non-compliance to each of these requirements. Arrange the checklist according to the headings and items in each section in this specification. Mark items with “N/A” where the item is not applicable.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Refer to Specification 26 08 01 “Electrical Testing.”

B. Field quality-control reports.

C. Emergency Service: Providing emergency maintenance and repairs at the Project site with an 8-hour maximum response time.

1.4 CLOSE-OUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," 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.

B. Commissioning Plan
   1. A commissioning plan shall be developed and documented according to NFPA 70B-2013, Recommended Practice for Electrical Equipment Maintenance.

2. Provide a commissioning plan to perform baseline test results to verify the proper operation and sequence of operation of electrical equipment:
   a. Component and system tests
   b. A set of baseline test results shall be documented
   c. A functional performance test program shall be established, documented, and executed upon complete installation
   d. Acceptance testing
   e. Integrated system testing
   f. Operational tune-up
   g. Start-up testing

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer to specification 26 08 01 “Electrical Testing.”

1.6 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: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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 10.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. NEMA ICS 10-2005 - Industrial Automation Control Products & Systems

F. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

G. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.

H. 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.

I. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2% or better over an operating temperature range of minus 20 to plus 70°C.

J. 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 10.

K. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

L. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

M. 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.

N. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop the drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations.
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.

O. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Automatic Switch Company. (ASCO)
2. ABB/GE Zenith Controls, Inc.
3. Russelectric, Inc.
4. Approved equal

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switch Action: Double throw; mechanically held in both directions.
2. 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.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Tin-plated aluminum.
5. Main and Neutral Lugs: Compression type.
6. Ground Lugs and Bus-Configured Terminators: Compression type
7. Connectors shall be marked for conductor size and type according to UL 1008

C. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

D. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.

2. Voltage and frequency on both the normal and standby sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified). In the following table, “N” equals Normal; “S” equals Standby:

Parameter	Sources	Dropout / Trip	Pickup / Reset
Undervoltage	N and S,3ϕ	70 to 98%	85 to 100%
Overvoltage	N and S,3ϕ	102 to 115%	2% below trip
Under frequency	N and S	85 to 98%	90 to 100%
Over frequency	N and S	102 to 110%	2% below trip
Voltage unbalance	N and S	5 to 20%	1% below dropout

3. Test Switch: Simulate normal-source failure.
4. Switch-Position Pilot Lights: Indicate source to which load is connected.
5. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and standby-source sensing circuits.
   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
   b. Standby Power Supervision: Red light with nameplate engraved "Standby Source Available."
6. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
7. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to standby power source regardless of condition of normal source. Pilot light indicates override status.
8. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
9. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
10. 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. Pushbutton programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.
11. Time Delays:
    a. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals.
    b. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
    c. An adjustable time delay of 0 to 6 seconds to override momentary emergency source outage to delay all retransfer signals during initial loading of engine generator set.
    d. Two time delay modes (that are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the

test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

e. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

f. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5-minute time delay in any of the following modes:
   1) Prior to transfer only.
   2) Prior to and after transfer
   3) Normal to standby only.
   4) Standby to normal only.
   5) Normal to standby and standby to normal.
   6) All transfer conditions or only when both sources are available.

g. The controller shall also include the following built–in timer delays for Closed Transition operation:
   1) 1 to 5 minute delay on failure to synchronize normal and standby sources prior to closed transition transfer.
   2) 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.

h. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.

12. Communications Interface – The controller shall be capable of interfacing, through an optional communications interface module, with a network of transfer switches. It shall be able to connect via an RS-485 Serial communication module (up to 4000 feet direct connect or multi-drop configuration), an Ethernet connectivity module (over standard 10baseT Ethernet networks) or remotely through PSTN dial-up modem communications. This module shall allow for seamless integration of existing or new communication transfer devices. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters. The transfer switch shall also be able to interface to 3rd party applications using ModbusRTU and ModbusTCP open standard protocols.

2.3 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:
   1. Source Limitations: Same manufacturer as transfer switch in which installed.
   2. Comply with requirements for Level 1 equipment according to NFPA 110.
   3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
      a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
      b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
      c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.

d. Transition: Provide closed-transition operation when transferring between power sources.
e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
g. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
h. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
i. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator and Control System:
1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:
a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Indication of switch position.
c. Indication of switch in test mode.
d. Indication of failure of digital communication link.
e. Key-switch or user-code access to control functions of panel.
f. Control of switch-test initiation.
g. Control of switch operation in either direction.
3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
a. Controls and indicating lights grouped together for each transfer switch.
b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
c. Digital Communication Capability: Matched to that of transfer switches supervised.
d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.4 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 10.

B. Prepare test and inspection reports. For each of the tests required by UL 1008, performed on representative devices, for standby systems. Include results of test for the following conditions:
1. Overvoltage

2. Undervoltage
3. Loss of supply voltage
4. Reduction of supply voltage
5. Alternative supply voltage or frequency is at minimum acceptable values
6. Temperature rise
7. Dielectric voltage-withstand; before and after short-circuit test
8. Overload
9. Contact opening
10. Endurance
11. Short circuit
12. Short-time current capability
13. Receptacle withstand capability
14. Insulating base and supports damage

PART 3 - EXECUTION

3.1 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 Division 03 Section "Cast-in-Place Concrete."
   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. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.2 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 except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

C. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

D. Final connections to equipment shall be made with liquid-tight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Refer to specification 26 08 01 “Electrical Testing.”

B. Field Tests: Give 7-day advance notice of the tests and perform tests in presence of the Owner's representative. Coordinate tests with tests of generator plant and run them concurrently.

C. Perform the following tests and inspections:
   1. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with the 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 torque-wrench 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.
      l. 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 the drawings.
         3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
   2. Electrical Tests: Refer to specification 26 08 01 “Electrical Testing.”
   3. Ground-Fault Tests: Refer to specification 26 08 01 “Electrical Testing.”

D. Coordinate tests with tests of generator and run them concurrently.

E. 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.

F. Transfer switches will be considered defective if they do not pass tests and inspections.

G. Remove and replace malfunctioning units and retest as specified above.

H. Prepare test and inspection reports.

3.4 COMMISSIONING PLAN

A. Perform the approved commissioning plan; establish baseline test results to verify the proper operation and sequence of operation of electrical equipment.

3.5 DEMONSTRATION

A. Train the 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 26 36 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants, grass, and other vegetation to remain or as designated by Owner in pre-construction conference.
2. Removing existing grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Removing existing fill.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
2. Division 31 Section “Temporary Erosion and Sedimentation Control” for storm water erosion and sediment mitigation.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to be stockpiled or to remain on Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions. Information required may also be included in Division 1 Section "Project Record Documents."

1.6 QUALITY ASSURANCE

A. Preconstruction Conference: Conduct conference at Project site as directed by Owner's Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing indicated removal and alteration work on property adjoining Owner's property will be obtained by Owner before award of Contract. Authority and permits for performing indicated removal and alteration work on adjacent rights-of-way shall be obtained by Contractor.

1. Do not proceed with work on adjoining property until directed in writing by Owner's Representative.

C. Protect improvements on Owner's property.

D. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

E. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

F. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

G. Restore damaged improvements to their original condition, as acceptable to parties having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving," (PART 2 – PRODUCTS).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks, survey control points, monuments, property line pins and other reference points from disturbance during construction. If disturbed or destroyed, restore or replace at no cost to Owner.

B. Provide erosion control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust from leaving project site.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.

1. Restore or replace damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain temporary fencing around drip line of individual trees or around perimeter drip line of groups of trees to remain before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
2. Do not permit vehicles, equipment, or foot traffic within fenced area.
3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.
2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
3. Coat cut faces of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.

4. Cover exposed roots with wet burlap to prevent roots from drying and backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Owner's Representative.

1. Employ a qualified arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

A. Contractor will locate, identify, arrange for disconnect and seal or cap off utilities indicated to be removed before site clearing.

1. Verify that utilities indicated as abandoned have been disconnected and capped before proceeding with site clearing.
2. Arrange with utility companies having jurisdiction to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner's Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's Representative's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Removal of underground utilities may also be included in Division 2 Sections covering site utilities. Removal of underground utilities may also be included in Division 15 Mechanical or Division 16 Electrical Sections.

E. After removal of underground utilities, as indicated, properly cap and/or plug existing lines to remain in accordance with authorities having jurisdiction.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Use only hand methods for grubbing within drip line of remaining trees.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earth moving is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered or as determined by Geotechnical Engineer in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches unless authorized by Owner's Representative.
2. Do not stockpile topsoil within drip line of remaining trees.
3. Dispose of excess topsoil as specified for waste material disposal.
4. Stockpile surplus topsoil to allow for respreading a thicker layer of topsoil.

3.6 SITE IMPROVEMENTS

A. Remove existing above and below grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated on plans.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

C. Remove existing fill. Refer to Geotechnical Investigation and/or drawings for information regarding suitability for re-use and estimates of location/extent of existing fill.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 31 1000

SECTION 31 2000 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Additional information concerning earth moving may be found on the civil drawings. In case of conflict between the drawings, jurisdictional criteria, and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing and grading subgrades for slabs-on-grade.
2. Excavating and backfilling for buildings and structures, including over-excavation of existing unsatisfactory on-site soil materials and replacement with structural fill.

B. Related Sections include the following:
1. Division 31, Section “Site Clearing” site stripping, grubbing, stripping **and stockpiling** topsoil, and removal of above-grade and below-grade improvements and utilities.
2. Division 31, Section “Temporary Erosion and Sedimentation Control” for erosion and sedimentation control measures.

C. References:

1. Americans with Disabilities Act (“ADA”); Architectural Barriers Act Accessibility Standard- ABAAS as provided for in the regulations of the United States Access Board
2. Uniform Federal Accessibility Standards (UFAS)
3. American National Standards Institute (ANSI) - *ANSI A117.1*
4. United States Department of Transportation and Federal Highway Administration accessibility standards principally listed in 2010 ADA Standards for Accessible Design and Proposed Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines (“PROWAG”)
5. Local Jurisdiction Having Authority – standards, rules and regulations.

D. Permits and Fees: Obtain and pay for all permits and fees required for the work of this section, including erosion and sediment control and water quality permits required by the agency having jurisdiction and the Colorado Department of Public Health and Environment, Water Quality Control Division.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill approved by the Geotechnical Engineer.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of all material of various characteristics required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders. See Section 3.4 “EXCAVATION, GENERAL” for definition of unclassified and classified excavation.

G. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions, as directed or approved by the Owner's Representative and the testing and inspections agency to correct unsatisfactory conditions. Authorized additional excavation and replacement material will be paid for according to contract provisions for changes in the work.

H. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.

I. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner's Representative. Unauthorized excavation, including disposition of over-excavated materials and other work resulting from slides, cave-ins, swelling, upheaval, or remedial work, as well as remedial work directed by the Owner's Representative, shall be without additional compensation.

J. Fill: Fill is all material placed to raise the grade of the site or to backfill excavation, upon which the Geotechnical Engineer has made sufficient tests and observations to enable him/her to issue a written statement that, in his/her opinion, the fill has been placed and compacted in accordance with the requirements of these specifications.

K. Structural Fill: Select granular material for use below floor slabs and to 5 feet beyond the building lines. On-site material may be used if approved by the Geotechnical Engineer.

L. Underslab Gravel: Imported Class 6 road base per Colorado Department of Transportation Standard Specifications for Road and Bridge Construction (current addition) or material approved by the Geotechnical Engineer.

M. Rock Excavation: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for Bulk Excavation or 3/4 cu. yd. for footing, trench, and pit excavation which in the Geotechnical Engineer’s opinion cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,090 lbf (125 kN) and stick-crowd force of not less than 18,650 lbf (83 kN); measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp (157-kW) flywheel power and developing a minimum of 48,510-lbf (216-kN) breakout force with a general-purpose bare bucket; measured according to SAE J-732.

N. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

O. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

P. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

Q. Utilities: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Material Test Reports: Provided by the Contractor from a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D2487 of each on-site or borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D698 for each on-site or borrow soil material proposed for fill and backfill.

B. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. Comply with applicable codes, ordinances, regulations, references, and standards in effect at bid date:

1. Uniform Building Code (UBC) or International Building Code (IBC) per jurisdiction criteria.
2. American Society for Testing and Materials (test methods as specified hereafter) (ASTM).
3. State and local codes.

B. In case of conflict between the above codes, regulations, references and standards, and these specifications, the more stringent requirements shall govern.

C. Testing Agency: The Contractor will employ a qualified independent geotechnical testing agency. The Contractor shall furnish testing agency access to work, facilities and incidental labor required for testing. Notify the testing and inspection agency not less than 48 hours in advance of all work requiring testing.

D. Geotechnical Engineer: All materials and operations under this section of the specifications shall be executed under the supervision of a Geotechnical Engineer who will place qualified personnel on the site during earth moving operations as necessary.

The Geotechnical Engineer shall approve all foundation excavations and give written approval of the completed foundations to the Owner's Representative at the following times:

1. When excavations are first open.
2. Just prior to placing of concrete, shall test and control the fill compaction, approve the materials and method of placing and compacting and give written approval to the Owner's Representative that all bearing surfaces and fill requirements have been inspected.
3. The Contractor shall be responsible to notify the Geotechnical Engineer when tests are to be made.

E. For approval of imported or on-site fill material, notify the Geotechnical Engineer at least four working days in advance of intention to import material, designate the proposed borrow area, and permit the Geotechnical Engineer to sample, as necessary, from the borrow area for the purpose of making acceptance tests to prove the quality of the material. The Geotechnical Engineer report on the acceptability shall be final and binding.

F. Reference Standards:

Compaction Standard: Standard Proctor Density ASTM D698.

G. Preconstruction Conference: Conduct conference at Project site as directed by the Owner's Representative prior to start of construction. The Contractor is to comply with requirements, which may also be included in Division 1, Section “Project Management and Coordination.”

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locations, sizes and depths, or invert elevations of existing utilities, as shown on the drawings, are based on information provided by others and believed to be correct but may not be absolutely so. Such information is therefore presented only as approximations and should be verified prior to construction. Protect from damage any sewer, water, gas, electric, phone, or other pipe lines or conduits uncovered during the work until they have been examined by the Owner's Representative. If such lines are found to be abandoned and not in use, remove affected sections without extra cost. If such lines are found to be in use, carefully protect and carry on work around them. If the Owner's Representative deems it advisable to move such lines, the Owner will pay cost of moving. Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by the Owner's Representative and then only after arranging to provide temporary utility services according to requirements indicated.

1. Contact utility-locator service for area where project is located before excavating.
2. Notify the Owner's Representative not less than two days in advance of proposed utility interruptions.

3. Do not proceed with utility interruptions without the Owner's Representative's written permission.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Remove all existing fill deemed by the Geotechnical Engineer to be unsatisfactorily placed.

D. Existing Contours and Elevations: Contours and spot elevations of existing ground elevations at the site, and approximate elevations of finish-grade cuts, fills, and excavations for the work are shown on the drawings. Contours and elevations for existing ground lines are based on information provided by others, and are believed to be correct, but may not be absolutely so. Existing contours and elevations should therefore be considered approximate and should be verified at the site prior to construction.

E. Verification of Existing Conditions: Visit the site prior to submission of bids. Verify existing conditions, elevations, and contours. In the event of discrepancies between existing conditions and those indicated on the contract documents or survey, contact the Owner's Representative for clarification.

F. Existing Benchmarks: Carefully preserve and maintain existing benchmarks, monuments, property line pins, and other reference points. if disturbed or destroyed, restore or replace by a professional land surveyor at no additional cost to the Owner.

G. Frost Protection: When freezing temperatures may be expected, do not excavate to the full depth indicated unless the footing or slabs are to be poured immediately after the excavation has been completed. If placing of concrete is delayed, protect the bottoms of excavations from frost until concrete is placed.

1.7 WARRANTY

A. Settlement in backfill, fill, or in structures built over backfill or fill, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any structures damaged by settlement shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Shall meet approval of the Geotechnical Engineer and shall be free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Clean, on-site, natural soils, or imported materials, as approved by the Geotechnical Engineer.

C. Unsatisfactory Soils: Soil Classification Groups GP, SP, CH, MH, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups, as identified by the Geotechnical Engineer.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Approved by the Geotechnical Engineer.

E. Structural Fill: Approved by the Geotechnical Engineer.

F. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

H. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

I. Sand: ASTM C33; fine aggregate, natural, or manufactured sand.

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage and Separation Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M288. Utilize Mirafi 140N or as recommended by Geotechnical Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Preparation of subgrade for earth moving operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31, Section “Site Clearing.”

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31, Section “Temporary Erosion and Sediment Control,” during earth moving operations. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties and rights-of-way.

D. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials, as necessary.

E. Cold Weather Work: Prevent frost from entering bearing stratus upon which construction will take place or in areas where fill will be placed in that season.

3.2 DEWATERING

A. Prevent surface water and subsurface ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.
3. Obtain and comply with all provisions of the Colorado Department of Public Health and Environment, Water Quality Control Division, Construction Dewatering Permit.

C. Protection of Persons and Property:

1. Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.
2. Protect adjacent streets, roadways, and properties throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, sidewalks, pavements, and other improvements from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: All excavation (other than rock excavation) is considered as unclassified and is defined as removal of all material encountered, regardless of soil type. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include soil materials, and obstructions. Unclassified excavation is considered normal excavation and no extra costs will be allowed.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove material of every nature or description encountered in obtaining required lines and grades. Excavate and/or place and compact fill to provide for building pad elevation(s) required by drawings.
3. Excavate wide enough at foundations and retaining walls to permit erection and removal of forms, application of dampproofing or waterproofing.

4. Pitch grading around excavations to prevent water from running into excavated areas.
5. Pre-rip hardpan and soft bedrock with single-tooth ripper or other suitable equipment to facilitate excavation with conventional earth-moving equipment.
6. Bearing soils disturbed by excavating equipment must be recompacted to 95 percent of maximum Standard Proctor Density (ASTM D698) prior to placing concrete.
7. Exposed areas which will receive fill once properly cleaned, shall be scarified to a minimum depth of 8 inches, conditioned to near optimum moisture content, and compacted.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth excavation and rock excavation. Do not excavate rock until it has been classified and cross sectioned by the Owner's Representative.

1. Earth excavation includes excavating pavements and obstructions visible on surface, underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
   a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

C. Stability:

1. Slope sides of excavations in compliance with OSHA requirements and local codes or ordinances. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Continuously monitor cut slopes for distress. Take all necessary precautions to safeguard workers, structures, and utilities.
3. Provide all necessary shoring, sheeting, or bracing of sides of excavations required to prevent caving, erosion, and gullying. Provide underpinning of existing structures or other improvements adjacent to excavations which are subject to damage.

D. Unanticipated Conditions: Notify the Owner's Representative immediately upon finding evidence of previous structures or filled materials which penetrate below designated excavation levels, groundwater or water-bearing strata, or other conditions which are not shown, or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Owner's Representative instruction before proceeding with further work in such areas.

E. Rock Excavation: Includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction. Rock excavation in unconfined areas is defined as removal and disposal of material which in the Geotechnical Engineer’s opinion, cannot be excavated without continuous and systematic drilling and blasting, or continuous use of a suitable ripper or other special equipment.

1. Unanticipated Rock Excavation: Rock excavation that is not indicated on existing surveys or which cannot be reasonably assumed from geotechnical studies of the site and which could not have been anticipated without extensive investigations. Unanticipated rock excavation shall be subject to change order procedures or previously agreed upon unit prices.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10 feet. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb the bottom of excavation. Excavate by hand to final-grade before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 inches to 12 inches (150mm to 300mm) above the bottom of the pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final-grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1-inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
4. Excavation Below Slab on Grade: Over-excavate within the proposed footprint of the slab-on-grade to a minimum depth of 12” and replace with on-site or imported materials as approved by the Geotechnical Engineer.

B. Existing man-made fill shall be removed under structures, as required by the Geotechnical Engineer.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

B. Scarify subgrade soils beneath exterior slabs, sidewalks, and pavements to a minimum depth of 8 inches, moisture condition and recompact, as specified.

C. Existing man-made fill shall be removed under walks and pavements, as required by the Geotechnical Engineer.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Refer to Division 31, Section “Trenching and Backfilling,” for excavating and backfilling of utilities.

3.8 SUBGRADE INSPECTION

A. Notify the Geotechnical Engineer when excavations have reached required subgrade.

B. If the Owner's Representative and Geotechnical Consultant determine that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Authorized additional excavation and replacement material will be paid for according to contract provisions for changes in the work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner's Representative, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi (17.2 MPa), may be used when approved by Geotechnical Engineer. If approved by the Geotechnical Engineer, structural fill placed at 100 percent ASTM D698, 2 percent below to 1 percent above optimum moisture may be used.

1. Fill unauthorized excavations under other construction or utility pipe, as directed by the Owner's Representative.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials in approved locations without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below-finish-grade, including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
8. Acceptance of subgrade by the Geotechnical Engineer.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 SOIL FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

1. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
2. In areas of fill, scarify natural soil following removal of unsatisfactory material, to a depth of 8 inches.

B. Place and compact fill material in layers to required elevations per the geotechnical report and as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill or structural fill, as approved by the Geotechnical Engineer.
4. Under building slabs, use engineered fill or reconditioned on-site soils or imported fills of native soils, as approved by the Geotechnical Engineer.
5. Under footings and foundations, use engineered fill or reconditioned on-site soils or imported fills of native soils as approved by the Geotechnical Engineer.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to optimum or to 3 percent over optimum moisture content for clay soils, or within 2 percent of optimum moisture content for granular soils. Refer to the geotechnical study for additional recommendations.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content beyond the tolerances described above and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:

1. Under exterior flatwork, slabs, steps, and pavements, scarify and recompact top 8 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Underfootings and interior floor slabs, excavate to approved natural soils, in fill condition, compact to 95 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below-subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. Compact foundation wall backfill to 95 percent.
5. Compact scarified subgrade soils to 95 percent.
6. Compact retaining wall backfill to 95 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Grading tolerances identified herein apply to non-accessible routes, unless within this paragraph or specifically stated. Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 0.10 feet.
2. Walks: Plus or minus 0.10 feet.
3. Pavements: Plus or minus 0.10 feet.

C. Accessible Routes: For accessible routes, finished construction of accessible areas to meet published values for dimension and slope. No tolerance is permitted below minimum or above maximum values and must meet accessible requirements such as ADA, ABAAS, ANSI A117.1 and as provided for in regulations of the United States Access Board, the United States Department of Transportation and Federal Highway Administration which requirements are principally listed in 2010 ADA Standards for Accessible Design, Proposed Guidelines for Pedestrian Facilities in the Public Right of Way Accessibility Guidelines (“PROWAG”) and Local standards. All construction or alterations of accessibility routes (walks, ramps, entrances, etc.) shall comply with standards, rules and regulations set forth above, including but not limited to 5% maximum longitudinal grade on walks without handrails, 8.33% maximum longitudinal grade on walks with handrails, and landings 2% maximum composite slope. 2% maximum cross slope on walks, and 2% maximum composite slope in handicap parking/loading areas. No tolerance regarding maximum slope will be allowed.

Prior to construction, contractor shall coordinate as necessary with Owner/Developer, Engineer, Architect or designated official if rules and regulations of accessibility routes cannot be met or a discrepancy of requirements are indicated on drawings.

3.16 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:

1. Install separation geotextile, if requested by Geotechnical Engineer, on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase and base course to required crown elevations and cross-slope grades.
4. Place subbase and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

6. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow the testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test the results for the previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Owner's Representative.

D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, and ASTM D 2937, as applicable. Perform field moisture tests in accordance with ASTM D6031. Tests will be performed at the following locations and frequencies at a minimum:

1. Sidewalks, Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2,000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by the Owner's Representative; reshape and recompact.

C. Where settling occurs before the Project correction period elapses, remove finished surfacing and backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to designated storage areas on Owner’s property. Stockpile or spread soil as directed by the Owner's Representative.

1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner’s property.

END OF SECTION 31 2000

PART 1 - GENERAL

1.1 RELATED WORK

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

B. Additional information concerning temporary erosion and sedimentation control may be found on the civil drawings. In case of conflict between the drawings, jurisdictional criteria and the information specified herein, the more stringent requirements shall govern.

1.2 SUMMARY

A. Work Included. Furnish, install, maintain, and remove temporary erosion and sedimentation controls as shown on the drawings or specified herein, or as required to complete the work.

B. Related Sections include the following:
   1. Division 31 Section "Site Clearing" site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
   2. Division 31 Section “Earth Moving” for soil materials, site excavating, filling and grading.

C. Permits and Fees: Obtain and pay for all permits and fees required for the work of this section, including erosion and sediment control and water quality permits required by the authority having jurisdiction and the Colorado Department of Public Health and Environment, Water Quality Control Division.

D. Erosion Control: The Erosion and Sedimentation Control Drawings included in the Contract Documents is the minimum requirement to be implemented. Provide additional control as necessary to meet applicable local, State and Federal criteria.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Unclassified Excavation: Removal of all material of whatever character required for the work encountered above subgrade elevations and to lines and dimensions indicated, including boulders.

C. Fill: Fill is all material placed to raise the grade of the site or to backfill excavation, upon which the Soils Engineer has made sufficient tests and observations to enable him to issue a written statement that, in his opinion, the fill has been placed and compacted in accordance with the requirements of these specifications.

D. BMP: Best Management Practice. Erosion and sediment control devices, which may consist of silt fence, crates, filter fabric, riprap, etc.

E. SWMP: Storm Water Management Plan. Identifies BMPs, which are erosion and sediment control measures for the project.

F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

H. Utilities: Include on-site underground pipes, conduits, ducts, and cables, as well as underground services to buildings.

1.4 SUBMITTALS

A. Submittal Procedures: All submittals are to be made to the Owner's Representative. If provided refer to Division 1 section "Submittal Procedures."

1.5 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with applicable local, State and Federal ordinances, rules and regulations concerning sedimentation control and storm water runoff.

B. In case of conflict between the above codes, regulations, references and standards and these specifications, the more stringent requirements shall govern.

C. Preconstruction Conference: Conduct conference at Project site as directed by Owner's Representative prior to start of construction. Contractor to comply with requirements, which may also be included in Division 1 Section "Project Management and Coordination."

1.6 PROJECT/SITE CONDITIONS

A. Existing Conditions: Verify all existing conditions affecting the work of this section prior to submitting bids or proposals. Additional compensation will not be allowed for revisions or modification of work resulting from failure to verify existing conditions.

1.7 WARRANTY

A. Temporary Erosion and Sediment Control measures shall be maintained until permanent measures are in place. All damaged, disturbed or devices filled with sediment, which may occur within the specified project warranty period, shall be corrected at no cost to the Owner. Any devices damaged by erosion or sediment shall be restored to their original condition by the Contractor, at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Erosion and Sedimentation Control Materials: Provide one or more of the following materials, as shown on the plans or as applicable for site conditions:

1. Sand bags.
2. Silt fences.
3. Rock riprap.
4. Temporary seeding.
5. Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh.
6. Biodegradable twisted jute or spun-coir mesh, 0.92 lb/sy minimum, with 50 to 65 percent open area.
7. Drainage geotextile.
8. Impervious fill.
9. Other materials proposed for use on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:

1. Determine the existing ground elevations, drainage patterns, and changes to such patterns during excavation in order to satisfactorily plan and provide materials for adequate erosion and sediment control devices.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and rights-of-way according to requirements of authorities having jurisdiction.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

D. Secure grading permit from agency having jurisdiction prior to commencing grading operations.

3.3 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this section will be performed. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.

3.4 INSTALLATION

A. Erosion and Sedimentation Control Devices. Erosion and sedimentation control measures to be taken during construction include, but are not necessarily limited to the following:

1. Apply soil stabilization within 14 days to all disturbed areas that are to be dormant for a period longer than 30 calendar days after reaching grade. Stabilize soil with mulch anchored per criteria of authorities having jurisdiction. Temporarily revegetate areas that will remain in an interim condition for more than 30 days.
2. Roads and parking areas indicated to be paved may be covered with an appropriate aggregate base course in lieu of mulch. Temporary mulching or aggregate base course is not required if final pavement construction will take place within 30 days after grading to final contours.
3. Soils that will be stockpiled for more than 30 days must be mulched and seeded within 14 days after stockpile construction.
4. Prevent sediment from leaving the project site by installing a silt fence or other BMPs as indicated on the plans. Protect existing storm inlets adjacent to the site by an approved gravel filter.
5. Excavate the future detention/water quality pond and construct the outlet structure/storm sewer such that the pond may function as a temporary sediment basin during development of the site. Construct the sediment basin in accordance with authority having jurisdiction's criteria. Provide temporary swales to convey site runoff to the pond.
6. Locate stone stabilization pads at all points of vehicular ingress and egress to the construction site.
7. Provide temporary erosion controls consisting of berms at the top of slopes and interceptor ditches at ends of berms and at those locations which will eliminate or minimize erosion during construction, along with temporary seeding, temporary diversion, chutes, and down pipes and lining of water courses.
8. Temporary sedimentation controls shall consist of silt dams, traps, silt fence, barriers, and appurtenances at the top of spoil and borrow area slopes and where runoff water exits the site.
9. Maintain the available silt holding capacity of silt dams, fence traps and barriers until no longer needed. The sediment capacity of sediment retainage areas shall be at a minimum, the capacity shown on the plans in conformance with Urban Drainage Criteria Manual, Volume 3. Prior to removal, obtain concurrence of the Owner and Engineer.
10. Remove accumulated sediment and debris from a BMP when the sediment level reaches one-half the height of the BMP, or at any time the sediment or debris adversely impacts the functioning of the BMP.
11. The erosion/sediment control plan shows the minimum required for the project. If it becomes apparent that additional controls are necessary, the Engineer shall be notified and with approval of the Owner's Representative additional controls shall be installed.

B. Chemicals and Pollutants:

1. Store construction materials and chemicals that could contribute pollutants to the runoff within an enclosure, container, or dike located around the perimeter of the storage area, to prevent discharge of these materials into runoff from the construction site.
2. Locate areas used for collection and temporary storage of solid and liquid waste away from the storm drainage system. Provide covering or fencing as required to prevent windblown materials; construct perimeter dike to contain liquid runoff. These measures may not be necessary if materials are immediately placed in covered waste containers.

3. Perform equipment maintenance in designated areas using measures such as drip pans to control petroleum products spillage.
4. Immediately clean up and properly dispose of spills of construction related materials such as paints, solvents, or other chemicals.

C. Final Stabilization and Long-Term Management:

1. Final stabilization shall be achieved through permanent vegetation and landscaping after construction of all buildings and paved surfaces.
2. With approval of authorities having jurisdiction, temporary erosion and sediment control measures may be removed within 30 days after final site stabilization is achieved or after temporary measures are no longer needed.

D. Inspection and Maintenance: Inspect erosion and sediment control measures weekly during construction. In addition, inspect all facilities immediately after any significant runoff or snowmelt which results in runoff. Repair or otherwise mitigate any damage to the erosion and sediment control facilities at no additional cost to the Owner.

3.5 CLEANING

A. Removal of Controls: Remove controls upon completion of that portion of the work for which controls were furnished. Leave the site and work area in a clean condition.

END OF SECTION 31 2500