ADDENDUM #1
ROUTE 206 FORCE MAIN REPLACEMENT AND PUMP STATION
DAA #R05695-03
COUNTY OF KING GEORGE, VIRGINIA
AUGUST 27, 2009

The purpose of this Addendum is to provide the following clarifications and revisions:

(1) The bid date remains as <u>Wednesday, September 9, 2009 at 2:00 p.m.</u> at the King George County Purchasing Manager's Office, 10459 Courthouse Drive, Suite 201, King George, VA 22485.

(2) Division 16 - Electrical, is hereto attached.

<u>Attachments</u>:

Division 16 – Electrical
- 16010 – General Conditions
- 16055 – Earth Work
- 16111 – Conduit and Fittings
- 16123 – Building Wire and Cable
- 16124 – Wire and Cable Connections and Devices
- 16130 – Boxes
- 16131 – Wireways and Auxiliary Gutters
- 16190 – Supporting Devices
- 16195 – Electrical Identification
- 16310 – Underground Duct System
- 16440 – Disconnect Switches
- 16450 – Grounding and Bonding

SECTION 16010

GENERAL CONDITIONS

1.01 RELATED DOCUMENTS

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

1.02 DEFINITIONS

A. Architect, Engineer, or Architect/Engineer: The term used to designate the Architect and/or the Engineer who contracts with the Owner to provide the Architectural and Engineering services for the project. The Architect/Engineer is a separate Contractor and not an agent of the Owner. The term includes any associates or consultants employed by the firm to assist in providing the Architectural/Engineering services. Referred to herein as the Architect/Engineer.

B. Construction: As used in these documents shall include new construction, reconstruction, renovation, restoration, major repair, demolition and all similar work upon buildings and ancillary facilities owned or to be acquired by the Owner and any draining, dredging, excavation, grading or similar work upon real property.

C. Contractor: The person, firm, or corporation with whom the Downer has entered into a contractual agreement and includes the plural number and the feminine gender when such are named in the Agreement as the Contractor.

D. Defective: An adjective which when modifying the work "work", refers to work that is unsatisfactory, faulty, or deficient, or does not conform to the Contract Documents, or does not meet the requirements of any inspections, standard, test or approval referred to in the Contract Documents, or has been damaged prior to Architect/Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion).

E. Owner: The institution with whom the Contractor has entered into a contractual agreement and for whom the work or services is to be provided.

F. Provide: Shall mean furnish and install ready for its intended use.

G. Submittals: All drawings, diagrams, illustrations, schedules and other data required by the Contract Documents which are specifically prepared by, or for, the Contractor to illustrate some portion of the work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a supplier and submitted by the Contractor to illustrate material or equipment for some portion of the work.

H. Subcontractor: An individual, partnership, or corporation having a direct contract with Contractor or with any other Subcontractor for the performance of the work.

It includes one who provides on-site labor but does not include one who only furnished or supplies materials for the project.

I. Substantial Completion: The work that is sufficiently complete, in accordance with the Contract Documents, so that the project can be utilized by the Owner for the purposes for which it is intended.

J. Supplier: A manufacturer, fabricator, distributor, or vendor who provides material for the project but does not provide on-site labor.

K. System Contractor: Any Contractor or Subcontractor providing any of the following systems: CCTV, Fire Alarm, Duress Alarm, Security, Paging, Sound, Intercom, Generator, Telephone, Data, Access Control and Cable TV.

L. Wiring: Shall mean provide raceway, [cable tray,] conductors, and make connections at equipment, devices, etc., as required to provide a complete and functional system.

M. Work: The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

1.03 DESCRIPTION

A. The work of this Section includes the providing and installation of all electrical equipment, materials and devices as indicated on the electrical drawings and/or as specified herein, including but not limited to:

1. Coordinate with plant operating and county personnel for all electrical power outages required to accomplish the scope of work.

2. Provide separate feeder for the pump station from the existing waste water treatment plant service switchboard. Provide a dedicated circuit breaker, in the existing electrical service switchboard, to serve the pump station as indicated on drawings.

B. All materials, equipment, apparatus or other products not specifically mentioned in the specifications or noted on the drawings, but which are obviously necessary to make a complete working installation, shall be provided.

1.04 QUALITY ASSURANCE

A. Codes and Standards:

1. The installation of all work under this Section shall comply with all applicable codes, laws, standards and regulations. Nothing in the specifications shall be construed to permit deviation from these governing items.

2. Electrical material and equipment shall bear the UL label except where UL does not label such types of material and equipment. Materials, equipment and installation shall meet requirements of applicable codes and standards listed below:

ANSI	American National Standards Institute
ETL	Electrical Testing Lab
IEEE	Institute of Electrical & Electronic Engineers
NEC	National Electric Code – 2005
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
UL	Underwriters Laboratories, Inc.

B. Qualifications of Workman:

1. Provide, as a minimum requirement, one qualified Virginia licensed master electrician who is thoroughly experienced with the materials and methods specified and familiar with the design requirement. License shall be available upon request.

2. At least one qualified, Virginia licensed journeyman shall be present at all times during the execution of the work. License shall be available upon request.

3. In acceptance or rejection in any portion of the electrical work, no allowance shall be made for lack of skill on the part of the workmen.

C. All material and equipment shall be new and in first class condition, unless otherwise specified, and shall conform to grade, duty, quality, and standards hereinafter specified.

D. Reasonable care shall be exercised for the protection against damage to all electrical equipment, apparatus, materials, devices and accessories during the course of construction, through the use of protective coverings, barriers, railings and similar devices. Protection shall be suitable for application as approved by the Engineer of Record. Damages resultant from negligence or lack of protection shall be corrected to the Engineer of Record's satisfaction at no additional cost to owner.

1.05 INTENT OF DRAWINGS AND SPECIFICATIONS

A. The implied and stated intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable electrical and mechanical systems in every respect.

B. The drawings are diagrammatic only, intending to show general arrangement and location of system components. Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets and fittings may not be shown, but shall be provided at no change in contract price.

C. All work shall be accurately laid out and coordinated with other trades to avoid conflicts and to provide maximum accessibility for operation and maintenance.

1.06 SUBMITTALS

A. Submit shop drawings of the electrical materials to the Engineer for review in accordance with the provisions of Division 16 of these specifications. The drawings and data shall show principal and critical dimensions, characteristics, manufacturer and other pertinent information and shall be submitted in sufficient copies to permit one copy of each to be retained by the Architect/Engineer and Owner. If samples are required, the Contractor shall bear the cost of such samples. Approval of the above submissions shall not relieve the Contractor from complying with the drawings and Specifications, nor shall such approval be construed as a guarantee of the accuracy of dimensions or other data covered therein.

B. The following is a list of those items required to be submitted, in addition to items listed in DIVISION 1 submittal register:

1. Wire and cable (and associated markers).
2. Control wiring diagrams.
3. Service equipment.
4. Conduit, back boxes, fittings (including flexible conduit and fittings).
5. Underground pull boxes, manholes, and underground cable marking tape.
6. Equipment identification labels.
7. Grounding materials (ground rod, connectors, etc.).
8. Pull and junction boxes.
9. Molded case circuit breakers (includes shunt trip type).
10. Supporting devices (slotted channel, conduit straps, and conduit hangers).

C. Do not begin fabrication or work which requires submittals until return of submittals with Architect/Engineer's approval.

D. Contractor shall provide loose-leaf, 3-ring binders for each copy holder of shop drawing data. The binders shall be provided as part of the first submission. The binders shall be complete with index, tabs, legend and cross-reference to the applicable item and specification section. Tabs shall be provided for subsequent submissions. Each tab shall include related specification sections. All submittal data shall be original printed material or good grade permanent copy. Fax and poor quality copies are not acceptable.

1.07 SUBSTITUTIONS

A. The following paragraphs shall supersede the DIVISION 1 substitutions section for all DIVISION 16 work.

B. Specific materials or equipment of certain manufacturers have been specified under certain items to describe in effect the standard of quality and performance

desired. When a particular manufacturer or catalog number is definitely mentioned, it shall be known as standard.

C. Where two or more manufacturers are specified for a product, one of the named manufacturers shall be known as standard, but the other named manufacturers may be also provided if so desired.

D. If a substitution is offered, submit request to the Engineer fifteen (15) calendar days prior to the bid date with full descriptive and technical data to substantiate the equality of the substitution. The Architect/Engineer shall determine whether the proposed substitution meets the requirements of the specifications. Any modifications of the new work necessitated by the use of substitute materials or equipment shall be made by the Contractor. **Substitutions will not be considered after award of Bid by the Engineer of Record.**

E. Prior approval submittal, review and approval shall not be considered to be shop drawing review and approval.

F. Specific reference is also made to the fact that all changes required in the work of this or any other Division by the acceptance of any substitution, shall remain the responsibility of this Subcontractor herein involved at no additional expense to the Owner.

1.08 SITE VISITATION

A. All persons proposing to submit quotations for work in accordance with these plans and specifications are **REQUIRED** to visit the site of the work covered by the plans and specifications and are to familiarize themselves with existing conditions as they affect the work of this Section of the specifications. Claims resulting from a failure to visit the site or inspect the existing conditions shall not be considered.

1.09 OPERATING AND MAINTENANCE DATA

A. Compile product data and related information appropriate for Owner's maintenance and operation of products provided under Contract.

1. Prepare operating and maintenance data as specified in this Section and as referenced in the General Conditions an applicable Section of Division 1 General Requirements.

2. Provide three loose-leafed-bound copies of instructions, manuals, parts lists, diagrams and other applicable published data which shall furnish guidance and reference material on the operation, adjustments, maintenance and repair of the various pieces of equipment.

B. Instruct Owner's personnel in maintenance of products and in operation of equipment and systems.

C. Preparation of data shall be done by personnel:

1. Trained and experienced in maintenance and operation of desired products.

2. Familiar with requirements of this Section.

3. Skilled as technical writer to the extent required to communicate essential data.

4. Skilled as draftsperson competent to prepare required drawings.

D. Prepare data in form of an instructional manual for use by Owner's personnel.

1.10 PAINTING

A. All steel surfaces not galvanized, factory-finished or of weathering type steel shall be cleaned free of all rust and painted with primer and finish coats as specified in SECTION 09900.

B. All factory-finished steel surfaces; boxes, enclosures, etc., shall be cleaned and retouched or repainted as necessary to provide a rust-resistant coating. Where painting or galvanizing is not specifically specified, ferrous devices, bolts, nuts, inserts, etc., shall be galvanized.

C. All nameplates shall be left unpainted and in a clean condition.

1.11 IDENTIFICATION

A. Laminated nameplates shall be used on the exterior surfaces of all electrical apparatus. These laminated nameplates shall be of white and black Bakelite or similar material, machine engraved through the white layer to expose the black layer (black letters on a white background), with letter heights not less than 3/16 inches. Nameplates area shall be secured with chrome plated screws

1.12 POWER AND CONTROL WIRING RESPONSIBILITIES FOR MECHANICAL SYSTEMS

A. Definitions:

1. Power Wiring (by Electrical Contractor): All line voltage wiring to the mechanical equipment including line voltage that also serves as a control circuit (such as required for a line voltage thermostat) or to provide power to control panels/boxes for mechanical equipment. The Division 16 Contractor shall be responsible for reviewing and understanding the exact requirements called for by DIVISION 15 and all related mechanical drawings on control diagrams. All questions relating to this portion of work shall be resolved prior to bid. Failure to do so shall not relieve the Electrical Contractor's responsibility for providing labor and materials to make this portion of work complete and operational. The Plumbing, Heating, Air Conditioning and Ventilation, and Fire Protection Contractors shall provide the Electrical Contractor with locations, wiring diagrams, and any additional information required to properly provide power wiring (and line-voltage control wiring where applicable). Power

wiring shall be considered as the motor (or equipment) branch circuit wiring from the branch circuit overcurrent, protection device through the disconnect switch (at equipment location), starter (manual or magnetic), and to the equipment load being served. Interlock wiring from manual starter with selector switch (es) to building automation system control device shall be considered as control wiring, and shall be the responsibility of the Division 15 Automatic Temperature Control (ATC) Contractor.

2. Control Wiring (by Automatic Temperature Control Contractor; ATC): All wiring, high or low voltage other than power wiring, required for the proper control operation of the mechanical systems.

3. All control and power wiring shall be provided by the Electrical Contractor. Packaged mechanical systems having integral controls shall require power wiring only.

B. Refer to specification SECTION 15600 and coordinate all requirements with Mechanical Contractor prior to commencing work. Bring to the attention of the Architect/Engineer, and items requiring clarification.

1.13 EQUIPMENT TESTS

A. An operating test of the complete electrical system shall be made. System shall test free from grounds, shorts and other faults. Connections shall be for positive mechanical and electrical connection and continuity. Equipment shall be demonstrated to operate in accordance with the requirements of the plans and specifications. Provide all personnel and test instruments required. Performance of tests shall be made in the presence of the Owner's representative.

B. The following tests shall be performed as a minimum:

1. Control and Distribution Equipment:
   a. Check the wire terminals, clean connections.
   b. Check all control switches, alarm devices, indicating instruments for proper operation under normal and simulated abnormal conditions.

2. Phase rotation: The connections of all equipment shall be checked for correct phase rotation, prior to coupling motor to mechanical equipment (pumps, fans, etc.).

3. Circuit Breakers: The following tests shall be performed:
   a. Inspect each circuit breaker.
   b. Check for loose connections.
   c. Operate each circuit breaker manually.
   d. Set the adjustable trips to the values specified.

1.14 WARRANTIES

A. All equipment installed under this Division of the work shall be warranted for a minimum of one year after the date of Owner's final acceptance.

B. During this warranty period, replace any and all defective equipment and parts at no cost to the Owner.

C. Warranty shall include all warranties and guarantee provided by equipment manufacturers.

1.15 TEMPORARY POWER

A. The Contractor, at his own expense, shall make arrangements for the purchase and /or rental of power or portable power and provide for the extension of utility power to the point of usage. The cost of power shall be included in the appropriate bid items to which it is appurtenant and shall include full compensation for providing all labor, materials, tools and equipment which may require power.

1.16 BRANCH CIRCUITS

A. The branch circuit wiring has been designed to utilize the advantages of multi-wire distribution and shall be installed substantially as indicated on the drawings. No major changes in the grouping or general routing of the branch circuits shall be made without the approval of the Engineer in writing

B. The number of conductors in each run of conduit is indicated on the drawings and where there is a conflict between the number of wires indicated and the actual number required as determined by the functional design requirements, the number of wires determined by the functional design requirements shall govern.

C. In general, there is a number associated with each branch circuit outlet which identifies the particular branch circuit to which the device served by the outlet is to be connected. The circuit number indicated has been assigned for reference and guidance, and is not intended to limit panelboard circuitry. All branch circuits shall be connected to breakers in accordance with indicated schedules. The balancing of all loads shall be included in the work of this Division and shall be submitted for Engineer review before proceeding.

D. Home runs shall not be combined where such would require derating of conductor ampacity, unless specifically noted on the drawings.

1.17 MOTOR, APPLIANCE AND EQUIPMENT CONNECTIONS

A. Unless otherwise indicated on the drawings or specified herein, it is the intent of this Division to provide all electrical equipment and connections required to protect, properly operate, and control all motors, appliances, electrical devices, and equipment provided and installed under this and other Divisions of the specifications or indicated on the drawings. Division 16 shall be responsible for providing all wirenuts or compression lugs to properly make final connections to all motors, appliances and equipment.

1.18 CONDUIT SLEEVES AND OPENINGS

A. The General Contractor shall, under this Section of the Specifications, be responsible for the proper type, location and size of all sleeves and openings,

including those required to be structurally framed, and similar items required for all equipment and wiring installations throughout the project to provide the systems as intended.

B. All sleeves where required, shall be extended ¼ inch beyond the finished surface in finished areas, 2 inches in Equipment and similar rooms. Openings for conduits passing through fire resistant rated construction shall be sealed around and inside by means of sealants, caulks, putties, mortars and collars similar to those manufactured by Specified Technologies, or approved equivalent to maintain the integrity of the fire rating (see Virginia Uniform Statewide Building Code).

C. All sleeves installed for the passage and protection of bare grounding conductors shall be of the non-metallic type.

D. Conduit sleeves shall be galvanized, Schedule 40 heavy-duty steel.

1.19 CUTTING AND PATCHING

A. The General Contractor shall provide all cutting and patching of floors, walls, etc. necessary for the proper installation of work under this Division. No structural member shall be cut without specific approval of the Engineer.

B. Where holes through bearing walls are required for the passage of conduits, and where such holes are not already provided or are improperly located to suit the needs, cut the necessary holes upon the approval of and as directed by the Engineer. These holes shall be true smooth circles, sawed or drilled to the smallest practical diameter. Seal improperly located holes that are not to be used. Refer to structural drawings and DIVISION 3, DIVISION 4, and DIVISION 5 specifications as to what locations and methods of holes to be cut are allowed.

C. Where holes are required through fire resistant rated construction for the passage of conduits, the Contractor shall seal the opening around the conduit and inside the conduit with fire proofing materials as required to maintain the fire rating of the wall.

1.20 MISCELLANEOUS WORK

A. The Electrical Contractor shall provide labor and material for construction of pads, chases, pockets and openings required for the proper installation of the work under this Division.

B. Certain electrical equipment shall be furnished as a part of the mechanical facilities to be provided under other Divisions of these Specifications. All electrical equipment so furnished which is not installed in or on the equipment it serves shall be mounted as a part of the Electrical Work using approved wiring diagrams and information which shall assure proper and safe operation of the apparatus and equipment.

C. Provide all necessary sizes, locations, arrangements, details and data required for proper construction of concrete bases, chases, pockets, supports holes, sleeves,

etc., which are to be built into the building construction for the accommodation of work to be installed under this section of the Specifications. Refer to SECTION 03300 for cast-in-place concrete requirements.

D. Other Divisions of these Specifications and all drawings shall be carefully examined and understood to determine the requirements of the project as a whole and to determine interconnecting points between the various trades. All such interconnections shall be properly made and with due regard for correct arrangements suited to the equipment or material concerned.

1.21 MISCELLANEOUS IRON AND STEEL

A. Provide steel supports, racks, gratings, ladders, platforms, special wireways and hangers as shown or not shown on the drawings or required to support and provide access to the entire electrical system.

B. All work shall be cut, assembled, welded and finished by skilled mechanics. Stands, brackets and frameworks shall be properly sized and strongly constructed.

C. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be performed by experienced metalworking mechanics.

D. Members shall be straight and true and accurately fitted. Scale, rust and burrs shall be removed. Welded joints shall be ground smooth where exposed. Drilling, cutting and fitting shall be done as required to properly install the work.

E. Members shall be generally welded except that bolting may be used for field assembly where welding would be impractical.

F. All structural steel shall meet the requirements of ASTM A-36. Cast iron shall meet the requirements of ASTM A-48, Class No. 20.

G. All shop-fabricated iron and steel work shall be cleaned, dried and given a shop coat of primer and oil base machinery enamel.

1.22 WIRING AND ELEMENTARY DIAGRAMS

A. Wiring and elementary diagrams for equipment as indicated the drawings are based on the product of the specified equipment manufacturer and are shown for convenience to aid in estimating the extent of the work involved. The equipment actually installed shall be wired and connected in accordance with the equipment manufacturer. All equipment so connected shall be made to operate in a safe, proper and efficient manner. Note that the control circuitry is not necessarily shown on the electrical d4rawings but shall be installed in conduit between the points and devices indicated or required on the wiring diagrams.

B. Upon completion of work, each System Contractor shall provide a point-to-point as-built wiring diagram prepared specifically for this project. The wiring diagram shall indicate cable routing, cable numbering, color codes, end-of-line resistors, supervisory relays, surge suppressors, control modules, head-end equipment, etc.

Wiring diagrams shall be reviewed by the Engineer prior to being turned over to the Owner.

1.23 MOTORS AND APPLIANCES

A. Motors shall be provided as part of the equipment they drive.

B. All motors and appliances shall be wired and connected. Provide disconnects and controllers as indicated on the drawings.

C. The purpose of this specification is to mount all control devices and provide the electrical connections required to properly operate, protect and control the electrically operated equipment and devices indicated on the electrical drawings.

D. Installation of appliances shall include providing and installing control and/or disconnect devices for appliances as required by Article 422 of the NEC. Caution shall be used to coordinate exact requirements for appliances from "approved" equipment submittals prior to commencing roughing-in work.

E. Provide all necessary conduit, junction boxes, wire, flexible conduit, compression type lugs, and all other materials necessary to properly make final connection to the motors and appliances.

F. Coordinate all connections to kitchen equipment and appliances with Section 11400 Food Service Contractor.

1.24 SETTING OF EQUIPMENT

A. The setting of equipment shall be carefully coordinated with the work and requirements of the other trades involved to ensure compatibility and to avoid conflicts.

B. Equipment, base mounted on concrete or masonry slabs, pads and piers, or mounted on stands, gratings, platforms, or other, shall not be set in any manner, except on the finished and permanent support.

C. Support of equipment on studs or by other means, and the placing or building of the supporting slab, pad, pier, stand, grading, or other, "to the equipment", is prohibited.

D. Provide concrete reinforced equipment pads for all ground-mounted equipment, whether or not pads are indicated on the drawings. Exterior concrete equipment pads shall project a minimum of 6" above finished grade, and 6" out from each edge of the equipment base with 1" chamfered corners, unless otherwise noted on the drawings.

1.25 INSPECTION AND TESTING

A. The installation shall be inspected on at least three (2) widely spaced occasions by a local inspection authority. Application shall be made to the local authority for such inspections and this Contractor shall pay all costs for this inspection service.

B. Inspections shall be made for compliance with the power company requirements, the National Electrical Code and any local codes.

C. A copy of inspection reports shall be promptly sent to the Contractor, Owner, and Engineer, including a Certificate of Compliance on completion of the work.

D. At the completion of the electrical installation and at such time as the Engineer or Owner may direct, the Contractor for this Division shall conduct an operating test for approval. All equipment shall be demonstrated to operate in accordance with the Contract Documents.

E. The tests shall be conducted in the presence of the Owner, Engineer or an authorized representative. All instruments, devices and personnel required for the tests shall be provided by the Contractor.

F. Provide test reports and test documentation for each operational test to the Engineer as specified herein.

1.26 UTILITY COMPANY REQUIREMENTS

A. The Owner shall make application for electrical and telephone services in coordination with the Contractor.

1.27 PERMITS AND TAXES

A. The Contractor shall pay for permits, inspections and other costs incidental to providing electrical installations.

B. The Contractor shall be responsible for the payment of all applicable Federal, State and local sales and use taxes. The taxes shall be considered as part of the Contract.

1.28 RECORD DRAWINGS

A. Maintain a neatly marked set of record "as-built" drawings showing the installed location and routing of conduits, cables, junction boxes, pull boxes, manholes, outlets, panelboards, lighting fixtures and interconnection circuits, etc. which deviate from the Contract Documents. At project completion, submit record drawings to the Engineer for review, and then make necessary corrections before submitting to the Owner.

B. Exterior underground conduit routing and underground manhole locations (for lighting, power and communications) are specifically required to be shown and dimensioned on the record drawings.

1.29 ELECTRICAL POWER OUTAGES

A. Electrical power outages required for installation of service equipment shall be limited to maximum duration of **3 hours**. The Contractor shall coordinate work and provide sufficient labor, including multiple shifts or overtime, in order to honor this limitation. The Contractor shall obtain authorization from the

Waynesboro Public Works and coordinate with the Public Works personnel prior to initiating each outage.

1.30 CHANGE ORDER PRESENTATION

A. Change order requests shall be broken down and itemized for both labor and materials.

B. Provide change order requests in the following form:
EXAMPLE:

Item	Quantity	Unit	Unit	Labor Total	Labor Unit	Material Total	Material Total
½" conduit	50	LF	-	-	-	-	-
12 AWG CU	150	LF	-	-	-	-	-

1.31 SCHEDULE OF VALUES

A. Provide a Schedule of Values per the following categories:

1. Permit
2. Mobilization/De-mobilization.
3. Temporary power and lighting.
4. Demolition.
5. Raceways and fittings (includes pull and junction boxes).
6. Wire and cable (includes branch circuit grounding).
7. Wiring devices (includes switch and outlet boxes).
8. Operational testing and demonstrations to Owner.

END OF SECTION

SECTION 16055

EARTHWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. All excavating and backfilling required to execute this work. Provide all labor, materials, and equipment, and perform all work required to complete the EARTHWORK indicated on the drawings and specified herein. Earthwork shall include, but not be limited to the following:

1. Preparation of grade and excavation required for equipment pads.
2. Core Boring, Trenching and backfilling required for underground wiring.

B. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the Work.

C. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.

D. Provide this work in accordance with the Contract Documents, FFPA 70-NEC, (and the pertinent sections of the other References), and the manufacturers requirements and recommendations. Conflicts shall be as determined by the Engineer.

E. All accessories required or recommended by the References or the manufacturer shall be provided.

1.03 REFERENCES: (ALL SHALL BE THE LATEST EDITING THAT IS RECOGNIZED BY THE LOCAL GOVERNING AUTHORITIES, FOR THIS PROJECT.)

A. ANSI/NFPA 70 – National Electrical Code.

B. NECA “Standard of Installation.”

1.04 SUBMITTALS

A. Submittals concerning the work of this Section are only required as stipulated within this Section. Extraneous submittals will be returned with no action.

B. Required Submittals

1. Submit product data.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Use all means necessary to protect all material of this Section before, during and after installation and to protect all objects designated to remain.

1.06 PROJECT CONDITIONS

A. Conduit routing is shown on Drawings diagrammatically in approximate locations unless dimensioned. Route as required for a complete system.

PART 2 PRODUCTS

2.01 CONDUIT REQUIREMENTS

A. Direct buried conduits shall be equivalent to Carlon PVC Sch.40 and Sch.80.

PART 3 EXECUTION

3.01 INSTALLATION

A. All backfill material shall be clean and free of all stones, rocks, debris or deleterious substance.

B. Provide backfill consisting of clean sand for direct buried conduit(s). Sand shall be filled and tamped around conduits to completely fill all voids, to a minimum of 6” above top of conduit(s).

C. Verify the location of all underground piping, foundations and any other underground utilities before commencing work. All existing underground utilities shall be protected from damage.

D. Trenches for laying of conduit shall be excavated with a trenching machine to a depth to provide a minimum cover of 24” after the conduits are installed. Widths of trenches shall be no wider than is necessary to accomplish the installation.

E. Excavation shall be made to the proper depths. If excavation is carried below that required. The bottom shall be brought to the required elevation with sand fill, thoroughly compacted.

F. Backfilling shall not be made until wiring or conduit has been inspected by the Owner’s representative. Backfill shall be placed by hand to a depth of 6” over the conduit and compacted by hand tamping.

G. Prior to further backfill, apply a continuous red permanent warning strip 6” below finished grade which suitably identifies the characteristics and danger of conduit below. Where ductbanks are 24” or wider, provide two warning strips, one even with each edge of the ductbank. Where ductbanks are 36” or wider, provide one warning strip every 18”. Backfill above the warning strip shall be applied and

piled on to above normal and thoroughly compacted with tampers with excess left to allow for reasonable settlement. Provide red warning tape above all exterior ground conduit installations.

H. All cables and conduit shall be left covered at the end of the day, with ends capped water-tight, as specified in SECTION 16111 – CONDUIT AND FITTINGS. Backfill within 5 feet of roads, walks and equipment pads shall be compacted in layers for the full depth of the trench to obtain a Standard Proctor 100% rating.

I. Where conduits pass below footings, install steel pipe sleeves with at least 2" clearance all around conduit and fill excavation to the bottom of the footing with concrete. Where conduits pass through walls below grade, install steel pipe sleeves with at least 2" clearance all around conduit. Fill annular space around conduit with inorganic compressible filler to provide a watertight seal.

J. Any excavated material which is not necessary to re-establish existing grade (i.e. excess material) shall be disposed of off-site at the Contractor's expense.

K. Provide temporary barricades required to properly guard the work during construction and to insure safety of workmen and the public.

END OF SECTION

SECTION 16111

CONDUIT AND FITTINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. SECTION INCLUDES

1. Metal conduit.
2. Flexible metal conduit.
3. Liquidtight flexible metal conduit.
4. Nonmetallic conduit.
5. Fittings and conduit bodies.

B. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the Work.

C. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.

D. Provide this work in accordance with the Contract Documents, NFPA 70-NEC, (and the pertinent sections of the other References), and the manufacturers requirements and recommendations. Conflicts shall be as determined by the Engineer.

E. All accessories required or recommended by the References or the manufacturer shall be provided.

1.03 RELATED WORK

A. SECTION 16130 - Boxes.

B. SECTION 16190 – Supporting Devices

C. SECTION 16310 – Underground Duct System

D. SECTION 16450 – Grounding and Bonding

1.04 REFERENCES: (ALL SHALL BE THE LATEST EDITING THAT IS RECOGNIZED BY THE LOCAL GOVERNING AUTHORITIES, FOR THIS PROJECT.)

A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

C. ANSI/NFPA 70 - National Electrical Code.

D. NECA "Standard of Installation."

E. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

F. NEMA TC 2 - Electrical Plastic Conduit (EPC-40 and EPC-80).

G. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.05 SUBMITTALS

A. Submittals concerning the work of this Section are only required as stipulated within this Section. Extraneous submittals will be returned with no action.

B. Required Submittals

1. Submit product data.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. Protect PVC conduit from sunlight.

1.07 PROJECT CONDITIONS

A. Verify that field measurements are as indicated on Drawings.

PART 2 PRODUCTS

2.01 CONDUIT REQUIREMENTS

A. No conduit shall be less than 1/2”. No conduit from panelboard to first outlet’s junction box shall be less than 3/4”.

B. Underground or Below Slab Installations:

1. More than 5 feet exterior to Foundation Wall: Provide Schedule 40 nonmetallic conduit. Where beneath areas susceptible to vehicular traffic, provide Schedule 80 nonmetallic conduit.

2. Within 5 feet exterior to Foundation Wall: Provide Schedule 40 nonmetallic conduit.

3. In or Under Slab on Grade: Provide Schedule 40 nonmetallic conduit.

C. Outdoor Locations, Above Grade: Provide rigid steel .

D. In Slabs Above Grade:

1. Provide sch. 40 pvc conduit.

2. No conduit larger than 3/4" shall be routed horizontally through the slab.

3. If two conduits must cross, one shall be in the deck flute.

E. Wet and Damp Locations: Provide rigid steel conduit.

F. Dry Locations:

1. Concealed: Rigid Steel.

2. Exposed: Rigid Steel.

2.02 METAL CONDUIT

A. Manufacturers:

1. Allied.

2. Triangle.

3. Republic.

4. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1 Zinc plated or galvanized.

C. Fittings and Conduit Bodies: ANSI/NEMA FB 1 UL S14; all steel fittings, zinc plated or galvanized. Appleton or OZ Gedney

2.03 FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. Electri-Flex

2. American Flex Cable

3. Anaconda

B. Description: Interlocked steel construction.

C. Fittings: ANSI/NEMA FB 1. Connectors shall be angle saddle type with bushings between the conductors and the conduits. Basis of Design: Thomas & Betts XC-130 series

2.04 LIQUID TIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. Electric-Flex
2. Eastern
3. Anaconda

B. Description: Interlocked steel construction with PVC jacket.

C. Fittings: ANSI/NEMA FB 1. Basis of Design: Thomas & Betts LT 700 series..

2.05 NONMETALLIC CONDUIT

A. Manufacturers:

1. Carlon
2. Cantex
3. Fre

B. Description: NEMA TC 2; Schedule 40 and 80 PVC

C. Fittings and Conduit Bodies: NEMA TC

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 16190 for supporting devices.

B. Raceways shall be provided as a complete system without wires and shall be continuous from device to device and from fitting to fitting. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded. All conduits shall be concealed except when specifically indicated or approved.

C. Arrange supports to prevent misalignment during wiring installation, to maintain headroom and to present a neat appearance.

D. Do not attach conduit to ceiling support wires. Support conduits with pipe spacer single hole strap.

E. Route conduit parallel and perpendicular to walls.

F. Route conduit under slab from point-to-point.

G. Maintain adequate clearance between conduit and piping and insulation.

H. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

I. Cut conduit square using saw or pipecutter; de-burr cut ends.

J. Bring conduit to shoulder of fittings; fasten securely.

K. Provide conduit hubs to fasten conduit to electrical equipment in damp and wet locations.

L. Install no more than equivalent of three 90 degree bends between boxes or conduit bodies. Provide conduit bodies where make sharp changes in direction, as around beams.

M. Avoid moisture traps; provide junction box or tee conduit with drain fitting at low points in conduit system.

N. Provide suitable fittings to accommodate expansion and deflection where conduit crosses expansion joints.

O. Provide suitable pull string in each empty conduit except sleeves and nipples.

P. Provide suitable caps to protect installed conduit against entrance of dirt and moisture.

Q. Conduit shall be sized as indicated. Where not indicated, they shall be sized to equal or exceed the minimum requirements of the NEC. All conduit sizes are based on the use of Type THWN/THHN copper conductors unless otherwise indicated. Any and all deviations from this criteria shall be made at no additional cost.

R. The swing of all doors shall be checked on the job site before roughing-in for local switches. Routing of conduit shall be coordinated with the work of other trades to avoid conflicts with structural members, pipe, ductwork, etc.

S. Conduits shall enter switchboard and motor control centers in the same cubicle in which the conductors they contain are to be terminated. Horizontal cross wiring runs of entering conductors within the enclosure will not be permitted.

T. Conduit shall not pass through any ductwork. Ductwork or other equipment shall not be supported from conduit.

U. Sealing fittings shall be provided in conduits where required by the NEC and where conduits enter and leave air handling equipment. Conduits shall not be supported from ductwork or mechanical equipment.

V. All new conduits indicated as being unused, empty or spare shall be sealed at both ends by a coupling and a screwed plug or cap. A 1/8 inch nylon pulling cord shall be installed with three feet of slack tied off at each end. Provide tags on the ends of all unused conduit with termination location of that conduit.

W. Grounding electrode conductor conduit shall be nonmetallic conduit throughout, except where run in a plenum space, conduit shall be metallic with bonding bushings at entry and exit points.

X. Connection of Conduit to Sheet Metal Boxes and Enclosures:

1. Connection to NEMA 1 type boxes and enclosures:
   a. Rigid Metal Conduit: Install insulated bushings and double locknuts.

2. Connection to NEMA 3R, 4, 4X and 12 type boxes: Install insulated bushings and sealing locknuts or hubs.

3. When conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.

4. Install conduit sealing compound (DUX seal) within all conduits which have entered a building from outside, whether from above or below grade.

Y. Each conduit penetrating a fire wall shall be installed such that during a fire, falling portions of the structure shall not affect the fire rating of that wall. A single length of conduit could be dislocated in a manner to cause that portion of the conduit entering the fire wall to breach the wall, thereby eliminating the fire wall's rating. Raceway systems installed in fire rated walls shall be installed isolated from the non-fire wall, a box or coupling shall be provided that shall allow the conduit to shear or break clear of the conduit in the fire wall. Refer to Virginia Statewide Uniform Building Code.

Z. Conduit shall not be embedded in the required fire protective covering of a structural member that shall be individually encased in accordance with BOCA 715.3.

AA. Each conduit passing from a hazardous location into a non-hazardous location shall be provided with a sealing fitting which may be located in either side of the boundary. The seal shall be installed in accordance with the NEC and shall be UL approved, and shall be filled with an approved sealing compound.

BB. Provide tie-down stakes for all conduits embedded in, or located below, floor slabs to prevent conduits from floating during concrete pouring.

CC. Maintain a minimum 1 inch clearance between underground or in-slab conduits to prevent voids during backfill.

DD. During construction, provide securely fastened caps or plugs on all conduit stub-ups to prevent debris from entering the conduit.

EE. Conduits stubbed through floor slab for connections to free-standing equipment shall be hot-dipped galvanized metal Conduit. Conduits shall be terminated with a threaded coupling set flush with top of finished floor slab or top of equipment pad. Where no equipment connections are made, install a flush plug in end of coupling.

FF. Conduits installed in concrete floor slabs shall be located so as not to adversely affect the structural strength of the slab. Curved portion of conduits turning up

shall not be visible above the slab. Rigid Steel conduits encased in concrete shall be coated with bitumastic paint.

GG. Provide a factory manufactured 90 degree elbow for all transitions from underground (or in-slab) conduits to above slab conduits, as follows:

1. 2” and smaller: metal conduit.

2. 2-1/2” and larger:
   a. Concealed: Nonmetallic Conduit.
   b. Exposed: Metal Conduit.

3. Equipment feeders within the space (all sizes): Metal Conduit.

4. Provide all grounding and bonding bushings and jumpers as required.

HH. FLEXIBLE CONDUIT

1. Liquidtight flexible metal conduit shall be used for connections to all motors, dry type transformers and any equipment where flexible connections are required because of vibration or relative motion. Application of liquidtight flexible metallic conduit shall conform to Article 351 of the NEC. Fittings shall be provided with insulated throats.

2. The use of flexible metal conduit shall be limited in application to the connection of recessed lighting fixtures, equipment and devices installed in suspended ceiling, and in length not to exceed 6 feet.

END OF SECTION

SECTION 16123

BUILDING WIRE AND CABLE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. Section Includes:

1. Building wire and cable.
2. Wiring connectors and connections.

B. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the Work.

C. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.

D. Provide this work in accordance with the Contract Documents, (and the pertinent sections of the other References), and the manufacturers requirements and recommendations. Conflict shall be as determined by the Architect/Engineer.

E. All accessories required or recommended by the References or the manufacturer shall be provided.

1.03 REFERENCES: (ALL SHALL BE THE LATEST EDITING THAT IS RECOGNIZED BY THE LOCAL GOVERNING AUTHORITIES, FOR THIS PROJECT.)

A. ANSI/UL44 – Rubber Insulated Wires and Cables.

B. ANSI/Ul83 – Thermoplastic Insulated Wires and Cables.

C. UL486A – Wire Conductors and Soldering Lugs for Use with Copper Conductors.

D. ANSI/UL493 – Thermoplastic Insulated Underground Feeder and Branch Circuit.

E. ANSI/UL854 – Service Entrance Cables.

F. NEMA WC3 – Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

G. NEMA WC5 – Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

H. NEMA WC7 – Cross-linked Thermosetting Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

I. NECA Standard of Installation (National Electrical Contractors Association).

J. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

K. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS FOR REVIEW

A. Submittals concerning the work of this Section are only required as stipulated within this Section. Extraneous submittals will be returned with no action.

B. Required Submittals

1. Megger Test – See Field Testing

PART 2 PRODUCTS

2.01 DESCRIPTION

A. All conductors shall be copper of the number and AWG sizes indicated on the drawings and sized to equal or exceed the requirements of the NEC. Unless indicated otherwise, wiring shall be not less than No. 12 AWG.

B. Each coil of wire shall be delivered to the job in its original unbroken wrapping bearing Underwriter's Laboratories listing.

C. All conductors shall be copper, Type B stranded, except conductors #10 AWG or smaller, shall be solid. All conductors feeding motors and transformers shall be stranded copper, regardless of size.

D. Conductors No. 6 and smaller shall be identified by a continuous insulation color. Conductors larger than No. 6 shall be identified by three laps of colored tape equal to Scotch #35 at each point of access to the conductors.

E. All wire sizes indicated on the drawings are based upon the use of copper conductors with 75 degrees C rated insulation.

F. Provide lugs to accept the indicated conductor sizes and conductor sets on all equipment provided under Division 16.

2.02 BUILDING WIRE

A. Acceptable Manufacturers:

1. Triangle.

2. Southwire

3. Senator.

4. Okonite

B. Description: Single conductor insulated wire.

C. Conductor: Copper.

D. Insulation Voltage Rating: 600 volts.

E. Insulation Temperature Rating: 75°C.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify the raceway installation is complete and supported.

B. Completely and thoroughly swab raceway before installing wire.

3.02 WIRING METHODS

A. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

B. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

C. Above Accessible Ceilings: Use only building THHN/THWN insulation, in raceway.

D. Wet or Damp Interior Locations and Exterior Locations: Use only building wire, Type THWN

E. insulation, in raceway.

3.03 INSTALLATION

A. Route wire and cable as required to meet Project Conditions.

B. Install cable in accordance with the NECA "Standard of Installation."

C. Use stranded conductors for control circuits.

D. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet, and for 20 ampere, 277 volt branch circuits longer than 200 feet. The Contractor shall be responsible for determining distances and making this adjustment where applicable.

E. Pull all conductors into raceway at same time.

F. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

G. Color coding of conductors shall be as follows:

1. Conductors No. 8 AWG and smaller shall have continuous colored outer insulation.

2. Conductors No. 6 AWG and larger shall be color coded using colored plastic tapes at each termination.

3. 480/277 Volt (3 phase, 4 wire) System

Phase C	Yellow
Neutral	White
Ground	Green
Phase A	Brown
Phase B	Orange

4. 208/120 Volt (3 phase, 4 wire) Systems:

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

H. The cable pulling lubricant shall be compatible with all cable jackets. The lubricant shall be UL and CSA listed. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes.

I. Provide all wire and cable of AWG sizes indicated on the drawings and as specified or required to provide a complete installation.

J. Install wiring in conduit as recommended by the wire manufacturer, unless otherwise indicated. Install splice-free conductors within ducts, conduits or earth.

K. Conductors shall be continuous from outlet to outlet with splices made only in pull, outlet or junction boxes.

L. Insulate splicing connectors to at least 200 percent of insulation. Use pre-stretched tubing connector insulator, (Basis of Design: 3/M PST), for No. 2 and larger conductors. Pull conductors using recognized methods and equipment leaving eight inches (minimum) of wire at junctions for connections.

M. Use UL listed compound as required to facilitate pulling. Complete all conduit connections and clean out the conduit system before pulling wire.

N. Form all wiring in panelboards, switchboard, and control panels utilizing cable ties equal to T&B “TY-RAP”.

O. Use split-wedge cable supports or cable support grips, which clamp or support each conductor individually, in vertical feeders where required.

P. Wiring in hot locations and for recessed fixtures shall have heat-resistant insulations applicable for the purpose.

Q. Cable pulling tension shall not exceed cable manufacturer's specifications.

R. Each conductor shall be identified by phase and system wherever the conductor is accessible. Identification shall be by conductor insulation color or marking tape color. This means of identification shall be permanently posted at each panelboard.

S. Provide wire markers on each conductor indicating its circuit number. Also provide wire markers on each neutral and ground conductor indicating the circuit(s) served. The aforementioned wire markers shall be required at conductor terminations and at each accessible point along the circuit patch.

T. Field Testing

1. Prior to termination and energizing, megger test cable insulation integrity by impressing 1000-volt DC with Biddle Major megger for size #3 AWG and larger. Record and certify the test results and submit the same to the Engineer of Record **prior to termination for review**. The megger test shall be performed in the presence of the Owner or his representative. The Contractor shall replace any cable and be responsible for the cost of replacement of the cable(s) if the tests indicate the cable insulation is defective.

2. Prior to energizing, test wires and cable for electrical continuity and for short circuits.

3. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

4. The size and type of insulation for feeder conductors shall be readily visible in each panelboard or cabinet in which cables are visible, or the cables shall be tagged with this information.

END OF SECTION

SECTION 16124

WIRE AND CABLE CONNECTIONS AND DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, AND GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. Installation of wire and cable devices for splicing and terminating conductors in power, lighting, equipment, grounding, and control circuits 600 volts and below.

1.03 RELATED WORK

A. Section 16120 – Wire and Cable, 600 Volts and Below

1.04 REFERENCES

A. NEC – National Electrical Code, 2002

B. UL 486 – Wire connectors and soldering lugs for use with copper conductors

1.05 SUBMITTALS

A. Submit product data under provisions of Section 16010.

PART 2 PRODUCTS

2.01 GENERAL

A. Insulation of terminations, splices, and taps shall be at a minimum equal to the insulation of the wire or cable.

B. Conductors No. 10 and 12 AWG shall be connected with pre-insulated spring connector encased in a steel shell and rated at not less than 105 degrees C. The connector shall have an insulated vinyl cap with a minimum 3/8 inch skirt to cover the bare wires.

C. For run and tap applications in fixture wiring, wire sizes 18 through 10 AWG, preinsulated selfstripping, double U contact connectors shall be used.

D. Splices in conductors #8 AWG and larger shall be made with compression connectors.

E. Lugs for control wiring shall be nylon or vinyl insulated slotted spring spade lugs.

F. Run taps in conductors #8 AWG and larger shall be made with an insulated molded body device that provides a spring like action on contact teeth, ensuring continuous pressure at the point of electrical contact. Contact teeth shall be tin plated with silicon lubricating compound, filling all voids to avoid corrosion.

G. Lugs for copper, power wiring, sizes No. 12 and No. 10 AWG, shall be uninsulated ring type. Lugs for copper power wiring No. 8 to size 1/0 AWG shall be one-hole compression type. Size 1/0 AWG and larger conductors shall be two-hole compression type except where one hole is required to match motor leads.

H. Where motor leads are furnished without lugs, furnish and install ring tongue lugs on both motor leads and power feed conductors and bolt together with high strength bronze hex head bolts, nuts and lock washers.

I. Motor connections shall be made with an insulated heat-shrinkable, cross linked polymeric insulating material. Bolt connection area shall be kept free of mastics and fillers.

2.02 ACCEPTABLE MANUFACTURERS

A. LUGS

1. Thomas & Betts
2. Burndy
3. 3-M
4. Homac

B. RUN AND TAP CONNECTIONS

1. Kupler
2. Burndy
3. Ilsco

C. SPLICES

1. Thomas & Betts
2. Burndy
3. 3-M
4. Ilsco

D. MOTOR LEAD CONNECTION KITS

1. Ray Chem
2. 3-M

PART 3 EXECUTION

3.01 INSTALLATION

A. Power or lighting conductors shall be pulled from terminal to terminal without splices or taps unless otherwise indicated.

B. Control conductors shall terminate in terminal boards. No conductor shall be tapped or spliced unless specifically indicated.

C. Compression type connectors shall be installed with appropriate dies and compression tools. Connectors and dies shall be keyed or coded to assure accurate matching.

D. Cable and wire ends shall not be strand-snipped to reduce in size or shimmed to fit oversized of undersized connectors.

E. All splices, taps, and connections shall be taped except where pre-insulated run and tap connections and motor lead connection kits are used. Wire nuts shall be taped.

F. Large and Bulky Connections

1. All voids, sharp corners, and bolt projections shall be made smooth by filling with an electrical grade, rubber-based, elastic type putty in tape form.

END OF SECTION

SECTION 16130

BOXES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. Section Includes:

1. Wall and ceiling outlet boxes.
2. Pull and junction boxes.

B. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the Work.

C. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.

D. Provide this work in accordance with the Contract Documents, NFPA 70-NEC, the pertinent sections of the other References, and the manufacturers requirements and recommendations. Conflicts shall be as determined by the Engineer.

E. All accessories required or recommended by the References or the manufacturer shall be provided.

1.03 REFERENCES: (ALL SHALL BE THE LATEST EDITION THAT IS RECOGNIZED BY THE LOCAL GOVERNING AUTHORITIES, FOR THIS PROJECT.)

A. NECA - Standard of Installation.

B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NFPA 70 - National Electrical Code.

F. ANSI/UL 50 – Electrical Cabinets and Boxes.

G. ANSI/UL 514 – Electrical Outlet Boxes and Fittings.

H. ANSI/NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

I. NEMA ICS6 – Enclosures for Industrial Controls and Systems.

1.04 SUBMITTALS

A. Submittals concerning the work of this Section are only required as stipulated within this Section. Extraneous submittals will be returned with no action.

B. Required Submittals

1. Submit product data.

1.05 REGULATORY REQUIREMENTS

A. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS – BOXES

A. Outlet and Junction Boxes.

1. Appleton
2. Steel City
3. Raco
4. Carlon

B. Pull Boxes

1. James F. Burns
2. General metal
3. Hammond
4. Hoffman

2.02 OUTLET BOXES

A. General

B. Cast type boxes shall be of cast iron, or ferrous alloy. Boxes shall have threaded hub and sheet steel gasketed covers.

1. Equipment Supporting Boxes: Rated for weight of equipment supported; include ½ inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 16140.

2.03 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, ANSI/UL 514, galvanized steel.

B. Hinged Enclosures: As specified in Section 16160.

C. Surface Mounted Cast Metal Box: NEMA 250, ANSI/UL 514; flat-flanged, surface mounted junction box:

1. Material: Galvanized cast iron, with threaded hubs.

2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify locations of floor boxes and outlets prior to rough-in.

3.02 INSTALLATION

A. All conduit boxes shall be securely and rigidly attached to the permanent construction and shall not depend upon conduit for support.

B. Install boxes in accordance with NECA "Standard of Installation."

C. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

D. Set wall mounted boxes at elevations to accommodate mounting heights indicated.

E. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.

F. Maintain headroom and present neat mechanical appearance.

G. Install pull boxes and junction boxes in accessible locations only.

H. Inaccessible Areas: Install outlet and junction boxes no more than 6 inches from access panel or from removable recessed luminaire. Provide access panels in inaccessible door and ceilings where none are shown or indicated.

I. Install boxes to preserve fire resistance rating of partitions and other elements.

J. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

K. Locate outlet boxes to allow luminaires to be positioned as indicated.

L. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices. Verify all door swings and casework locations prior to installing boxes.

M. Provide flush mounting outlet box in finished areas.

N. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

O. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.

P. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

Q. Provide stamped steel bridges to fasten flush mounting outlet box between studs.

R. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

S. Provide adjustable steel channel fasteners for hung ceiling outlet box.

T. Do not fasten boxes to ceiling support wires.

U. Outlet boxes for surface installation shall be the cast [aluminum] ferro alloy type with threaded hubs.

V. Provide gang box where more than one device is mounted together. Do not use sectional box.

W. Provide gang box with plaster ring for single device outlets.

X. Provide cast outlet box with threaded hubs and cast iron [aluminum] gasketed cover in exterior locations exposed to the weather and wet locations.

Y. Provide cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installation in elevated slabs.

Z. Pull Boxes: Provide hinged enclosure NEMA 1 in interior dry locations, wet locations. NEMA 3R.

AA. For boxes mounted in exterior walls, provide insulation behind outlet box.

3.03 ADJUSTING

A. Adjust floor box flush with finish flooring material.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused box openings.

3.04 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 16131

WIREWAYS AND AUXILIARY GUTTERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. Necessary bends, couplings, and connectors shall be furnished for proper installation.

1.03 RELATED WORK

A. Section 16110 – Rigid Metal Conduit and Fittings

B. Section 16114 – Liquidtight Flexible Conduit and Fittings

C. Section 16450 – Grounding

1.04 REFERENCES

A. NEC – National Electrical Code, 2002

B. UL 870 – Wireways, Auxiliary Gutters, and Associated Fittings

1.05 SUBMITTALS

A. Submit product data under provisions of Section 16010

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square D

B. Hoffman

C. Products similar in construction to the manufactured products specified herein, from local sheet metal fabricators having UL follow-up service and who are authorized to UL label their finished products, will be acceptable.

2.02 WIREWAYS AND AUXILIARY GUTTERS

A. GENERAL

1. Wireways shall be constructed in accordance with UL 870 for Wireways, Auxiliary Gutters and Associated Fittings. Every component, including

lengths, connectors and fittings shall be UL listed. Hinged covers shall be removable and capable of being reinstalled without tools. Provisions shall be included in the construction to allow converting the hinged cover to a screwed cover without the need for additional parts. It shall also be possible to seal the cover in the closed position with a sealing wire. Ample knock-outs shall be provided as required.

2. Wireways shall be suitable for lay-in conductors. Connector covers shall be permanently attached so that removal is not necessary to utilize the lay-in feature. All sheet metal parts shall be provided with a rust inhibiting phosphatizing coating and ANSI grey baked enamel finish. All hardware shall be plated to prevent corrosion. All screws installed towards the inside shall be protected by spring nuts or otherwise guarded to prevent wire insulation damage.

3. All connectors shall be slip-in type with self retained mounting screws. All hangers shall be two-piece with hook together feature to permit preassembly of wireway and hanger bottom plate before hanging on pre-installed upper bracket.

PART 3 EXECUTION

3.01 INSTALLATION

A. Bolt auxiliary gutter to steel channels fastened to the wall and level.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. All required hangers, supports, clamps, sleeves, inserts, anchors, etc. required for the installation of the electrical work of this Division.

B. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the Work.

C. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.

D. Provide this work in accordance with the Contract Documents, (and the pertinent sections of other References), and the manufacturers requirements and recommendations. Conflicts shall be as determined by the Engineer.

E. All accessories required or recommended by the References or the manufacturer shall be provided.

1.03 REFERENCES: (ALL SHALL BE LATEST EDITING THAT IS RECOGNIZED BY THE LOCAL GOVERNING AUTHORITIES, FOR THIS PROJECT.)

A. UL – Underwriter's Laboratories.

B. NECA Standard of Installation (National Electrical Contractors Association).

C. NFPA 70 - National Electrical Code.

D. IEEE – Institute of Electrical and Electronic Engineers.

E. ANSI – American National Standards Institute.

F. NFPA National Fire Protection Association.

G. NEMA – National Electrical Manufacturer's Association.

1.04 SUBMITTALS FOR REVIEW

A. Submittals concerning the work of this Section are only required as stipulated within this Section. Extraneous submittals will be returned with no action.

B. Required Submittals

1. Submit all product data.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Materials and Finishes: Corrosion resistant.

B. Select materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit, including weight of wire in conduit.

1. All hangers and supports shall be fabricated and assembled in such a way that they will not be disengaged by movement of the supported equipment.

2. Hanger rods for support of electrical equipment shall not be less than 3/8” diameter.

3. All channel framing system members, fittings and brackets shall be formed steel with hot-dipped galvanized finish conforming to ASTM A-124 and/or A-153 (galvanized after fabrication). All threaded fasteners, hardware and hanger rods shall have electro-galvanized zinc coating to commercial studs.

2.02 FORMED STEEL CHANNEL

A. Manufacturers:

1. Unistrut

2. Kindorf

3. Globe

B. Description: Galvanized steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

1. Do not fasten supports to pipes, ducts, mechanical equipment, conduit or cable tray.

2. Obtain permission from Architect/Engineer before drilling or cutting structural members.

B. Fabricate supports from structural steel or formed steel members. Rigidly weld members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

C. Install surface-mounted cabinets and panelboards with minimum of four anchors.

D. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.

E. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

F. The exact location of all equipment shall be carefully coordinated with the work and requirements of the other trades involved to ensure compatibility and to avoid conflicts.

G. Supports

1. Conduit supports, fastened boxes, panels, etc. shall be fastened with wood screws on wood; with cinch anchors, precast inserts, or bolts and expansion shields on concrete or brick; with toggle bolts on hollow masonry units; and with machine screws, welded thread studs, beam clamps with safety straps or rods or welded clips on steel work. Raceway and equipment hangers shall be attached to channels or angles fastened to these inserts as required. Heavy equipment shall be bolted through wall and furnished with support plates on the back side of the wall as required. Wooden plugs inserted in concrete or masonry or wire and strap hangers are not acceptable as a base for raceway fastenings, nor shall raceway or pipe straps be welded to steel structures. All supports not factory galvanized shall be painted with at least one coat of zinc chromate primer and with one coat of pearly gray enamel.

2. Hangers and supports shall be placed at intervals in accordance with the requirements of the National Electrical Code.

3. All horizontal or vertical runs of raceways shall be properly grouped and hung to true alignment.

4. Single Runs: Galvanized conduit straps on ring bolt type hangers with specialty spring clips. Do not use plumbers perforated straps.

5. Multiple Runs: Conduit racks with 25 percent spare capacity, utilizing steel slotted channel, with steel conduit straps.

6. Vertical Runs: Steel slotted channel support with steel conduit straps.

7. Horizontal Runs: Steel slotted channel support with steel conduit straps.

H. Anchor Methods:

1. Hollow Masonry: Toggle bolts or spider type expansion anchors.

2. Solid Masonry: Lead expansion anchors or preset inserts.

3. Metal Surfaces: Machine screws, bolts, or welded studs.

4. Wood Surfaces: Wood screws.

5. Concrete Surfaces: Self-drilling anchors or powder actuated studs.

6. Anchors shall be Hilti, Ramset / Redhead, or Rawl.

I. Indoors in Dry Areas: Slotted channels shall be minimum 12 gauge galvanized steel.

J. Indoors in Wet, Damp or Corrosive Areas: Threaded materials shall be stainless steel. Slotted channel and other materials shall be aluminum and / or steel, minimum 12 gauge.

K. Outdoors: Threaded material shall be stainless steel. Slotted channel and all other

L. Materials shall be aluminum, stainless steel or both, minimum 12 gauge.

M. Cable Supports: Provide cable strain relief device on vertical runs exceeding 20 ft., as manufactured by Kellums.

N. Installation:

1. Layout to maintain headroom, neat mechanical appearance, and to support equipment loads required.

2. Loading of Equipment Supports:
   a. Spans up to 5 feet: Deflection shall not exceed 1/24- of span.
   b. Spans 5 feet and greater: Deflection shall not exceed 1/360 of span.
   c. Compressive loading shall not exceed 33 percent of manufacturer's published ratings.

O. All horizontal runs of conduit shall be properly grouped and hung to true alignment using substantial and appropriate hangers, clamps, etc., equal to Unistrut or B-Line. Hanger and support locations shall be coordinated with work of the existing and new equipment to avoid conflicts. hangers and supports for conduits shall be placed at intervals not exceeding the spacing of eight (8) feet, maximum.

P. Prime paint all bare unplated, unpainted metal surfaces of materials and equipment furnished and / or installed under these specifications. All outside surfaces of steel exposed to the weather shall be hot-dip galvanized.

3.02 MISCELLANEOUS IRON AND STEEL

A. Furnish and install steel supports, racks, gratings, stairs, ladders, platforms and hangers as shown on the drawings or required, to support and provide access to all electrical equipment. Shop drawings of proposed work shall be submitted.

B. All work shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets, frameworks and platforms shall be properly sized and strongly constructed.

C. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be performed by experienced metal-working mechanics. Members shall be straight and true and accurately fitted. Scale, rust and burrs shall be removed. Welded joints shall be ground smooth where exposed. Drilling, cutting and fitting shall be done as required to properly install the work and to accommodate the work of other trades as directed by them. Generally, cutting, bolting and welding shall conform to the requirements of AISC.Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

D. Members shall be generally welded or riveted; except that bolting may be used for field assembly where welding or riveting would be impractical. Welders shall be qualified for the type of welding involved in accordance with the procedures of the American Welding Society (AWS).

E. All shop fabricated iron and steel work shall be cleaned and dried and given a shop coat of rust inhibitive paint on all surfaces and in all openings and crevices.

F. All field fabricated metal materials shall be treated and primed painted.

3.03 ROOF CONDUIT SUPPORT SYSTEM

A. Provide conduit and pipe support products equivalent to MIRO Industries Inc.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the Work.

B. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.

C. Provide this work in accordance with the Contract Documents, (and the pertinent sections of the References), and the manufacturers requirements and recommendations. Conflicts shall be as determined by the Architect/Engineer.

D. All accessories required or recommended by the References or the manufacturer shall be provided.

1.03 REFERENCES (ALL SHALL BE THE LATEST EDITION THAT IS RECOGNIZED AND ACCEPTED BY THE LOCAL GOVERNING AUTHORITIES)

A. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

A. Submittals concerning the work of this Section are only required as stipulated within this Section. Extraneous submittals will be returned with no action.

B. Required submittals:

1. Submit product data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers

1. Acceptable Manufacturers:

a. Seton
b. Wilmington Plastics Co.
c. W.H. Brady Co.
d. Ideal
e. Thomas & Betts

2.02 LABELS

A. Description: Laminated mylar, ½" high, adhesive backed with printed identification. Black letters on white background.

2.03 NAMEPLATES

A. Laminated three layer plastic, with engraved black letters on contrasting white background.

B. Letter size for equipment shall be 2" high.

2.04 VINYL CABLE MARKERS

A. Shall be pre-packaged, numbered, all temperature self sticking.

2.05 MARKER

A. Black, indelible ink, wide tip.

2.06 UNDERGROUND WARNING TAPE

A. Bright colored, 6 inch wide plastic tape, detectable type with continuously printed suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates.

3.02 INSTALLATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using corrosive-resistant mechanical fasteners or epoxy.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Identify above ceiling conduit using marker, by panel and circuit number(s).

E. Identify pull and junction boxes (above ceiling) using marker.

1. Lighting and power boxes shall be identified by panel and circuit(s).

2. System boxes shall be identified by system type (security, intercom, data, phone, etc.)

F. Fire alarm, pull and junction boxes shall have their covers painted red, with the zone and circuit identified by marker within the box.

G. Identify underground conduits using one underground warning tape per trench at 3 inches below finished grade.

END OF SECTION

SECTION 16310

UNDERGROUND DUCT SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, AND GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. Underground Duct System

1.03 RELATED WORK

A. Section 02300 – Earthwork

B. Section 16450 – Grounding

1.04 REFERENCES

A. American National Standards Institute (ANSI) Publication:

1. C2-2001 – National Electrical Safety Code (NESC)

B. National Electrical Manufacturer's Association (NEMA) Publications:

1. TC3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
2. TC6 – PVC and ABS Plastic Utilities Duct for Underground Installation

C. National Fire Protection Association (NFPA) Publication:

1. 70 – National Electrical Code (NEC)

D. Underwriters' Laboratories, Inc. (UL) Publications:

1. 467 – Grounding and Bonding Equipment
2. 510 – Insulating Tape

1.05 SUBMITTALS

A. Submit product data under Provisions of Section 16010. Provide list of product manufacturers only.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Conduit: Shall be rigid plastic conforming to the following:

1. Plastic conduit for concrete encased (EPC –40-PVC) shall conform to NEMA TC2 and TC6.

B. Pull Wire: Pull wire shall be plastic, having a minimum tensile strength of 200 pounds.

C. Grounding: Grounding and bonding equipment shall conform to UL 467. Ground rods shall be copperweld type copper clad steel with diameter adequate to permit driving to full length of the rod, but not less than ¾ inch in diameter and 20 (sectional) feet long unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Underground installation shall conform to ANSI C2 and NFPA 70 except as otherwise specified or indicated.

3.02 CONTRACTOR DAMAGE:

A. The contractor shall acquire the services of a professional underground utilities locator to locate and identify existing utilities. The contractor shall promptly repair any indicated utility lines or systems damaged by his operations. If the Contractor is advised in writing or shown as or identified on the site of the location of a non-indicated line or system, such notice shall provide that portion of the line or system with “indicated” status in determining liability for damages.

3.03 UNDERGROUND DUCT WITHOUT CONCRETE ENCASEMENT:

A. Underground duct lines shall be constructed of individual conduits. Except where rigid galvanized steel conduit is indicated or specified, the conduit shall be of PVC – SCH 40. The kind of conduit used shall not be mixed in any one duct bank. Ducts shall not be smaller than 4 inches in diameter unless otherwise indicated.

B. The top of the duct shall not be less than 18 inches below grade except that under roads and pavement, it shall be not less than 24 inches below grade.

C. Duct lines shall have a continuous slope downward toward underground structures and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 feet; sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with conduits of less than

3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter and larger. Trenches shall be excavated along straight lines from structure to structure before ducts are laid or structure constructed so the elevation can be adjusted, if necessary, to avoid unseen obstruction.

D. Terminate conduits in end-bells where duct lines enter underground structures. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked-in duct bank. Install spacers per manufacturer's instructions but provide a minimum of two spacer assemblies per 10 feet of duct bank.

E. As each section of duct line is completed from structure to structure, a testing mandrel not less than 12 inches long with a diameter ¼ inch less than the size of the conduit shall be drawn through each conduit; after which a brush, having the diameter of the duct and having stiff bristles, shall be drawn through until the conduit is clear of all particles of earth, sand, and gravel; conduit plugs shall then be immediately installed.

F. New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

G. Connections to Existing Manholes: For duct line connections to existing structures, break the structure wall out to the dimensions required and preserve the steel in the structure wall. Cut the steel and extend it into the duct line envelope.

H. Warning Tapes in Earth Trenches: For the purposes of early warning and identification during future trenching or other excavation, continuous identification tapes shall be provided in the trench. Tape shall be magnetic plastic tape manufactured for the purpose of early warning and identification of utilities buried below the tape. Tape shall be at least 1 inch high with not less than the following identification on the tape: "BURIED ELECTRIC LINE BELOW". Tape shall be installed according to the printed recommendations of the tape manufacturer, as modified herein. Tapes shall be buried at a depth of 6 inches below the top surface of earth; in pavements, this 6 inches shall be measured from the top of the subgrade.

3.04 GROUNDING

A. Grounding: Noncurrent-carrying metallic parts associated with electrical equipment shall have a maximum resistance to solid "earth" ground.

B. Grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required, shall be made by exothermic weld. Exothermic welds shall be made strictly in accordance with the weld manufacturer's written recommendations.

Welds which have “puffed up” or which show convex surfaces, indicating improper cleaning, are not acceptable.

C. Grounding conductors shall be stranded bare copper conforming to ASTM B8, Class B, for sizes No. 6 AWG and larger, and shall be solid bare copper conforming to ASTM B1 for sizes No. 8 and smaller. Cable sheaths, cable shields, conduit, and equipment shall be grounded with No. 6 AWG.

D. Ground Cable Crossing Expansion Joints: Ground cables crossing expansion joints or similar separations in structures and pavements shall be protected from damage by means of suitable approved devices or methods of installation which will provide the necessary slack in the cable across the joint to permit movement. Stranded or other approved flexible copper cable run or jumper shall be used across such separations.

E. Special Conditions: During the construction of all duct lines and underground structures located in streets, the streets shall remain open to traffic. The Contractor shall plan and execute his work to meet this condition.

F. Field Tests: As an exception to requirements that may be stated elsewhere in the contract, the Engineer shall be given 5 working days notice prior to each test. The Contractor shall provide all labor, equipment and incidentals required for testing, except that the Owner will provide electric power required for the tests. All defective material and workmanship disclosed as the result of the test given herein shall be corrected by the Contractor at no cost to the Owner. The Contractor shall show by demonstration in service that all circuits and devices are in good operating condition. Tests shall be such that each item of control equipment will function no less than five times.

G. Ground Rods: Test ground rods for ground resistance value before any wire is connected. Ground resistance measurements shall be made in normally dry weather, not less than 48 hours after rainfall. Ground resistance shall also be measured for each piece of equipment to the ground electrode. A portable ground testing meggar shall be used to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground electrode under test. Provide one copy of the meggar manufacturer’s directions for use of the ground meggar, indicating the method to be used.

H. Compaction: Backfill shall be tested in accordance with ASTM D1556, one test per lift per 2000 square feet.

END OF SECTION

SECTION 16440

DISCONNECT SWITCHES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, and GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. Disconnect switches.

1.03 RELATED WORK

A. Section 16410 – Fuses.

B. Section 16450 – Grounding.

1.04 REFERENCES

A. NEC – National Electrical Code.

B. NEMA KS 1 – Enclosed Switches.

C. NEMA ICS 6 – Enclosures for Industrial Controls and Systems.

D. UL 98 – Enclosed Switches.

1.05 SUBMITTALS

A. Submit product data under provisions of Section 16010.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS – SAFETY SWITCHES

A. Square D

B. Cutler Hammer/Westinghouse

2.02 SAFETY SWITCHES

A. Disconnect switches shall be of heavy duty HD single throw, non-fusible or fusible type as shown on the drawings.

B. Fusible Switch Assemblies: NEMA KS 1: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch on ON position. Handle

lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses as specified.

C. Non-Fusible Switch Assemblies: NEMA KS 1: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. Enclosures: NEMA KS 1; Type as shown on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Enclosure shall be adequate for connection of conduit and wire size shown on the drawings, including installation of all necessary connector hardware and insulation. Any deficiency in this regard shall be made good by replacement with an adequately sized enclosure.

B. Enclosures shall be aligned and fastened to the adjoining construction. Connecting conduit shall not be used to support the enclosure.

END OF SECTION

SECTION 16450

GROUNDING AND BONDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, DIVISION 1, GENERAL REQUIREMENTS shall apply to the work of DIVISION 16, ELECTRICAL, as fully as if included herein.

1.02 WORK INCLUDED

A. SECTION INCLUDES

1. Furnish, install, test, and place into operation, Equipment Grounding System complete, as specified herein.

B. The work indicated in this Section shall be provided complete, suitable for its intended use, and shall be fully incorporated into the Work.

C. The provisions of the Contract Documents apply to the work of this Section, and shall be carefully examined, for their applicability to this Section, to ensure a complete installation.

D. Provide this work in accordance with the Contract Documents, NFPA 70-NEC, (and the pertinent sections of the other References), and the manufacturers requirements and recommendations. Conflicts shall be as determined by the Engineer.

E. All accessories required or recommended by the References or the manufacturer shall be provided.

1.03 REFERENCES (ALL SHALL BE THE LATEST EDITION THAT IS RECOGNIZED AND ACCEPTED BY THE LOCAL GOVERNING AUTHORITIES)

A. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

B. NFPA 70 - National Electrical Code.

C. Institute of Electrical and Electronic Engineers (IEEE)

1. 81 – Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth.

D. American Society for Testing and Materials (ASTM)

1. D2216 – Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil Aggregate Mixtures.

PART 2 PRODUCTS

2.01 ROD ELECTRODES

A. Material: Copper-clad steel.

B. Diameter: 3/4 inch.

C. Length: 20 feet (sectional).

2.02 WIRE

A. Material: Stranded copper.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

A. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve 5 ohms or less resistance to ground. Provide exothermic connections for sectional ground rods.

B. Direct buried ground connections and building steel connections shall be exothermic type Cadweld or Thermoweld.

C. Provide bonding to meet Regulatory Requirements.

D. Provide isolated grounding conductor for circuits supplying telecommunications equipment.

E. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

F. Interface with lightning protection system installed.

G. Second Distribution Ground System:

1. Ground the electrical service system neutral at service entrance equipment to metallic water service and to supplementary grounding electrodes.

2. Ground each separately derived system neutral to nearest effectively grounding metallic water pipe, nearest effectively grounded building structural steel member or separate grounding electrode.

END OF SECTION