

SECTION 33 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide complete, tested and fully functional electrical systems as shown on the Drawings and as specified herein.
- B. Electrical equipment and installed systems shall be suitable for the intended application, shall be safe for the intended use, shall be fully rated for the available fault current, and shall conform to local building codes and statutory requirements.
- C. Section Includes:
 - 1. General Provisions
 - 2. Electrical equipment coordination and installation.
 - 3. Common electrical installation requirements.
 - 4. Common Quality Plan requirements
 - 5. Common Safety program requirements
 - 6. Supplemental Staffing for University Supervised Project Related Activity
 - 7. Selective demolition of existing equipment and structures

1.3 SCOPE OF WORK

- A. The work includes, but is not limited to, the following:
 - 1. Secondary electrical service
 - 2. Modifications to existing manholes
 - 3. Grounding and bonding
 - 4. Electrical identification

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5. Removal and/or relocation of existing equipment
 6. Site Security Lighting
 7. Thorough cleaning of all equipment prior to energization
 8. Protection of all equipment under this Division until the final acceptance of the job
- B. Coordinate Division 26 and Division 33 requirements with work in other Divisions.
- C. Submit preconstruction submittals, shop drawings, product data, samples, design data, test reports, certificates, manufacturer's instructions, manufacturer's field reports, operation and maintenance data, closeout submittals and other specified documents to the Engineer for review and approval as described in Division 1, in this Section, and in other Sections of Division 33.
- D. Coordinate electrical acceptance tests performed by a Testing Company under a separate contract.

1.4 DEFINITIONS

- A. EPR: Ethylene-propylene-rubber.
- B. UTHVS: Utilities High Voltage Services, within Utilities, Energy Services and Sustainability Department, within the Facilities Operations and Development Division, at the Ohio State University.
- C. Medium Voltage: Voltages less than 35kV (thirty-five kilo-volts) and higher than 600V (six hundred volts). 13.2kV (thirteen point two kilo-volts) and 4160V (four-thousand one hundred sixty volts) are medium voltages.
- D. Service Connection: A Medium Voltage Primary Select switch(es), fused disconnect switch(es) and facility Primary step down transformer.
- E. Primary: 13.2 kV power distribution system
- F. Lateral: The portion of the 13.2 kV Primary distribution system connecting the Primary Select switch to the primary Mains
- G. Load-way: The 13.2 kV cables running from the load side of the Primary Switch to the Facility fused transformer disconnect and transformer.
- H. Testing Company: A NETA Certified testing company, contracted independently from the Construction Contractor.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow access for operation and maintenance.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and pre-existing conditions.
 4. Maintain raceways, clear of obstructions and clear of the working and access space of other equipment or utilities.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate the availability of suitably skilled and qualified personnel to assist the University UTHVS in executing the certain critical aspects of the demolition, make ready and switch refurbishment activities associated with the project.
- D. Coordinate Selective demolition activities with the Project and Utilities UTVS and requirements of Division 02 Section "Selective Structure Demolition".
- E. In case of conflict between the as found conditions and contract drawings and specifications, the Contractor shall promptly notify the A/E / Associate through the RFI Process.

1.6 SAFETY IN THE WORKPLACE

- A. Electrical equipment and materials, and the Contractor's installation practices, shall conform to the following:
1. Current edition of OSHA sections of the Code of Federal Regulations (CFR): Part 29 CFR 1910 for General Industry and Part 19 CFR 1926 for Construction Activities
 2. NFPA 70, the National Electrical Code
 3. Current edition of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces
 4. Current edition of the National Electric Safety Code (NESC)
 5. Utilities Project Safety and Health Guide; High Voltage Switch and Cable Replacement.
- B. These regulations and standards impose obligations on equipment manufacturers to obtain NRTL certification, listing, and labeling to comply with OSHA (Occupational Safety and Health Act) and Department of Labor regulations.
- C. All electrical equipment for which NRTL test procedures have been established shall be certified, listed, and labeled, or otherwise determined to be safe for its intended use, by a NRTL. The absence of a specific reference to NRTL-listing in other Sections shall not

relieve the Contractor of the requirement to provide NRTL-listed equipment, and to obtain certification as required by the University UTHVS in cases where NRTL listing and labeling is not a manufacturer's standard offering for a particular product.

- D. Equipment shall not be modified in any manner adversely affecting safety for the intended use, nor shall any equipment be modified on-site without the approval of the manufacturer, the engineer, and the University.
- E. Equipment with moving parts shall be fully guarded in compliance with OSHA rules and regulations.

1.7 INSPECTIONS BY UTHVS

- A. Work shall be conducted in conformance with the Utility Project Construction Quality Plan: High Voltage Cable Switch and Cable Project.
- B. All Primary service connections shall be inspected and approved in conformance with the Policy On Service Connections prior to being placed into service.
- C. The Contractor shall make arrangements for electrical inspections of the project as required by UTHVS for in-process inspections and witnessing. Upon completion of the work, final certificate of approval documents shall be submitted to the Engineer for forwarding to the University. This certificate shall be submitted prior to request for final payment.

1.8 WORKMANSHIP AND MATERIALS

- A. Materials and equipment shall be new and undamaged, shall be marked by the manufacturer, and shall be delivered to the construction site in the original factory packaging.
- B. Materials and equipment shall be installed in accordance with the Drawings, the Specification, and the manufacturer's installation, operation, and maintenance instructions. In the event of apparent conflicts or discrepancies, the Engineer shall be informed of the apparent conflict or discrepancy through the RFI process.

1.9 RESOURCES AND CONSTRUCTION SCHEDULE

- A. The Contractor shall provide sufficient resources, including qualified and experienced project managers, superintendents, technicians, supervisors, electricians, tools and construction equipment to complete the electrical work in accordance with the activity durations and sequences shown on the Construction Schedule for this project.
- B. General Requirements:
 - 1. All switchovers of existing circuit pairs and building loads shall be performed in an orderly manner.
 - 2. Once work has started at any switch site, work shall be maintained utilizing multiple shifts until the new switch is installed, operational and energized.

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- C. The construction schedule shall include the following activities and milestones, in realistic sequence, for the work indicated:
1. Sequence of work and detailed phasing plan
 2. Submittal review and approval
 3. Equipment installation
 4. UTHVS inspections
 5. Tests on completion of installation (prior to energization)
 6. Energization (milestone)
 7. Functional testing
 8. Acceptance testing
 9. Installation, testing, and commissioning complete (milestone)
- D. Sequence of work shall be as follows unless modified by the University:
1. Install primary cable from existing SF6 switch loadway #2 to pad mounted transformer with fusible and non-fusible load break cable terminators
 2. Install ductbank and system from the existing ductbank stub out at the sub-station to the secondary metering cabinet.
- E. All switchovers of existing circuit pairs and building loads shall be performed in an orderly manner.

1.10 CONTRACT DRAWINGS

- A. The Electrical Drawings provide scaled layouts of representative equipment and key building dimensions, for example, structural gridlines, but do not include "approved for construction" dimensions for equipment.

1.11 COORDINATION OF WORK

- A. Work under this Division shall be performed in conjunction with the work of other trades. Coordinate electrical installation work with the overall construction schedule. Examine the plans and specifications prior to commencement of work and become familiar with all phases of work involved prior to commencing installation work.

1.12 CODES AND STANDARDS

- A. All equipment and materials shall be manufactured, tested, and installed in accordance

with the National Electric Safety Code (NESC) and all applicable portions of local codes, in accordance with the requirements of the University UTHVS.

- B. In addition, work shall be in accordance with the versions of the following referenced standards in effect at the time of bid opening:
1. American Association for Laboratory Accreditation (A2LA)
 2. American Society for Testing and Materials (ASTM)
 3. American National Standards Institute (ANSI)
 4. Americans with Disabilities Act (ADA)
 5. Code of Federal Regulations (29 CFR 1903, 1910, and 1926)
 6. Factory Mutual Engineering & Research (FME&R)
 7. Illuminating Engineering Society of North America (IESNA)
 8. Insulated Cable Engineers Association (ICEA)
 9. International Organization for Standardization (ISO)
 10. National Electrical Manufacturers Associates (NEMA)
 11. Institute of Electrical and Electronic Engineers (IEEE)
 12. National Fire Protection Association (NFPA)
 13. Occupational Safety and Health Act (OSHA)
 14. Underwriters Laboratory, Inc. (UL) and other NRTL standards and test procedures

1.13 ELECTRICAL SERVICE

- A. Provide primary electrical service as shown on the Drawings and specified herein.
- B. Coordinate the installation of the building electrical service with the University.

1.14 OUTAGES

- A. Electrical outages: Do not interrupt electrical service to facilities occupied by the University. University UTHVS will perform all switching operations.
1. Coordinate all required outages with UTHVS. Submit step-by-step sequence and schedule for proposed interruption, and when required, proposed method of providing temporary electrical service, to the University for approval.

2. Interruption of electrical service shall not be planned without written approval from UTHVS.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Install in compliance with IEEE C2 (NEC) and NFPA 70 where applicable.
- B. Perform selective Demolition of existing equipment and structures in accordance with Division 02 Section "Selective Structure Demolition".
- C. Equipment delivered to site shall be handled in accordance with manufacturer's recommendations by experienced riggers, crane operators, and fork lift truck operators.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to existing structures, utilities and piping systems.
- F. All work shall be performed in accordance with the contract construction drawings and specifications.
- G. All work shall be performed in accordance with the contractor's OSU Project Safety and Health Guide compliant safety program.
- H. All work to be conducted in accordance with the requirements of Section 014000 of this specification and the requirements of the OSU Utilities Project Construction Quality Plan.
- I. Installed equipment, raceways, and wiring shall be inspected on completion of installation for compliance with the Specification and approved installation drawings.
- J. Comply with NECA 1.

3.2 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly as required by the contract drawings.

3.3 ALTERATIONS AND REMOVAL OF EXISTING WORK

- A. Perform selective Demolition of existing equipment and structures in accordance with Division 02 Section "Selective Structure Demolition".

END OF SECTION 33 05 00

SECTION 33 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Equipment enclosure grounding
 - 3. Neutral grounding
 - 4. Touch potential grounding
- B. Provide a complete system of grounding electrodes, grounding electrode conductors, main bonding jumpers, equipment grounding conductors, and bonding in accordance with NEC requirements, in conformance with this Section and as shown on the Drawings.
- C. Design and installation of grounds shall follow IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems, most current edition.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Ground rods.
 - 2. Ground conductors
 - 3. Bonding hardware and systems
 - 4. Ground bus.

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- C. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Instructions for testing and inspection of grounding features based on NETA MTS.
 - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the University Utilities (UTHVS).
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with National Electric Safety Code (NESC) for grounding and bonding requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with the requirements described in this Section, provide products by one of the listed manufacturers in the Sub-Sections below.
 1. Ground Rods:
 - a. Copperweld Corp.
 - b. Eritech / Erico International Corporation
 - c. Galvan Industries, Inc.
 - d. Harger Lightning and Grounding, Inc.
 - e. Robbins Lightning, Inc.
 2. Grounding electrode connectors:
 - a. Exothermic type:
 - 1) Cadweld / Erico International Corporation

- 2) Furseweld
 - 3) Harger Lightning and Grounding, Inc. (Ultraweld)
 - 4) ThermOweld, a division of Continental Industries
- b. Copper compression type:
- 1) Dossert Corp.
 - 2) Framatome Connectors / Burndy
 - 3) Harger Lightning and Grounding, Inc.
 - 4) ILSCO
 - 5) O. Z. Gedney / EGS Electrical Group
 - 6) Panduit Corp.
 - 7) Robbins Lightning, Inc.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper cable insulated for 600 V (THWN) unless otherwise required by applicable Code, contract drawings and specifications. Insulation color shall be green.
- B. Bare Copper Ground Conductors:
1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.
 3. Bonding Cable: 4/0 solid conductor, 4/0 medium stranded (7 conductor), 4/0 high stranded (17 conductor) as required for each application.
 4. Bonding Conductor: No 2, No. 4 or No. 6 AWG, stranded conductor.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 1 inch in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory (NRTL) acceptable to the University Utilities UTHVS for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors: Copper or copper alloy, bolted pressure-type, with at least two bolts.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 5/8 inch by 10 feet in diameter.
- B. Ground Ring: #4/0 AWG Class A stranded copper conductor (7 strand) or solid conductor. 19 strand ground wire is not acceptable in contact with earth.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install stranded conductors unless otherwise indicated.
- B. Enclosures: All electrical equipment, enclosures and skids are to be provided with safety grounding.
 - 1. Equipment case grounding shall be via 4/0 bare copper solid conductor. It shall be attached to the grounded equipment via exothermic weld or bolted connection where required to facilitate removal for equipment maintenance. It shall be bonded to an established ground grid, ground system, or grounded building steel.
 - 2. Equipment skids and multiple equipment enclosure line-up shall have two independent 4/0 ground points. For one of these ground points, individual instrument cabinets and small enclosures (eg. lighting transformers) can utilize the ground carried back to the supply panel with the power cable as long as this conductor carries no load current and is properly identified as a grounding conductor. Multiple groupings of enclosures can have their equipment grounds daisy chained and do not require that both ground paths be direct to building or station ground so long as the maximum ground resistance limitation is observed.
- C. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
- D. Grounding Bus: Install in all electrical vaults and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

- E. Conductor Terminations and Connections:
1. Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Only exothermic welded connections are permitted (Cadweld® or equivalent).
 3. 4/0 bare solid conductor shall be used in applications where the conductor is placed below grade or in a corrosive environment.
 4. 4/0 bare medium stranded (7 conductor) may be used in lieu of solid conductor in below grade applications and in mildly corrosive environments, and where conductor flexibility is a consideration.
 5. 4/0 bare high stranded (up to 19 strands) is permitted in all above grade applications where exposure to corrosives is not a concern.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Grounding system applied shall at a minimum conform to applicable requirements of the National Electric Safety Code (NESC) for medium voltage installations (13.2kV and 5kV) and the NEC for low voltage installations. Where NEC requirements conflict with this specification, this specification shall govern. The installations shall also comply with IEEE C2 grounding requirements.
- B. All connections in the primary grounding system shall be clamped, exothermic welded (Cadweld® or equivalent). Individual grounding rods connected to the grounding system shall have a measured ground resistance of ten ohms (10Ω) or less. This measurement may be made by any of the commonly accepted methods for measuring ground rod resistance to earth. Grounding for power equipment power circuit neutral grounding shall be no greater than one-tenth ohm (0.1Ω) measured from the neutral bus to the local ground bus or building structural steel. Primary circuit (13.2kV system) grounding shall conform to the NESC for potential rise during ground fault. Ground resistance shall be no greater than three ohms (3Ω) for cabinet and control circuit grounds. Only copper to copper ground connections may be clamped or bolted. All other terminations shall be exothermic weld except as noted on the contract drawings and specifications.
- C. Grounding Manholes and Vaults: Install a driven ground rod through manhole or vault floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 4/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, pulling irons, ladders, and cable shields within each manhole, to ground bus. Make connections with No. 2 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls.

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- E. Pad-Mounted Switches: Install two ground rods and ground ring around the pad. Two independent paths to a common ground point or ground reference shall ground all high-voltage enclosures. Ground pad-mounted equipment and noncurrent-carrying metal items by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 36 inches (900 mm) from the foundation.

3.3 FEEDER GROUNDING

- A. All feeder circuit conduits shall include a No. 4/0 AWG grounding conductor. Grounding conductors shall be 600V green PVC-insulated installed in rigid PVC or rigid galvanized conduit along with the circuit phase conductors.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. All ground cables shall be properly supported:
1. Solid: supported at 4 foot maximum spacing
 2. Medium stranding: supported at 3 foot maximum spacing
 3. High stranding: supported at 2 foot maximum spacing
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. For grounding electrode system for touch potential ground ring, install at least two rods spaced at least one-rod length from each other.
 3. Ground Rods shall not be placed in back-fill.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted connector.

- E. Ground Ring: Install a grounding conductor, electrically connected to each ground rod and to each indicated item, extending around the perimeter of area or item indicated.

3.5 FIELD QUALITY CONTROL

- A. Prepare for Acceptance Tests as follows:
 - 1. Verify that electrical wiring installation complies with the Contract Drawings and applicable codes and standards.
 - 2. Verify completeness and tightness of all grounding connections.
 - 3. Verify that equipment is ready for pre-commissioning checks in accordance with the University (UTHVS) requirements.
- B. Testing: The University will engage a qualified Testing Company to perform field tests and inspections. Contractor shall coordinate testing activities and notify the University (UTHVS) ten days prior to testing.
- C. The Contractor shall provide experienced electricians to assist the Testing Company in performing visual and mechanical inspection and electrical tests according to NETA ATS.
- D. Excessive Ground Resistance: If resistance to ground exceeds specified value(s), drive rods deeper with a connecting rod. If driving the rods to twice the original depth does not yield specified values, notify the Engineer and include recommendations to reduce ground resistance.

END OF SECTION 330526

SECTION 33 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, and boxes for electrical wiring.
- B. Provide a complete system of raceways, including conduit, fittings, pull boxes, junction boxes, hangers, supports, and accessories, as shown on the Drawings and in conformance with the requirements in this Section.

1.3 DEFINITIONS

- A. RMC: Rigid metallic conduit

1.4 SUBMITTALS

- A. Product Data: For raceways, fittings, and boxes.
- B. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the University UTHVS, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Afflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1
- C. Fittings for Conduit: All fittings shall be threaded.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Indoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed and Concealed Conduit, all locations: Rigid galvanized steel conduit.
- B. Minimum Raceway Size:
1. 1-inch trade size for low-voltage applications
 2. 5-inch trade size for medium-voltage applications.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 33 Section "Hangers and Supports for Electrical Systems."
- D. Install no more than the equivalent of two 90-degree bends in any conduit unless approved by the Engineer.

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- E. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
 - F. Penetrations through concrete shall have a PVC insulating insert installed around opening to protect cables.
 - G. Cut conduits square with roller-wheel pipe cutter. Hacksaw cuts are acceptable only if the entire conduit is swabbed clean after cutting and threading is completed. Conduits cut in the field shall be threaded with sharp, standard NPT dies to achieve a fully cut tapered thread with a minimum of five full tapered threads at the end of the conduit. Running threads are not acceptable. Over- and under-threading are not acceptable. After threading, ream conduit ends, remove cuttings and debris from inside and outside of conduit, degrease, and apply cold spray-on zinc-rich paint.
 - H. Conduit bends shall be made with conduit bending tools manufactured for the purpose. Comply with conduit and bending tool manufacturers' instructions.
 - I. Do not cut or drill holes in structural beams and columns, or other structural members. Do not weld raceway supports to structural steel.
 - J. Join raceways with fittings designed and approved for that purpose and make joints wrench tight.
 - K. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box. Install bushings wrench-tight.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
 - 3. Install temporary closures to prevent foreign matter from entering raceways.
 - L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
 - M. Bond conduits at each end of each conduit run using a #4/0 AWG bare copper ground conductor using a bronze conduit-to-wire grounding fitting. Bond conduits to existing ground system in OSU Substation.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and boxes are without damage or deterioration at time of Project Completion.

END OF SECTION 33 05 33

SECTION 33 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
 - 2. Manholes.

1.3 DEFINITION

- A. RMC: Rigid metallic conduit.
- B. RNC: Rigid non-metallic conduit.
- C. PVC: Rigid Polyvinyl Chloride Conduit
- D. University: The Ohio State University

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators, accessories and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, vaults, and pull boxes.
 - 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Ladder details.
 - 5. Grounding details.
 - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.

- C. Product Certificates: For concrete and steel used in precast concrete manholes and vaults, comply with ASTM C 858.
- D. Qualification Data: Contractor or subconsultant personnel qualification information must be provided as required.
- E. Source quality-control reports.
- F. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Contractor must comply with all provisions set forth in the Contractors compliant Project Quality Manual.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Interruption of electrical service to facilities occupied by the University is permitted only under the following conditions and then only after arranging for temporary electrical service for buildings that can not accommodate a sustained power interruption:
 - 1. Notify the University no fewer than fourteen (14) working days in advance of planned proposed interruption of electrical service. Coordinate required switching operations with the University Utilities (UTHVS)
 - 2. The University will perform all switching operations necessary to proceed with the electrical service interruption and restoration.

1.8 COORDINATION

- A. Coordinate elevations of ducts and duct-bank entrances into manholes, equipment pads, and pull boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Propose revision to locations and elevations from those indicated as required to suit field conditions through the RFI process for approval by the Project and by the University.
- B. All underground utilities shall be entered into the University GPS system before the trench is filled. Contractor shall contact the University no fewer than three (3) working days to schedule the GPS surveyor.

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- C. Protection
 - 1. Manhole cleaning: Provide electrical insulating blankets, sleeves, gloves, etc., to protect workmen from electrical hazards as required.
 - 2. Provide protective devices as specified in Division 02 Section 02 41 13 "Selective Site Demolition."
 - D. In case of conflict between the as found conditions and contract drawings and specifications, the Contractor shall promptly notify the A/E through the RFI Process.
- 1.9 EXTRA MATERIALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - B. Furnish cable-support stanchions, arms, insulators, ground bus, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. PVC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Cantex, Inc.
 - 2. CertainTeed Corp.
 - 3. IPEX Inc.
 - 4. JM Manufacturing Co., Inc.
 - 5. Lamson & Sessions; Carlon Electrical Products.
 - 6. Underground Devices.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and retained to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
 - 2. Conduit fittings and bell ends
 - 3. Underground-line warning.
 - a. Concrete: Concrete for primary duct banks shall have a red color additive mixed in the concrete for identification. Specifically Solomon 417; mix approximately three and a half pounds (3-1/2 lbs.) per 80 pounds of cement to provide identifiable red color as warning to any one digging into the high voltage cable run. The concrete supplier shall pre-mix concrete. Color additive shall not be hand-troweled in and shall not be sprinkled.

- b. Warning tape: Tear tape of high visibility, suitably marked and rated for the application placed one foot above the buried duct bank.

2.3 PRECAST MANHOLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Norwalk Concrete Industries.
 - 2. EC Babbert
 - 3. Oldcastle Precast Inc.; Utility Vault Division.
 - 4. Utility Concrete Products, LLC.
- B. Comply with ASTM C 858 and with interlocking mating sections, complete with accessories, hardware, and features.
 - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks.
 - a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- C. Minimum interior dimensions of the manhole shall be 6 feet wide by 10 feet long by 7 feet high.
- D. All units H-20 structural load rating according to AASHTO HB 17
- E. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
- F. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties.
- G. Concrete: All concrete shall be Class C per Item 499 - Concrete, in the City of Columbus, Construction and Material Specification, Edition 2002.

2.4 MANHOLE ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Underground Devices Incorporated.

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- B. Materials: All concrete shall be Class C per Item 499 - Concrete, in the City of Columbus, Construction and Material Specification, Edition 2002.
- C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, round, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Covers shall be round, 30" diameter (760 mm), heavy duty, traffic rated with the word "ELECTRIC" cast in the cover as applicable.
 - c. Covers shall not have gaskets or be bolted down. Two slots, on opposite edges, shall be provided to permit using manhole hooks to remove cover.
 - d. All ferrous materials must be galvanized.
 2. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387/C 387M, Type M, may be used.
- D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron. Position sump in manhole floor in area below cover. Slope floor to sump.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
 2. Pulling eyes shall be in each wall opposite a duct bank at 3 foot AFF and the center of the floor, inserts, and cable racks.
- F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
- H. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment. UD model number CR36-B.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be 20.5 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties. UD model number RA20.

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- I. Fixed Manhole Ladders: Arranged for attachment to opening of manhole.
 - 1. Ladder shall be removable with embedded hook strap as method of attachment.
 - 2. Ladder width shall be based on a nominal 16" rung.
 - 3. Ladder and mounting brackets and braces shall be fabricated from nonconductive, fiberglass-reinforced polymer or hot-dip galvanized steel.

2.5 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 CORROSION PROTECTION

- A. Aluminum shall not be installed in contact with earth or concrete.

3.2 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-40-PVC, in Reinforced concrete-encased duct bank per the requirements of the contract drawings.
- B. Ducts for Electrical Cables 600 V and Less: RNC, NEMA Type EPC-40-PVC in concrete encased duct bank per the contract drawings..
- C. Underground Ducts Crossing Paved Paths, Walks, Driveways, and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete per contract drawings.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Manholes: Precast concrete.
 - 1. All units H-20 structural load rating according to AASHTO HB 17.
 - 2. All installations in conformance with the contract drawings and specifications

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
- D. Direct burial of underground cables is prohibited.

3.5 DUCT INSTALLATION

- A. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm), both horizontally and vertically, at other locations unless otherwise indicated. Cold-bending of PVC conduits is prohibited. Primary cable ducts between manholes or other terminal points shall be as straight as practical. All bends shall be "sweep" bends and any bend greater than ten (10) degrees per ten (10) foot lengths of duct shall be made with rigid steel conduit. Where possible, duct banks shall be run straight from manhole to manhole; where bend are necessary, the total shall not exceed 90 degrees in addition to any turn up at the pad or equipment.
- B. End Bells: End bells shall be steel. Aluminum, plastic or pot metal end bells are prohibited. End bells on conduit entering a building or manhole shall have their broader opening mounted flush with the interior surface of the wall penetrated by the duct.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Coordinate design of concrete-encased duct banks approaching building wall penetrations with building structural design to support ducts at wall without reducing structural or watertight integrity of building. Do not use steel conduit in highly corrosive soils. Coordinate with Drawings.
- E. Pull Cord: Install No. 12 type TW pull wire in ducts, including spares.
- F. Concrete-Encased Ducts: Support ducts on duct separators.
1. Raceways for primary electric shall be encased in a reinforced concrete (3" minimum cover) envelope. The standard size for primary electric ducts shall be 6 inches for Primary mains, and 5 inches for Primary building laterals and Primary loadways.
 2. Ducts for Primary mains shall be placed on 9 ½ inch centers for a 3-inch spacing between power ducts. Ducts for Primary laterals and Primary loadways shall be in duct banks with power ducts placed on 8 ½ inch centers for a 3-inch spacing between power ducts. Primary mains shall contain a minimum of six 6-inch diameter schedule 40 PVC power ducts and two concentrically located 2-inch diameter schedule 40 PVC ducts provided for ancillary use. Primary laterals and Primary loadways shall contain a minimum of four 5-inch diameter schedule 40 PVC power ducts and one concentrically located 2-inch diameter schedule 40 PVC conduit provided for ancillary use.
 3. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, at approximately eight (8) foot intervals. Carlon Snap-Loc Spacers, or approved equivalent, shall be supported on concrete or ceramic blocks. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 4. **A member of UTHVS shall approve primary ducts before concrete is poured. A member of UTHVS shall witness the concrete pour.**
 5. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation if possible.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour.
 - b. Excess concrete shall not be placed in the hole or used to raise the top of the duct bank greater than 3" above the top of the ducts.

6. **Pouring Concrete:** Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Power-driven agitating equipment specifically designed for duct-bank application may be used. Concrete shall be compacted so as to avoid inclusion of air pockets or areas where concrete doesn't completely cover ducts and reinforcements. Remove all excess concrete from University property.
7. **Reinforcement:** Two longitudinal steel reinforcing bars with a minimum of 18 inch overlap shall be used for each layer of duct in all duct banks. In instances where the duct bank crosses a roadway or high vehicle traffic area, two additional steel reinforcing bars shall be provided at the top and bottom of the bank to assist in distributing the load. Ducts shall be bundled and tie-wired to assure integrity of the duct array during pour. Concrete shall encase the duct bank installation a minimum of 3-inches on all sides. Provide one (1) #5 steel reinforcing bar for each conduit in the duct bank. Tie off the reinforcing bars to the plastic supports holding the conduit in place. Allow for a minimum of 2" of concrete over the reinforcing. Concrete envelopes shall extend through foundation and manhole walls designed so the envelope becomes a structural member providing support for bridging the area that has been excavated and back filled for foundation or manhole walls.
8. **Forms:** Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
9. **Minimum Space between Duct Banks:** Multiple parallel duct bank installations shall observe a minimum horizontal spacing of two (2) feet. This provision does not apply to duct bank crossings with an acute angle of greater than 30 degrees.
10. **Depth:** Install top of duct bank at least 30 inches (750 mm) below finished grade in all areas.
11. **Stub-Ups:** Use manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. **Stub-Ups to Equipment:** For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
12. **Elbows:** All elbows shall be long-radius rigid steel conduit.
13. **During backfilling of trenches install continuous underground-line warning tape directly above ductbank at 12 inches (300 mm) below finished grade.**
 - a. **Tape:**
 - 1) Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
 - 2) Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3) Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - b. **Color and Printing:**
 - 1) Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2) Inscriptions for Red-Colored Tapes: **ELECTRIC LINE, HIGH VOLTAGE.**
 - c. **Tear Tape:**
 - 1) Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility service (13.2 kV, compounded for direct-burial service).
 - 2) Thickness: 4 mils (0.1 mm).
 - 3) Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).

- 4) 3-Inch (75-mm) Tensile According to ASTM D 882: 30 lbf (133.4 N), and 2500 psi (17.2 MPa).
14. Duct banks installation shall avoid crossing an area with an unfavorable thermal environment (i.e., crossing steam pipes, parking lots) as such cable installations may require derating.
15. Duct banks shall not pass within 10 feet of a buried steam line in any direction. If it becomes necessary to cross a steam line, acceptable insulation of the crossing must be provided and approved by UTHVS.
16. Primary duct banks shall cross gas lines below the gas piping without exception.
17. Soil may be used to backfill duct bank excavations provided they are not in streets or where recurrent heavy surface loadings are anticipated. High traffic and heavy load areas must be backfilled with $\frac{3}{4}$ " crushed stone or CDF with a covering layer of compacted soil or gravel and resurfaced to original wear surface.
18. All electrical ducts entering a manhole shall be perpendicular to the manhole wall and shall be at least a minimum of ten feet (10 ft.) straight from the manhole wall. All duct banks shall enter manhole within one foot of a corner. Do not center manhole on duct bank.

3.6 INSTALLATION OF CONCRETE MANHOLES

A. Precast Concrete Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manholes:
 - a. Manhole Lid: Install lid flush with pavement, sidewalk, or grass surfaces.
 - b. Vault Roof: Install with rooftop 24 inches below finished grade
2. Vaults under switches
 - a. Vault Roof: Install with rooftop 4-6 inches above finished grade.
3. Manhole ring and cover shall be centered over chimney.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
2. Access shall not be less than through a 30" round chimney equipped with a ladder mounted in each manhole.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated. Conduit end bells shall have their wide end positioned flush with the interior of the manhole wall.

F. Field-Installed Bolting Anchors in Manholes: Do not drill deeper than 3-7/8 inches (98 mm) , for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

- G. Stanchions shall be mounted to manhole walls using drop-in anchors shall have a 1/2-13 thread, rated pullout working capacity of 2100 lbs. and shall be made from either 303 or 316 stainless steel. A 316 stainless steel 1/2-13 hex head cap screw and a 316 stainless steel.562 ID x 1.250 OD x .078 THK. flat washer shall be used with each drop-in anchor.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

3.7 GROUNDING

- A. Ground underground ducts, new and existing utility structures according to Division 33 Section 33 05 26 "Grounding and Bonding for Electrical Systems."
- B. Install ground rods in accordance with Division 33 Section 33 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install bus bar and ground metallic components in accordance with Division 33 Section 33 05 26 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. A properly sized steel mandrel shall be pulled through all new or repaired ducts. Mandrel shall be 1/4" to 1/2" smaller in diameter than the duct; this shall be a test witnessed by UTHVS. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts, where required. Each duct shall be proved clear and usable, cleaned, have a No. 12 type TW pull wire left in place, and spare ducts shall have duct plugs installed.
 - 3. Test manhole, vault and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 33 Section "Grounding and Bonding for Electrical Systems"
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Dewater Manholes
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 33 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Splicing date identification.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- D. Submit legend / Name plate schedule for University approval. Include letter size and nameplate size on schedule along with wording.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.

- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits:
 - 1. Black letters on a white field labeled "DANGER 13,200 VOLTS"
- C. Snap-Around Labels for Raceways: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils

thick by 1 to 2 inches wide.

- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for mounting to cable with plastic tie wraps. 1 inch x 3 inches; Black letters on a white background. Minimum letter height shall be 3/8 inch. Minimum letter thickness shall be 1/16 inch.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background.
 - 1. Indoor & Outdoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - 2. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- B. Provide labels on all equipment disconnecting means, enclosed starters, panelboards, Medium voltage switches, etc.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, UV-stabilized, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb, minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.

- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Primary-Circuit Conductor Identification: For 15kV conductors in vaults, pull and junction boxes, and manholes use color-coding conductor tape to identify phase. Use acrylic tags to identify phase and feeder number of each set of conductors.
- B. Loadway Conductor Identification: For 15kV loadway circuit conductors use color-coding conductor tape to identify phases. Use acrylic tags to identify each building name or switch name branch.
- C. Splices shall be identified with acrylic tags and shall include the date of the splice and the name of the company performing the splice.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Identify cables in every manhole.
- E. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- G. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- H. Cable Ties: For attaching tags.

3.3 IDENTIFICATION SCHEDULE

- A. Accessible Raceways Medium Voltage Primary Circuits, Switched Primaries, and Loadways: Identify with snap around label. Install labels at 10-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings and Tunnels: Identify the covers of

each junction and pull box with self-adhesive vinyl labels with the wiring system legend and system voltage.

- C. Color-Coding for Phase Identification, greater than 600 V: Use the colors listed below for ungrounded feeder and branch-circuit conductors.
1. Cables in manholes shall be tagged with phase and feeder numbers marked using 1" x 3" plastic (Iamacoid) tags with ½" high by 1/16" thick engraved lettering (black on white).
 2. Primary cables to the Transformers and Switches: Cables going into buildings from manholes shall be marked with the building's name for identification using plastic (Iamacoid) tags with engraved ½" high by 1/16" thick lettering (black on white).
 3. Power-Circuit Conductor Identification, 15kV: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - a. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
 - b. Color-Coding for Phase and Voltage Level Identification, 15kV: Use colors listed below for ungrounded service conductors.
 - 1) Colors for 15kV Circuits:
 - a) Phase A: Brown.
 - b) Phase B: Orange.
 - c) Phase C: Yellow.
 - d) Neutral: White or Gray
 - e) Equipment Ground: Green/Black
 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings. Each cable shall have an identifiable colored stripe.
- D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed control connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

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2. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- E. Warning Labels for Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on a white background.
 3. Apply to exterior of door, cover, or other access.
- F. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, control panels, ATS control stations, medium voltage switch cabinets.
1. Labeling Instructions:
 - a. Equipment: Engraved, laminated acrylic or melamine label.
 - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:
 - a. Enclosures and electrical cabinets.
 - b. Enclosed switches.
 - c. Enclosed controllers.
 - d. Cables and Splices
 - e. Interconnecting power and control cables
- G. Plastic Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

END OF SECTION 33 05 53

SECTION 33 11 13 – SITE WATER DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work includes:

1. Pipe, fittings and accessories for site water line including domestic water line and fire protection water line.
2. Installing valves of type & size shown on plans.
3. Install fire hydrants at locations shown on plan. Hydrants are as per 809.02
4. Water line pressure testing.
5. Disinfection of potable water distribution system.
6. Testing and reporting results.

1.2 RELATED WORK

- A. Documents affecting this work shall include, but are not limited to Bidding Requirements, General Conditions and Division 1.
- B. Section 31 30 00: Earthwork.

1.3 REFERENCES

- A. City of Columbus, Construction and Material Specifications, Item 800 Water Supply and Distribution. 2002 Edition.
- B. AWWA B300 - Standard for Hypochlorites.
- C. AWWA B301 - Standard for Liquid Chlorine.
- D. AWWA C651 - Standards for Disinfecting Water Mains.

1.4 SUBMITTALS

- A. Record actual locations of piping mains, valves, connections, thrust restraints and invert elevations.
- B. Provide manufacturer=s certificate:
 1. Certify that products meet or exceed specified requirements.
- C. Submit product data:
 1. Provide data on pipe materials, pipe fittings, valves and accessories.
- D. Test report:
 1. Provide test report with water at 150 psi pressure in accordance with AWWA procedures.
 2. Test Reports: Indicate results comparative to specified requirements.
 3. Certificate: Certify that cleanliness of water distribution system meets or exceed speci

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fied requirements.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with the plans.
- B. Deliver and store valves in shipping containers with labeling in place.
- C. Valves:
 - 1. Manufacturer=s name and pressure rating shall be marked on valve body.
- D. Perform testing work in accordance with AWWA C651.
- E. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section, with a minimum of three (3) years experience.
- F. Testing Firm: Company specializing in testing potable water systems, certified by the State of Ohio.
- G. Submit bacteriologist’s signature and authority associated with testing.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1 and General Conditions.
- B. Disinfection report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start and time of completion.
 - 3. Test locations.
 - 4. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - 5. Date and time of flushing start and completion.
 - 6. Disinfectant residual after flushing in ppm for each outlet tested.
- C. Bacteriological report:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.
 - 3. Name of person collecting samples.
 - 4. Test locations.

5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water conforms, or fails to conform, to bacterial standards of the City of Columbus.

1.7 REGULATORY REQUIREMENTS

- A. Conform to applicable code or regulation for performing the work of this Section.
- B. Provide certificate of compliance from authority having jurisdiction, indicating approval of water system.

PART 2 - PRODUCTS
2.1 MATERIALS

- A. Provide new water line system on site as indicated on the drawings.
- B. Comply with the following standards:

1. Ductile Iron Water Pipe

- a. For sizes five (5") inches through twelve (12") inches: Marked from the factory with the words: ADUCTILE IRON@.
- b. Pipe shall be furnished with a thin bituminous coated cement lining and with an outside coating of bitumastic enamel or approved equal.
- c. Physical properties and wall thicknesses shall be:

Hardness	Rockwell B-90 maximum
Yield Strength	42,000 psi minimum
Tensile strength	60,000 psi minimum
Elongation in 2 inch	10% minimum

<u>Nominal Size</u>	<u>Class</u>	<u>Wall Thickness</u>
4 inch	53	0.32 inch
6 inch	53	0.32 inch
8 inch	53	0.36 inch
10 inch	53	0.38 inch
12 inch	54	0.43 inch

2. Gate Valves - Three (3") inches and over

- a. Bedding: In accordance with Item 801 of Columbus Construction and Material Specifications.

3. Accessories

- a. Concrete for Thrust Restraints: Concrete shall be City of Columbus Class C.

4. Pipe shall have slip ring joints and fittings shall be Class 250 gray cast iron with mechanical joints.

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C DISINFECTION CHEMICALS

- I. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 BEDDING

- A. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Excavate pipe trench per Item 801 of the Columbus Construction and Material Specifications.
- C. Place bedding material at trench bottom, level fill materials in one (1) continuous layer not exceeding six (6") inches compacted depth; compact to 95%.
- D. Form and place concrete for pipe thrust restraints at every change of pipe direction. Place concrete to permit full access to pipe and pipe accessories.
- E. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to 95%. Maintain optimum moisture content of bedding material to attain required compaction density.

3.3 INSTALLATION - PIPE

- A. Route pipe in straight line.
- B. Slope water pipe and position drains at low points.
- C. Install ductile iron piping and fittings per AWWA C600.
- D. Maintain separation of water main from sewer piping by not less than twelve (12") inches.
- E. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- F. Establish elevations of buried piping to ensure not less than forty-eight (48") inches of cover.
- G. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.

3.4 INSTALLATION - VALVES AND HYDRANTS

- A. Sew valves on solid bearing only.
- B. Center and plumb valve box over valve.
- C. Set valve box cover flush with finished grade.

3.5 INSTALLATION - VALVE BOXES

- A. All valve boxes shall be extended to final grade or pavement.
- B. Liners shall be removed as the last item of work at the installation.
- C. Valve boxes shall be furnished on all valves of water service piping.
- D. A three (3") inch galvanized steel pipe shall be installed in each valve box to prevent misalignment.

3.6 HYDROSTATIC TESTS

- A. A hydrostatic test as required in section 4 of the Standard AWWA Specification C600 shall be applied to the whole or in individual valved-off sections of the main and fire hydrant leads either before or after trench is backfilled. The pressure during the test shall be maintained at 150 PSI. The duration of each pressure test shall be at least one hour.

3.7 DISINFECTION OF WATER PIPING SYSTEM

- A. Perform operations in accordance with Item 801 of Columbus Construction and Material Specifications.
- B. Verify that piping system has been cleaned, inspected, and pressure tested.
- C. Perform scheduling and disinfecting activity with start-up, testing, adjusting and balancing, demonstration procedures, including coordination with related systems.
- D. Provide and attach required equipment to perform the work of this Section.
- E. Introduce treatment into piping system.
- F. Maintain disinfectant in system for 24 hours.
- G. Flush, circulate, and clean until required cleanliness is achieved; use domestic water.
- H. Replace permanent system devices removed for disinfection.

3.8 ADJUST AND CLEAN

- A. Keep premises free of debris and unusable materials. As work progresses, or at the request of the A/E remove waste materials from the site.

3.9 OUTINGS OF SERVICE

- A. The Contractor must notify The Ohio State University, Department of Physical Facilities, 614-292-9107, two weeks prior to any service outings. Representatives of The Ohio State University must be present at such outings.

END OF SECTION 33 11 13

SECTION 33 41 00 – STORM DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work includes:

1. Storm Sewer Piping, fittings, accessories and bedding.
2. Catch basins, manholes, curb inlets and downspouts.
3. Detention basin outlet structures
4. Concrete chambers.
5. Pipe Underdrain

1.2 RELATED SECTIONS:

1. Section 31 30 00 - Earthwork
2. Section 03 30 01 - Cast-in-Place Concrete for site work.

1.3 REFERENCE STANDARDS

1. City of Columbus, Construction and Materials Specifications, 2002 Edition.
2. City of Columbus, Division of Sewers & Drainage Standard Construction Drawings.
3. All grates shall be bicycle safe.

1.4 SUBMITTALS

A. Submit product data:

1. Provide data indicating pipe and pipe accessories.

B. Submit manufacturer's certificate:

1. Certify that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Perform work in compliance with City of Columbus requirements, and as directed by the A/E.

1.6 JOB CONDITIONS

- A. Locate existing underground utilities in areas of work. If utilities are to remain, provide adequate means of protection during earthwork operations. Repair damaged utilities to satisfaction of utility owner and at no cost to the University.
- B. Provide appropriate road plates and accessories over excavations to maintain safe and continuous traffic flow on existing streets and to the existing building.

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PART 2 - PRODUCTS

2.1 Materials:

A. Storm Sewer Pipe:

1. Shall be as per City of Columbus Construction and Material Specifications, Item 901.
2. Include fittings standard with pipe manufacturer in patterns necessary for complete installation. Provide all factory-made couplings, fittings, and accessory components to ensure continuity of systems.
3. Backfill shall be as detailed on the Drawings, and as per City of Columbus Specification, Item 901.

B. Catch Basin and Inlets:

1. Shall be the type and size detailed on the Drawings, and as per City of Columbus Specifications, Item 604 - Manholes, Catch Basins and Inlets.
2. For additional details, see the City of Columbus, Division of Sewerage and Drainage Standard Construction Drawings.

C. Manhole Covers and Basin Casting:

1. The type and size shall be as detailed on the Drawings, and as defined in the City of Columbus Specifications, Item 604.

D. Concrete Structure:

1. The cast-in-place concrete structure shall be as detailed on the Drawings, and as per City of Columbus Specification, Item 904 - Miscellaneous Concrete Structures.
2. The use of precast concrete modular construction for the concrete structure must be approved by the A/E.

E. Pipe Underdrain

1. The type and size shall be as detailed on the Drawings, and as defined in the City of Columbus Specifications, Item 605.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate location and sequence of site utilities installation with demolition, foundation, mechanical, and electrical work for proper execution of work.

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B. Saw cut existing bituminous paving. Provide excavation, trench wall support, and pumping of surface and ground water in accordance with Section 31 30 00, Earthwork.

- C. Install pipe, valves, fittings, and structures in accordance with City of Columbus requirements.
- D. Set drainage structures in accurate locations as indicated on drawings; set on solid bearing; construct brick structure tops to bring grate to required elevation. Install frame and grade in structure tops. Group cast iron outlets into walls of drainage structures and fill pickup holes solid with grout. Coordinate with installation of sewer piping and with finishing of adjacent surfaces; connect to drainage system.
- E. Obtain inspection by the A/E and test in accordance with applicable code requirements prior to any backfilling.
- F. Trench Backfill: Mechanically compact backfill in maximum 8-inch-deep layers in accordance with Section 02200 requirements.
- G. Refill, recompact, and restore settlement to original ground level or to finished plan elevation.
- H. Except where provided as work of other Sections, replace and restore existing materials to original condition or better which are removed or damaged by work of this Section.
- I. Provide methods of protection and uncovering of existing utilities at points of crossing in accordance with City of Columbus requirements.

3.2 CLEAN-UP

- A. Clean up and remove all debris from the site due to these operations.

END OF SECTION 33 41 00

SECTION 33 46 00 – SUBGRADE DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide subgrade drainage system as shown on the drawings and specified.
- B. Work includes:
 - 1. Trenching and removal of excavated materials.
 - 2. Protection of all existing and newly installed utility conduit and lines.
 - 3. Installation of subgrade drainage piping, including all pipes, fittings and connections.

1.2 QUALITY ASSURANCE

- A. Eight (8") inch pipe shall meet Item 605 and ASTM D3034, SRD-35.
- B. Four (4") inch and six (6") inch perforated pipe (per COC Item 720.07) shall meet requirements of Item 605 and ASTM F405-89.
- C. Gravel backfill shall consist of durable No. 57 aggregate.
- D. Fifteen (15") inch perforated pipe shall meet Item 605 and ASTM D3034, SRD-35.
- E. The tap tee shall be connected at the side centerline of the collector pipe.
- F. Secure the geotextile sock at seams and when torn with manufacturer=s approved tape. Review with A/E.
- G. All piping for subgrade drainage shall be installed in a geotextile sock installed by the pipe manufacturer at the place of manufacture.
- H. All piping, fittings and couplings shall be clearly marked at intervals of not more than ten (10') feet, with the following:
 - 1. Nominal size
 - 2. Manufacturer's name or trademark

1.3 SUBMITTALS

- A. Submit copy of manufacturer's certification that the product was manufactured, tested and supplied in accordance with this specification, together with a report of the test results and the date each test was completed.

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- B. Submit material samples for the following:
 - 1. No. 57 aggregate
 - 2. All drain pipe in all sizes in geotextile stock
 - 3. All pipe fittings, connections, Y's, tap tees and end caps in all sizes in geotextile stock

**PART 2 - PRODUCTS
2.1 MATERIALS**

- A. Drain Pipe
 - 1. Manufacturer's standard:
 - a. Advanced Drainage Systems, Inc.
288 Lafayette Street
London, Ohio 43140
1-800-733-9554
 - b. Hancor, Inc.
P.O. Box 1047
Findlay, Ohio 45839
1-800-537-9520
- B. PVC Drain Basin
 - 1. Manufacturer's standard:
 - a. Advanced Drainage Systems, Inc.
288 Lafayette Street
London, Ohio 43140
1-800-733-9554

**PART 3 - EXECUTION
3.1 INSTALLATION**

- A. End caps shall be used at all ending points to prevent soil infiltration into the system.
- B. Excavate the trench to the width and depth shown on the drawings.
- C. Place the polyethylene drainage tubing with geotextile sock, installed by the pipe manufacturer, in the trench.
- D. Backfill the trench with durable No. 57 aggregate.

- E. Tap tees shall be connected at the side centerline of the collector pipe.
- F. The location, arrangement, and installation of all drainage elements shall be as shown on the drawings, and as per manufacturer's instructions.
- G. The subgrade drainage system shall be installed before the 10-inches of topsoil has been placed.

3.2 ADJUST AND CLEAN

- A. Keep premises free of debris and unusable materials. As work progresses, or at the request of the A/E, remove waste material from the site.

END OF SECTION 33 46 00