

APPENDIX C

WORTHINGTON PARK FUTSAL COURT LIGHTING

Madison, Wisconsin

City of Madison Parks Division
330 E Lakeside Street
Madison, Wisconsin

PROJECT MANUAL

November 26, 2025

DE PROJECT # 25099



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Division 26

Electrical

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SECTION 26 0010 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

1.02 DESCRIPTION OF WORK

- A. Work shall include furnishing of all systems, equipment and material specified in this division and as called for on the electrical drawings, to include supervision, operations, methods and labor for the fabrication, installation, start up and tests for the complete electrical installation.
- B. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- C. All work shall be performed in a neat, professional manner in keeping with the highest standards of the craft.

1.03 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
 - 1. National Electrical Code
 - 2. National Fire Protection Association
 - 3. National Electrical Manufacturers Association
 - 4. Standards of Institute of Electrical and Electronic Engineers
 - 5. International Building Code
 - 6. Occupational Safety and Health Act
 - 7. Wisconsin Administrative Code
 - 8. NECA Standards
 - 9. Americans With Disabilities Act (ADA)
- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of professionalism shall take precedence, but such questions shall be referred to Design Professional for final decision.

1.04 REQUIREMENTS & FEES OF REGULATORY AGENCIES

- A. Contractor shall comply with the rules and regulations of the local utility companies. He shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.
- C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the electrical work including State of Wisconsin Electrical Inspections. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.
- D. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

1.05 ELECTRICAL DRAWINGS

- A. The electrical drawings indicate in general the building arrangement only. Contractor shall examine construction drawings to become familiar with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings for the electrical work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.

- C. Contractor shall layout their own work and shall be responsible for determining the exact locations for equipment and rough ins and the exact routing of conduits and raceway so as to best fit the layout of the work.
- D. Contractor shall take their own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as couplings, pull or splice boxes may not be shown, but where such items are required by code or by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.

1.06 ACTIVE SERVICES

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.

1.07 COORDINATION AND COOPERATION

- A. It shall be Contractor's responsibility to schedule and coordinate their work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of their work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to their equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required, and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and their decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided. Refer to Division 09 for painting protection.
- F. Where the final installation or connection of equipment in the building requires the contractor to work in areas previously finished by the General Contractor, the Electrical Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Electrical Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

1.08 EXCAVATING AND BACKFILLING

- A. Contractor shall do all excavating necessary for light pole bases, underground wiring, conduit and duct banks, and shall backfill trenches and excavations after work has been inspected.

1.09 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design

Professional. Where more than one unit is required of the same system, they shall be furnished by the same manufacturer except where specified otherwise.

- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

1.10 SUBMITTALS

- A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittal requirements are indicated in each corresponding technical specification section in the Project Manual.
- D. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- E. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION
AND
MAINTENANCE
MANUAL
FOR
ELECTRICAL SYSTEMS

(PROJECT NAME)
(LOCATION)
(DATE)

SUBMITTED BY
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
 - 1. Equipment and system warranties and guarantees.
 - 2. Installation instructions.
 - 3. Operating instructions.
 - 4. Maintenance instructions.
 - 5. Spare parts identification and ordering list.
 - 6. Local service organization, address, contact and phone number.
 - 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
- D. Items to be included shall be those listed in shop drawing section.

1.12 TESTS AND DEMONSTRATIONS

- A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner.
- B. Contractor shall test the electrical grounding system resistance in accordance with Specification Section 26 0526 – Grounding and Bonding for Electrical Systems and submit a report to Design Professional stating the results.
- C. Prior to acceptance of the electrical installation, the Contractor shall demonstrate to the Owner, or their designated representatives, all essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems. Owner instruction shall be provided for the following systems:

Sections	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
26 0010	Electrical Systems	4		Contractor		

REMARKS:

1. Perform complete system test at time of instruction.
3. Any unused hours shall be used at Owner's discretion during the first year of occupancy.

- D. Contractor shall submit to the Design Professional a certificate signed by the Owner stating the date, time, and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:

CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to the Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: _____

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: _____

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative: _____
signature
_____ date

Owner's Representative: _____
signature
_____ date

1.13 SUBSTITUTIONS

- A. Refer to Divisions 00 and 01 Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent. between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

1.14 ACCEPTABLE MANUFACTURERS

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.
 - 1. If Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
 - 2. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

1.15 WARRANTY

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
 - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
 - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
 - b. The entire Electrical system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 26 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

1.16 CHANGES IN THE WORK

- A. Refer to Divisions 00 and 01.

1.17 COMPLETION

- A. Systems, at time of completion, shall be complete, efficiently operating, non hazardous and ready for normal use by the Owner.
- B. When all the electrical work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

1.18 CLEANING

- A. Prior to assembly of electrical equipment, all loose dirt, scale, oil, and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good electrical practices.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- C. Electrical equipment shall be thoroughly cleaned. This includes, but is not limited to: removal of wiring trimmings within electrical panels and dirt/debris from activation boxes.

END OF SECTION 26 0010

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 0010 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish all material, tools, labor, and supervision necessary to install all wiring systems.
- B. This section describes the basic materials and methods of installation for general wiring systems of 600 volts and less. Wiring for a higher voltage rating, if required, shall be as specified in other sections or called for on the drawings.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable, and connectors.
- B. UL Compliance: Comply with UL standards pertaining to wire, cable, and connectors.
- C. UL Labels: Provide electrical wires, cables and connectors which have been UL listed and labeled.
- D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of wire and cable.
- E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.
- F. The materials used for wiring systems shall be the products of a manufacturer regularly engaged in the manufacturing of the specified material.

1.04 SUBMITTALS

- A. Refer to Division 01 Submittal requirements.
- B. Product Data - provide one submittal containing the following information:
 - 1. Manufacturer's technical product data for each product specified.

1.05 CLOSEOUT DOCUMENTS

- A. Refer to Division 01 Closeout requirements.
- B. Provide closeout items containing the following:
 - 1. Operation and Maintenance Manual:
 - a. Include approved Product Data and Drawings
 - 2. Startup and test reports: Submit reports immediately upon completion of tests.
 - 3. Manufacturer's Warranty: Submit manufacturers standard warranty document.

PART 2 - PRODUCTS

2.01 WIRE AND CABLE

- A. All wire and cable for power, lighting, control, and signal circuits shall have copper conductors of not less than 98% conductivity and shall be insulated to 600 V. All conductors shall be stranded.
- B. Minimum size conductors shall be #12 AWG for power and lighting.
- C. Type of wire and cable for various applications shall be as follows:
 - 1. Type XHHW-2 (90 deg. C) use for branch circuits, and feeders.

2.02 CONDUCTOR COLOR CODING

- A. Wiring systems shall be color coded. Conductor insulation shall be colored. Colors shall be assigned to each conductor as described below and carried throughout all main and branch circuit distribution. When necessary to use tape, use colored tape on black wire. Do not use colored tape on colored wire.

	120/240V
Phase 'A' Conductor	Black
Phase 'B' Conductor	Red
Neutral Conductor	White*
Equipment Grounding Conductor	Green

2.03 CONNECTORS

- A. Twist-on Wire Connectors.
 - 1. Wet locations. 600V rated, UL 485D listed with pre-filled silicone sealant. Ideal Industries 61/62/63 series or equal by 3M or Thomas and Betts. Use for #8 and smaller. To be used for all above ground splices in exterior locations and interior wet locations.
 - 2. Underground locations. 600V rated, UL 485D listed for direct burial with pre-filled silicone sealant. Ideal Industries 60/64/66 series or equal buy 3M or Thomas and Betts. Use for #8 and smaller. To be used for all below ground and in-slab locations.
- B. Conductor Taps and Splices.
 - 1. Wet and Underground Locations. 600V rated, UL 486D listed, watertight mechanical termination suitable for direct burial in earth. IlSCO SafetySub PDSS or equal by Burndy or 3M. Use for #6 and larger.
 - 2. Insulation piercing taps are not allowed.
 - 3. Split bolt connectors and splices are not allowed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Conduit shall be swabbed free of moisture and debris prior to pulling in wiring. Pull mouse through conduits prior to pulling conductors.

3.02 INSTALLATION

- A. All cable for major feeders shall be continuous from origin to termination, unless otherwise indicated.
- B. Branch circuit conductor sizes shall be increased to maintain a maximum 3% voltage drop.
- C. Conduit fill: Branch circuit fill shall be limited to 3 grounded, 3 ungrounded, and 1 equipment grounding conductor.
- D. Splices shall be made only in accessible junction boxes or handholes.
- E. All power feeder cable shall be pulled with the use of approved pulling compound or powder. Compound must not deteriorate conductor or insulation.
- F. If conductor insulation is damaged during installation, replace entire conductor.
- G. Use pulling means, including fish tape, cable or rope which cannot damage raceway.
- H. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.
- I. Keep branch circuit conductor splices to a minimum.
- J. The continuity of circuit conductors shall not be dependent on service connections such as lamp holders, receptacles, etc., where the removal of such devices would interrupt the continuity.
- K. Provide separate green equipment ground conductor throughout entire electrical system.

- L. Isolated ground conductors shall be kept isolated from the equipment grounding system from the outlet back to where the system is derived.
- M. All branch circuits shall have dedicated neutrals.
- N. Install 2-hour rated cable systems in strict accordance with the manufacturer's instructions and the UL Listing.

3.03 FIELD QUALITY CONTROL

- A. Prior to energizing system, test cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.
- B. After wire terminations are complete, energize circuitry and demonstrate functioning in accordance with requirements.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 0010 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of grounding work is indicated by drawings and shall comply with NEC.
- B. Applications of grounding work in this section include the following:
 - 1. Grounding electrodes.
 - 2. Grounding rods.
 - 3. Enclosures.
- C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL-listed and labeled.
- B. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.
- C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

1.04 SUBMITTALS

- A. Refer to Division 01 Submittal requirements.
- B. Product Data: provide one submittal containing the following information:
 - 1. Submittal data for equipment, cabling, and hardware shall consist of catalog cuts showing technical data necessary to evaluate the materials with specific item designated by arrow or by being highlighted.

1.05 CLOSEOUT DOCUMENTS

- A. Refer to Division 01 Closeout requirements.
- B. Provide closeout items containing the following:
 - 1. Operation and Maintenance Manual:
 - a. Include approved Product Data and Drawings.

PART 2 - PRODUCTS

2.01 GROUNDING SYSTEMS

- A. Materials and Components
 - 1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.
 - 2. All components shall be listed under ANSI/UL 467 – “Grounding and bonding Equipment”.
 - 3. Raceways: Provide raceways, and electrical boxes and fittings complying with Division 26, Section 26 0533 – Raceway and Boxes for Electrical Systems.

4. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.
- B. Connectors
 1. Lugs: Grounding and bonding conductors shall terminate in two-hole, long barrel irreversible compression lugs, Burndy YGA series or equal by Blackburn, IlSCO, Erico, Harger or Anderson.
 2. Exothermic welds: Graphite mold designed for the specific connection type required. Weld metal used for grounding connections shall contain copper oxide, aluminum and not less than 3% tin as the wetting agent. Exothermic weld products by Erico, Harger or approved equal.
- C. Grounding Rods
 1. Ground Rods:
 - a. Copper clad steel, 5/8" dia x 8'

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.
- C. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- D. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- E. Bury ground rods vertically with rod top a minimum of 2 feet below grade, or with rod top terminated in a gravel filled ground well. If extensive rock formation is encountered, inform the Design Professional and relocate ground rods, or provide supplemental ground rods as directed by the Design Professional.
- F. A No. 6 AWG minimum stranded copper wire shall be furnished and exothermically welded to all of the ground rods.
- G. Protect ground conductors from physical and environmental damage. Wherever possible, and where indicated, grounding electrode and bonding conductors shall be enclosed in a non-metallic raceway. Where ground conductors are subject to physical damage, install in galvanized rigid steel conduit with grounding bushings on each end. Locate exposed conductors which must extend from a concrete surface as close as possible to a corner. Where conductors are required to be exposed, as in the connection to the main ground bus, support ground conductors by corrosion resistant metallic hardware at 4-foot intervals or less.
- H. Exothermic Welding
 1. Clean and dry the surface to be welded. Wire brush or file the point of contact to a clean bare metal surface.
 2. Use welding cartridges and molds for the type of weld recommended by the manufacturer and perform welding in accordance with the manufacturer's recommendations. Worn or damaged molds not to be used.
 3. Test all welds by striking with a 2 pound steel hammer. Replace any defective welds.
 4. Where exothermic welds are made to a galvanized surface, remove the galvanizing using a non-resin bonded grinding wheel to expose a clean surface. After welding, touch up the steel surface with zinc rich primer.
- I. Provide separate green ground conductor throughout entire electrical system sized as required by the NEC.

- J. Conduit Grounding
1. Bond all metallic conduit systems together to provide a continuous electrical ground path. Bond metallic conduits to other conduit components using insulated ground bushings when required. Connect ground bushings to the grounding system using conductors sized in compliance with NEC.
 2. Provide ground conductors in non-metallic conduits in accordance with the NEC.

END OF SECTION 26 0526

SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 0010 - Electrical General Provisions are applicable to work required of this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall furnish all materials, tools labor and supervision necessary to fabricate and install complete conduit systems.
- B. Conduit systems shall be provided for all wiring, except where the drawings or other sections of the specifications indicate that certain wiring may be installed in cable trays, surface raceway, underfloor raceway, wireways and/or auxiliary gutters.
- C. Types of raceways in this section include the following:
 - 1. Galvanized Rigid Steel (GRS) conduit
 - 2. Rigid Polyvinyl Chloride (PVC) conduit
 - 3. High Density Polyethylene (HDPE) conduit
- D. Refer to 26 0553 Identification for Electrical Systems for required factory colored conduit requirements.
- E. Contractor shall furnish all material, tools, labor and supervision necessary to install electrical boxes and fittings as required by drawings and specifications.
- F. Types of electrical boxes and fittings in this section include the following:
 - 1. Pull boxes
 - 2. Handholes

1.03 QUALITY ASSURANCE

- A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled.
- C. NEC Compliance: Comply with requirements as applicable to the construction and installation of raceway systems.
- D. The materials used in the fabrication of the raceway system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material.
- E. NEC compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- F. UL Compliance: Provide electrical boxes and fittings which have been UL listed and labeled.
- G. ANSI/NEMA Standards Compliance: Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet steel outlet boxes, covers and box supports.

1.04 SUBMITTALS

- A. Refer to Division 01 Submittal requirements.
- B. Provide one submittal containing the following information:
 - 1. Raceway Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway listed below. Include data substantiating that materials comply with requirements for the following:
 - a. Raceway
 - 2. In-Ground Handhole Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of handhole required. Include data substantiating that units comply with requirements.

1.05 CLOSEOUT DOCUMENTS

- A. Refer to Division 01 Closeout requirements.
- B. Provide closeout items containing the following:
 - 1. Operation and Maintenance Manual:
 - a. Include approved Product Data and Drawings.
 - 2. Manufacturer's Warranty: Submit manufacturers standard warranty document.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. General: Provide conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums. See 26 0553 for color conduit requirements.
- B. Galvanized Rigid Steel Conduit (GRS).
Full weight, threaded, rigid steel conduit, galvanized inside and out by hot dip or electro galvanized process. Additional protection by electrostatically applied baked coating. Thread protective caps and couplings. Product shall conform to UL-6 and ANSI C80.1.
 - 1. Fittings (couplings, connectors and bushings): NEMA FB 1, UL 514B; steel, threaded connectors with double locknuts and insulating bushings. Threadless fittings including set screw and compression/gland are not permitted.
 - 2. Connector fittings over 2" shall have a grounding bushing.
- C. Rigid Polyvinyl Chloride (PVC) Conduit:
 - 1. Conduit shall be composed of Polyvinyl Chloride and shall conform to NEMA TC-2, and UL-651. Schedule 40 and 80 as specified in Part 3.
 - 2. Fittings: NEMA TC 3, UL 651
 - 3. Conduit, fittings, and cement shall be produced by the same manufacturer.
- D. High Density Polyethylene (HDPE) Conduit:
 - 1. Schedule 80 continuous length smooth wall for electrical applications per ASTM F2160. Conduit shall conform to NEMA TC-7 and UL 651A.
 - a. Power: Black or Black with red stripes
- E. MC cable will not be allowed.

2.02 PULL BOXES, AND JUNCTION BOXES

- A. Construction, sizes and installation of pull boxes and junction boxes shall comply with NEC, Article 314.
- B. Pull and junction boxes not specifically described in NEC, Article 314, shall be fabricated of heavy gauge galvanized steel with screw or hinged covers, and equipped with corrosion resistant screws and hardware.
- C. Pull boxes and junction boxes for outdoor installation shall be raintight.

2.03 IN-GROUND HANDHOLES

- A. UL or ETL Listed, polymer concrete construction, open bottom stackable. Quazite PG style or equal.
 - 1. Manufacturer: Subject to compliance with requirements, the following manufacturers are acceptable:
 - a. Quazite
 - b. HiLine
 - c. Armorcast
 - d. New Basis
- B. All stainless steel hardware with minimum two fasteners per lid.
- C. Provide with label on cover as noted on schedule.

- D. Extra heavy duty covers with non-skid surface, tier 22, 22,500 lb. vertical and 800 lbs/sq. ft. lateral design loads, unless noted otherwise.
- E. Minimum size to be 11"x18", unless noted otherwise. Larger handholes may be required at select locations.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Raceway uses permitted and not permitted per NFPA 70 requirements and as described below.
- B. Galvanized Rigid Steel Conduit (GRS)
 - 1. Installations below grade and under concrete slabs.
 - 2. Locations subject to physical damage
 - 3. Exposed exterior locations.
- C. Rigid Polyvinyl Chloride (PVC) Conduit
 - 1. Installations below grade and under concrete slabs, Schedule 40.
 - a. Where polyvinyl conduit (PVC) is provided, transition to galvanized rigid steel (GRS) conduit, where emerging from underground.
- D. High Density Polyethylene (HDPE) Conduit
 - 1. Directional bored below grade.
 - a. Where high density polyethylene (HDPE) conduit is provided, transition to galvanized rigid steel (GRS) conduit, where emerging from underground.
 - b. Conduit: Schedule 80; Continuous length smooth-wall HDPE conduit for electrical applications produced to ASTM F2160. Conduit shall be listed by a Nationally Recognized Testing Laboratory (NRTL) to UL Standard 651-A for smooth-wall duct to be used as electrical conduit for the installation of Listed electrical cables underground.
 - c. The recommended HDPE color for power conduits are black or black with red stripes. Red identifies the conduit as electrical and black provides UV protection for storage and at points where the conduit may exit the ground.
 - d. Fittings: Threaded Mechanical Fittings: Aluminum reverse-threaded conduit couplers designed for use with HDPE conduit. Compression Fittings and Socket Couplings designed for use with HDPE conduit may also be used.
 - e. Marking
 - 1) Each length of pipe and each fitting shall be clearly and durably marked on their outer surface with their manufacturing details.
 - 2) Marking shall include Material Type, listing and the date of manufacture.
 - 3) Fittings shall be clearly and durably marked, including manufacturer's name or trademark, material type, class of pipe, listing and a date or code of manufacture..
 - 4) Spacing of labeling on pipe shall not exceed 10-feet.
 - f. Tracer Wire
 - 1) Tracer wire shall be #10 stainless steel wire with 45 mil HDPE jacket.
 - 2) Alternately, tracer wire may be embedded in conduit wall.

3.02 INSTALLATION OF RACEWAY

- A. Do not install more than three 90 degree bends between panelboards, enclosures, junction boxes, or pull boxes
- B. Use approved thread lubricant for rigid steel conduits to ensure equipment grounding paths.
- C. Use approved thread sealant for all underground and wet locations threaded conduit joints.
- D. Install the conduit system mechanically and electrically continuous from outlet to outlet and to all cabinets, junction or pull boxes. Conduit shall enter and be secured to all cabinets and boxes in such a manner that all parts of the system will have electrical continuity.
- E. Installation of PVC conduit shall comply with the NEC with regard to grounding and expansion fittings.

- F. PVC conduit shall not be installed above grade unless noted otherwise.
- G. Support conduit raceway systems in accordance with requirements as set forth in the National Electric Code.
- H. Where grounding bushing are installed, provide bare bonding conductor interconnecting all bushings and connected to the equipment ground bar or solidly connected to a grounding lug at pull boxes. Conductor to be sized to match the largest equipment ground conductor.
- I. All connections to NEMA 3R enclosures shall maintain the enclosure listing regardless of the equipment location.
- J. Underground Installation:
 - 1. Minimum cover, unless otherwise indicated or required:
 - a. Underground, exterior: 30 inches.
 - 2. Provide tracer wire in all underground raceways.

3.03 INSTALLATION OF BOXES AND FITTINGS

- A. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

3.04 IN-GROUND HANDHOLE INSTALLATION

- A. Install all handholes flush with surrounding grade. Adjust handholes as required for finished grade.
- B. Do not install handholes at low grade points. Install at locations to allow drainage away from box.
- C. Provide 1" clean compacted fill beneath handholes for drainage. Clean fill shall extend 8" beyond the sides of the handhole enclosure, and a minimum of 12" deep.

3.05 HORIZONTAL DIRECTIONAL DRILLING

- A. General
 - 1. Comply with the requirements of applicable specification sections for the utility line being installed.
 - 2. Conduct any necessary field surveys, subsurface investigations and geotechnical investigations necessary to complete the work.
 - 3. Locate all known utilities located adjacent to or crossing the utility line being installed. Excavate to expose utilities prior to initiating drilling and as required to verify applicable clearances. Clearance shall meet applicable code requirements and the requirements of the directional drilling process.
 - 4. Locate and verify the clearance of known structures and foundations/footings located adjacent to or crossing the utility line being installed.
- B. Excavation, Backfill and Compaction
 - 1. Excavate insertion and receiving pits, and other access points as necessary to complete the work.
- C. Conduit Installation
 - 1. HDPE conduit may only be used in horizontal directional drilling applications. Installation must be in accordance with NFPA 70 National Electrical Code and be direct buried or encased in concrete.
 - 2. HDPE shall not be routed such that it is exposed above grade.
 - 3. Storage and handling of polyethylene pipe shall not result in damage to or deformation of the pipe. Protect polyethylene pipe from long-term exposure to temperature fluctuations and sunlight.
 - 4. Prepare pipe on a relatively smooth surface, free of sharp rocks, sticks, or debris. Utilize cribbing, pipe stands, rollers, or other equipment as necessary to support the pipe.
 - 5. Lift and move piping using ropes, slings, or straps. Do not use unprotected chains, hooks, or clamps to lift pipe.

6. When lifting and moving pipe, provide a minimum of two points of support. Do not support pipes at butt-fused joints.
 7. Sections of pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and rejoined at the Contractor's expense.
 8. Plug all pipes at end of each workday. Provide a watertight plug to prevent entry of foreign materials into the pipe.
- D. Drilling
1. Drilling methods shall generally consist of drilling a pilot hole the length of the bore, followed by reaming and pullback of the pipeline. Ream borehole multiple times, as necessary. The equipment and methods used to complete the bore and install piping shall be determined by the Contractor, but subject to the Contract Documents.
 2. The drill staging area shall be kept neat and orderly and disturb as little area as possible. The pipe staging area shall disturb as little area as needed to accommodate workers and equipment, and to string, fuse, and inspect the pipe.
 3. Install all pulleys, rollers, bumpers, alignment control devices and other equipment required to support and protect the new pipe from damage during installation.
 4. Utilize a drilling fluid cleaning/recycling system. Entry and exit pits shall be sized and constructed to completely contain drilling fluid.
 5. Install boring to line and grade shown on drawings. Alignment shall be within tolerances specified in applicable utility specification sections.
 6. Borehole survey instrumentation shall be used to monitor line and grade of the pilot hole. Contractor shall maintain records documenting the line and grade of the pilot hole.
- E. Drilling Fluid
1. ANSI/NSF 60 (Drinking Water Treatment Chemicals – Health Effects) certified bentonite-based drilling fluid.
- F. Joining Pipe
1. Joints between lengths of conduit and between conduit and couplings, fittings and boxes shall be by an approved method using either Heat Fusion, Electrofusion or listed Mechanical Fittings. Glue and/or solvents are NOT approved.
 2. Any joining method employed shall be in accordance with manufacturer recommendations.
 3. The tensile strength at yield of the butt-fusion joints shall not be less than the pipe.
- G. Ream and Pullback
1. Back-ream Pilot hole reamed to accommodate pipe. Select reamer size and number of passes required.
 2. Pull pipe back using swivel to prevent torsion of pipe.
 3. Monitor tension forces on pipe during pullback. Do not exceed maximum stresses recommended by the pipe supplier.
 4. Support pipeline during pullback operations. Provide supports/rollers in accordance with manufacturer's recommendations. Supports and rollers shall allow for free movement of the pipeline and prevent damage to the pipe.
 5. Use a drilling fluid in conjunction with the installation of the pipe to fill the annular space around the installed pipeline. Contractor is responsible for determining the type of fluid to use.
 6. Properly dispose all excess drilling fluid and slurry material recovered from the hole during drilling operations and displaced by the pipe during installation.
 7. Unless otherwise noted on the drawings, terminate and cap carrier pipe 5' above the proposed ground surface.
- H. Tracer Wire
1. Install Tracer Wire (unless embedded in conduit wall) during pullback operations.
 2. Terminate Tracer Wire at conduit end points and at all intermediate pull points in a fashion as to make it available for locating.

3. Allow the manufacturer's recommended amount of time for cooling and relaxation due to tensile stressing prior to connecting pipe to adjacent pipe sections, fittings, or structures, or backfilling of the insertion pit. Provide sufficient excess length of new pipe at insertion pits to allow for cooling and relaxation.
4. Continuity Testing:
 - a. Test continuity of the Tracer Wire using an ohmmeter prior to demobilizing.
 - b. Tracer Wire Resistance shall be no greater than 105% of the specified unit resistance times installed length.
 - c. Provide a written report describing equipment used, test methods, and detailed test results.
 - d. In the event of a failed test, make all necessary repairs required to provide a tracer wire system that complies with the performance requirements of this section.

END OF SECTION 26 0533