

Technical Specification 028

General Electrical Information

1.0 General

- a) The intent of this specification is to provide technical information and guidance for the furnishing of all labor, equipment, supplies, and materials, and the performing of all operations necessary to complete the installation of an electrical system as indicated on the approved plans or Contract Documents for County projects.

This work includes, but is not limited to, trenches, wiring, conduit, fittings, outlet boxes, junction boxes, pull boxes, switches, receptacles, pump stations, panel boards, lighting fixtures, lamps, relays, timers, alarms, control centers and surge arrestors.

- b) All electrical work shall be performed by a North Carolina licensed electrical contractor. The electrical contractor may function as a prime contractor or as a sub-contractor to a North Carolina licensed general contractor.
- c) The electrical contractor shall assume complete responsibility for any portion of the work provided by his subcontractors.
- d) All electrical work shall be in conformance with the National Electrical Code (NEC) and other applicable standards and local rules and codes of the Authority having Jurisdiction (AHJ).
- e) The electrical contractor shall obtain all required permits from the Authority having Jurisdiction (AHJ) prior to beginning any of the work.
- f) Related Brunswick County Technical Specifications are:
- 1) TS 029: Electrical Services
 - 2) TS 030: Grounding and Bonding
 - 3) TS 031: Surge Protection
 - 4) TS 032: Standby Emergency Power Generator for Sewer Pump Stations
 - 5) TS 033: Automatic Transfer Switch
 - 6) TS 034: SCADA Control System for Sewer Pump Stations
 - 7) Brunswick County Standard Details

- g) It is the intent and meaning of the project drawings and specifications to require completely finished work that has been tested and is ready for operation. The electrical contractor shall take this meaning into consideration and include in his bid minor pieces of material and labor to allow for contingencies and thus provide a finished product without numerous requests for minor extra labor and material.
- h) All permits for the electrical work shall be obtained and paid for by either the general contractor or the electrical contractor. All inspections, tests, or additional fees required for the completion of the work shall also be paid for by either the general or electrical contractor. Determination of who pays the required fees shall be a coordination issue between the general and electrical contractor.
- i) Work shall be executed as required by the approved drawings and accompanying technical specifications and shall be done in a neat, workmanlike manner by skilled mechanics. The electrical contractor is responsible for the finished work presenting a neat, trim, finished appearance, and capable of passing the final electrical inspection by the Authority Having Jurisdiction (AHJ).

2.0 Reference Standards

- a) National Electrical Code (NEC)
- b) National Electrical Manufacturing Association (NEMA)
- c) American National Standards Institute (ANSI)
- d) National Fire Protection Association (NFPA)
- e) Insulated Power Cable Engineers Association (IPCA)
- f) Institute of Electrical & Electronic Engineers (IEEE)
- g) Underwriter's Laboratories (UL)
- h) Electrical Testing Laboratory (ETL)
- i) Canadian Standards Association (CSA)

3.0 Submittals

- a) The electrical contractor shall submit shop drawings and other required materials to the Engineer for review and approval prior to beginning work. Such list shall include the manufacturer, trade name, type, model, series, and other pertinent information for the major items of electrical equipment proposed to be used by the electrical contractor.
- b) The electrical contractor shall submit a minimum of four (4) sets of all shop drawings and other materials to the Engineer per this Submittal Section. One set will be returned to the electrical contractor by the Engineer after review and approval.

- c) The electrical contractor shall analyze all shop drawings and other materials before submittal and ensure that they meet all requirements of the approved plans and Contract Drawings and Specifications. The electrical contractor shall place his “Contractor Certification” in the form of an approval stamp on the submittals prior to delivering the submittal package to the Engineer for review and approval.
- d) Certain makes and models of electrical equipment are specified. The electrical contractor shall submit his proposal for the specified materials and equipment, or their equivalent, provided the words “or equal” or “or approved equal” follow the named manufacturers. If the “or equal” or “or approved equal” phrases do not appear on the plans, Contract Drawings, or Specifications, then the specified manufacturers shall be furnished without substitution. Equivalent or approved equal is interpreted to mean an item of material or equipment, similar to that named and which is suitable for the same use, electrical characteristics, and capable of performing the same functions as that named. The Engineer shall be the judge of equipment equality and his decision is final.
- e) Where no specific material or equipment type is referenced any first class product of a reputable manufacturer may be used provided it conforms to the requirements of the approved plans, Contract Documents, and Specifications. These materials shall be third party listed as UL, ETL, CSA, etc.
- f) If the shop submittals deviate from the approved plans, Contract Documents, or Specifications, the electrical contractor shall advise the Engineer, in writing, of the deviations and the reason for the deviation.
- g) Approval by the Engineer of the submittals by the electrical contractor shall not relieve the electrical contractor from the responsibility of furnishing same of proper dimensions, size, quantity, quality, and all performance characteristics to efficiently perform the requirements and intent of the approved plans, Contract Documents, and Specifications.
- h) Physical sizes of equipment used in the design layout are those of reputable electrical equipment manufacturers. The electrical contractor is responsible for providing equipment that will fit the space provided as shown on the approved plans, Contract Documents, and Specifications. If the electrical contractor uses an “approved equal” as reviewed and approved by the Engineer, any resulting conflicts with space clearances, NEC required clearances, or local codes shall be the responsibility of the electrical contractor to correct at his expense. The electrical contractor is responsible for providing all code required electrical clearances.
- i) The approved drawings, Contract Documents, and Specifications indicate the extent and general arrangement of the various systems. If any departures from these drawings are deemed necessary by the electrical contractor, detailed drawings and descriptions of these departures and a statement of the reasons therefore shall be submitted to the Engineer for approval as soon as practicable. No departures from the arrangements shown on the drawings shall be made without prior written approval of the Engineer or County staff.

4.0 Drawings and Specifications

- a) The electrical drawings and specifications are complementary each to the other, and what may be called for by one shall be binding as if called for by both. The drawings are diagrammatic and indicate generally the location of outlets, switches, devices, equipment wiring, etc., and show the general arrangement of conduits, raceways, fixtures, and equipment. Drawings shall be followed as closely as actual building and / or pump station construction allow, and the work of other trades will permit; however, all work shall suit the finished surroundings.
- b) For a Brunswick County sewer pump stations the Class 1, Division 1 and Class 1, Division 2 hazardous location clearances shall be maintained – no exceptions. If the electrical contractor cannot install the equipment per the approved plans and County pump station Standard Details, and maintain the Class 1 Division 1 and / or Class 2 Division 2 clearances, he is to contact the Engineer immediately to request a resolution from the Engineer and / or County staff.
- c) It is understood that where the words “furnish”, “provide”, and / or “install” are used, it is intended that the electrical contractor shall purchase and install completely all material necessary and required for a particular item, system, equipment, etc.
- d) The electrical work shall conform to the requirements shown on the approved plans, Contract Documents, Specifications, and Standard Details. General and Structural drawings shall take precedence over Electrical Drawings. Because of the small scale of the electrical drawings, it is not practical to indicate offsets, bends, fittings, and accessories that may be required. The electrical contractor shall investigate the project site and shall arrange his work accordingly, providing such fittings and accessories as may be required to meet code and provide the final finished and functional product, without additional cost to the Owner and as directed by the Engineer.

5.0 Electrical Equipment and Materials

- a) All equipment and materials provided shall be new and unused, and shall bear the manufacturer’s name, trade name, and UL label (or other listing label) as applicable.
- b) Equipment and materials shall be delivered to the job site and protected against the elements until installed. All items subject to moisture damage shall be stored in dry, heated and / or cooled, conditioned spaces. Rusty and / or corroded equipment and materials shall not be used.
- c) It shall be the electrical contractor’s responsibility to ensure that items to be furnished fit in the space available.
- d) Manufacturer’s directions shall be followed completely in the delivery, storage, protection, and installation of all electrical equipment and materials.

- e) Anchor bolts, sleeves, inserts, supports, nuts, washers, bushings, etc., shall be furnished and installed by the electrical contractor.
- f) All materials and equipment, installed under this contract shall be firmly supported and secured to the structure where required.
- g) All metal items for use outdoors or in damp locations shall be stainless steel.
- h) Current Transformer (CT) cabinets shall comply with the requirements of the electric utility company.
- i) Meter Boxes shall comply with the requirements of the electric utility company.
- j) All concrete pads for electrical equipment shall be minimum 3,000 psi, twenty-eight (28) day compressive strength concrete, or as directed by the Engineer or County staff. Pads shall be a minimum four (4) inches larger, in all directions, than the equipment being supported. Use reinforcement as specified in the approved plans, Contract Documents, Specifications, or as directed by the Engineer and / or County staff.

6.0 Electrical Equipment Identification

- a) Cable labels:
 - 1) Colored adhesive tape, self-adhesive, not less than 3 mils thick by one (1) to two (2) inches wide.
 - 2) Permanent, heat shrinkable conductor labels.
 - 3) Underground line warning tape, permanent, bright, continuous printed, vinyl tape, not less than six (6) inches wide by four (4) mils thick, compounded and approved for direct burial, embedded continuous metallic strip or core, printed legend shall indicate the type of underground conductor, installed directly above the underground cable at six (6) to eight (8) inches below finished grade.
- b) Nameplates and signs:
 - 1) Safety signs – comply with 29 CFR, Chapter XVII, Part 1910.145
 - 2) Engraved plastic nameplates and signs, melamine plastic laminate, minimum one-sixteenth (1/16) inch thick for signs up to twenty (20) square inches, and one-eighth (1/8) inch thick for larger sizes, engraved legend, black letters on white face.
 - 3) Nameplates and signs shall be fastened to electrical equipment with high performance, double coated tape with adhesive, design basis 3M # 0683, or approved equal.

c) Installation:

- 1) All unit equipment shall contain individual unit nameplates. Nameplates will also be provided on all individual dry type transformers, individual panel boards, control panels, motor control centers, disconnect switches, enclosed circuit breakers, motor starters, push button stations, contactors, control devices, automatic transfer switches, safety switches, and combination starters.
- 2) All pilot lights will include laminated plastic nameplates indicating status of equipment being monitored.
- 3) If equipment identification will be applied to surfaces that require a finish the electrical contractor shall install the identification after completing the finish work.

d) Control Cables Labels:

- 1) Permanent, heat shrinkable matching labels, installed on both ends of each control and instrumentation conductor and cable, for pump stations the label text shall match that of the County pump station SCADA / RTU and pump control panel drawings.

e) Secondary Phase Conductors:

- 1) Phase conductors shall be color coded in accordance with the National Electrical Code (NEC) and the following colors:

a) <u>120 / 240 VAC</u>	b) <u>120 / 208 VAC</u>
Phase A: Black	Phase A: Black
Phase B: Red	Phase B: Red
Neutral: White	Phase C: Blue
Ground: Green	Neutral: White
	Ground: Green

b) <u>277 / 480 VAC</u>
Phase A: Brown
Phase B: Orange
Phase C: Yellow
Neutral: Grey
Ground: Green with yellow stripes

- 2) Colors shall be factory applied the entire conductor length, except the following field-applied; color coding methods may be used for wire sizes larger than No. 10 AWG:
 - a) Colored, pressure sensitive plastic tape in half-lapped turns for a distance of six (6) inches from terminal points and in boxes where splices or taps are made. Apply last two (2) turns of tape with no tension to prevent possible unwinding. Use one (1) inch wide tape

in the colors specified. Adjust tape bands to avoid obscuring the cable identification markings.

7.0 Conductors and Cables

- a) Approved manufacturers:
 - 1) American Insulated Wire Corporation (a Leviton company)
 - 2) General Cable Corporation
 - 3) Houston Wire and Cable
 - 4) Kerite Cable
 - 5) Okonite
 - 6) Senator Wire and Cable Company
 - 7) Southwire Company
 - 8) or approved equal.
- b) Conductor material: copper, stranded conductors for all sizes.
- c) Conduction Insulation Types: THHN-THWN

8.0 Conductor and Insulation Applications

- a) Use type THHN-THWN, single conductors in raceway for:
 - 1) Service Entrance
 - 2) Feeder concealed in concrete and below slabs-on-grade
 - 3) Exposed Branch Circuits
 - 4) Branch Circuits concealed in concrete and below slabs-on-grade
 - 5) Class 1 Control Circuits
- b) Use manufacturer approved pulling compound or lubricant where necessary; compound used must not deteriorate the conductor or insulation; do not exceed manufacturer's recommended maximum pulling tension and sidewall pressure values.
- c) Use pulling means, including fish tape, cable, rope, and basket weave wire / cable grips that will not damage cables or raceways.
- d) Identify and label conductors and cables prior to pulling in raceways.

9.0 Connectors and Splices

- a) Approved manufacturers, wirenuts:
 - 1) AMP, Inc. / Tyco International
 - 2) Cooper
 - 3) GB
 - 4) Ideal
 - 5) King
 - 6) Thomas and Betts
 - 7) 3M Company
 - 8) or approved equal
- b) Approved manufacturers, pre-insulated connectors:
 - 1) FCI
 - 2) Greaves
 - 3) Ilsco
 - 4) NSI
 - 5) Penn Union
 - 6) or approved equal
- c) Factory fabricated connectors and splices of size , ampacity rating, material, type, and class for application and service indicated, pre-insulated connectors shall have one (1) spare port for future connection.
- d) For conductors # 8 and smaller use wirenut type twist connectors.
- e) For conductors # 6 and larger use pre-insulated solderless connectors with one spare port for future connections.
- f) Pump cable connectors:
 - 1) For conductors # 8 and smaller use waterproof wirenut type twist connectors, design basis shall be King DryConn.
 - 2) For conductors # 6 and larger use waterproof pre-insulated solderless connectors, design basis shall be NSI Polaris Blue.

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

10.0 Field Quality Control

- a) After installing conductors and cables, and prior to energizing any electrical circuitry, the electrical contractor shall inspect the installed system for damage.
- b) Make splices and taps that are compatible with the conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- c) Inspect for any physical damage and test conductors and cables for continuity and shorts:

1) Megger test

- a) All current carrying phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a five hundred (500) volt megger.

Minimum readings between conductors and between a conductor and the grounded metal raceway shall be:

- 25 mega-ohms for # 6 and smaller conductors
- 50 mega-ohms for # 4 and larger conductors

- b) The electrical contractor shall correct any malfunctioning conductors and cables, including replacement if necessary, and retest to demonstrate compliance and satisfactory testing results.

2) Control and Signal Transmission Media Testing:

- a) Test cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts.
- b) Correct malfunctioning conductors and cables at the project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest until satisfactory results are obtained.

3) Neutral – ground bond testing:

- a) After all fixtures, devices, switches, and equipment are installed and all connections completed to each panel, the electrical contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and

the grounded enclosure.

- b) If the megger reading is less than twenty-five (25) mega-ohms, the electrical contractor shall then disconnect the branch circuit neutral wires from the neutral bar and test each branch circuit neutral

separately, conductor to grounded enclosure, until the low reading ones are identified. The electrical contractor shall correct the troubles, reconnect all the branch circuit neutral wires back to the neutral bar, and re-test until a minimum twenty-five (25) mega-ohms from the neutral bar to the grounded enclosure can be achieved with only the neutral feeder disconnected.

- d) The electrical contractor shall furnish a megger and demonstrate to the Engineer and County staff the conductors and electrical panels comply with the above requirements.

11.0 Raceways and Boxes

- a) Approved manufacturers, metallic conduit and tubing:

- 1) Anamet Electrical, Inc.
- 2) Grinnell Company / Tyco International
- 3) LTV Steel Tubular Products Company
- 4) Manhattan / CDT / Cole-Flex
- 5) O-Z Gedney
- 6) Wheatland Tube Company
- 7) or approved equal.

- b) Approved manufacturers, non-metallic conduit and tubing:

- 1) American International
- 2) Anamet Electrical, Inc.
- 3) Arnco
- 4) Cantex
- 5) Certainteed
- 6) Condux International
- 7) ElecSYS

- 8) Electri-Flex
 - 9) Heritage Plastics Central, Inc.
 - 10) Lamson & Sessions / Carlon Electrical Products
 - 11) Manhattan / CDT / Cole-Flex
 - 12) Queen City Plastics
 - 13) RACO
 - 14) Southern Pipe, Inc.
 - 15) Spiralduct, Inc. / AFC Cable Systems, Inc.
 - 16) Thomas & Betts
 - 17) or approved equal.
- c) Approved manufacturers, metal wireways:
- 1) Hammond
 - 2) Hoffman
 - 3) Rittal
 - 4) Square D
 - 5) or approved equal.
- d) The electrical contractor shall include fittings, accessories, couplings, offsets, elbows, adapters, expansion joints, hold down straps, end caps, terminations, and other fittings as needed to match and mate with conduit, tubing, and wireways as required to produce the complete electrical system.
- e) Wireway covers shall be the flanged and gasketed type.
- f) Approved manufacturers, boxes, enclosures, and cabinets:
- 1) Austin
 - 2) Hoffman
 - 3) or approved equal.
- g) Cast metal outlet, device, pull, and junction boxes shall be NEMA FB 1, with gasketed covers.

- h) All conduit at a Brunswick County sewer pump station shall be Schedule 80 PVC unless otherwise directed by the Engineer or County staff.
- i) The minimum conduit or raceway size shall be $\frac{3}{4}$ - inch trade size.
- j) Raceway fitting shall be compatible with raceways and suitable for use and location in every respect.
- k) Condulet fittings, such as LBs, LLs, LRs, Cs, and Ts, are not allowed in Brunswick County sewer pump stations.
- l) All conduits in County sewer pump stations shall enter the bottom of electrical equipment and enclosures with a watertight hub, Myers or approved equal, as shown on the Brunswick County pump station Standard Details.
- m) Complete the raceway and / or conduit installation prior to installing conductors.
- n) Provide adequate support(s) as needed for raceways and conduits.
- o) Install temporary closures to prevent foreign matter from entering raceways, conduit, and tubing.
- p) Protect stub-ups from damage where conduits rise above finished grade. Arrange such that curved portions of bends are not visible above the finished grade.
- q) For raceways and conduit between enclosures within a County sewer pump station the electrical contractor shall route the conduit from one enclosure to the next below grade, a minimum of eighteen (18) deep, with the conduit bends non-visible below grade. Refer to County pump station Standard Details. Horizontal raceways and conduits shall not be visible above grade.
- r) Bends and offsets shall be made such that the interior diameter (I.D.) of the conduit is not reduced.
- s) Raceways and conduits embedded in concrete slabs shall be installed in the middle $\frac{1}{3}$ of the slab with a minimum of two (2) inches of concrete cover. Secure conduit to reinforcing rods to prevent sagging or shifting during concrete pouring operations.
- t) Join raceways and conduits with fittings designed and approved for that purpose and make joints tight.
- u) Insulating bushings are required on conduit terminations inside enclosures to protect the conductors.
- v) Grounding and bonding bushings are required inside enclosures as required by the National Electrical Code.

- w) Conduit terminations inside enclosure shall be square and true, with threaded hubs, locknuts, and bushings, and securely tightened with the dished side of the locknut against the enclosure.
- x) Install pull wires in empty raceways and conduits for future use. Use polypropylene or monofilament plastic line with a minimum two hundred (200) pound tensile strength. Leave a minimum of twelve (12) inches of slack at each end of pull wire.
- y) Install raceway and conduit sealing fittings at suitable, approved, and accessible locations and fill with UL listed sealing compound or as directed by the Engineer or County staff.

12.0 Wiring Devices

- a) Wiring devices are duplex receptacles, ground fault protected duplex receptacles, ground fault circuit breakers, standard circuit breakers, arc fault protected duplex receptacles, arc fault circuit breakers, single pole snap switches, double pole snap switches, device plates, and other similar equipment.
- b) Wiring devices shall be listed and labeled as defined in the National Electrical Code, Article 100, by a testing agency acceptable to the Authority Having Jurisdiction (AHJ), and marked for intended use.
- c) All receptacles for owner furnished equipment shall match the plug configuration of the Owner's equipment.
- d) Acceptable Manufacturers:
 - 1) Bryant Electric, Inc. / Hubbell Subsidiary
 - 2) Eagle Electrical Manufacturing Company, Inc.
 - 3) Hubbell Incorporated
 - 4) Leviton Manufacturing Company, Inc.
 - 5) Pass & Seymour / Legrand
 - 6) or approved equal.
- e) Snap switches shall be heavy duty grade, quiet type, UL listed.
- f) Receptacles shall be straight blade type, heavy duty type, UL listed.
- g) Ground fault circuit interrupter (GFCI) receptacles shall be the straight blade type, feed – through capability, heavy duty, UL listed, NEMA rated, 20 ampere minimum, install in a minimum 2 ¾ inch deep outlet box without the use of an adapter ring.

- h) Device plates shall be single and combination types as required to match corresponding wiring devices.
- i) Install level, plumb, and square, flush with finished wall, with long dimension vertical, unless otherwise directed, and with grounding terminal of receptacles on top, group adjacent switches under single, multigang wall plates.
- j) Ground and bond all wiring devices and equipment in accordance with Article 250 of the National Electrical Code.
- k) Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- l) After installing wiring devices and after the electrical circuitry has been energized the electrical contractor shall test all devices for proper voltage, polarity, ground continuity, and compliance with all National Electrical Code and local requirements.
- m) The electrical contractor shall test all GFCI devices for proper operation, according to the manufacturer's written instructions, after the electrical circuitry has been energized,
- n) The electrical contractor shall replace all malfunctioning units with new units and re-test as specified above.

13.0 Protection of Completed Work

- a) The electrical contractor shall effectively protect his work, materials and equipment from damage during the construction period. All openings into any part of the conduit system, associated fixtures and equipment must be securely covered or otherwise protected. Steel conduit and other ferrous metal supplies shall be stored where they will not be exposed to corrosion.

14.0 Final Inspections and Equipment Demonstrations

- a) The electrical contractor shall furnish ladders, tools, testing, equipment, and employees at the time of final electrical inspection to allow the Engineer, County staff, and the Authority Having Jurisdiction (AHJ) inspector access to all fixtures, boxes, panels, etc., as needed in order to successfully pass the final electrical inspection.
- b) The electrical contractor shall furnish all clamp-on type ammeter, voltmeter, megger, ground resistance tester, etc., as needed for system testing and final inspection.

15.0 Operating Instructions

- a) At the completion of the work, and after obtaining the final electrical inspection, the electrical contractor shall operate, in the presence of the Engineer and County staff, each component of the system and then the entire system as a whole. When all the requirements of the approved plans and specifications have been met and all final punch list items corrected, the electrical contractor shall instruct and train the County operating and maintenance personnel in the correct and proper procedures for the operation and maintenance of the electrical system.

16.0 Spare Parts

- a) The electrical contractor shall provide any spare parts as required by the approved plans, Contract Documents, and Specifications. The parts shall be properly packaged and labeled with the name of the project and delivered to Brunswick County staff.

17.0 Payment

- a) The electrical work shall be bid as specified in the Contract Documents, either Lump Sum or on a Unit Cost basis. All incidental material required to produce the complete system shall be included in the Lump Sum or Unit Cost bid. No separate payment will be made for incidental material required to produce the finished work.