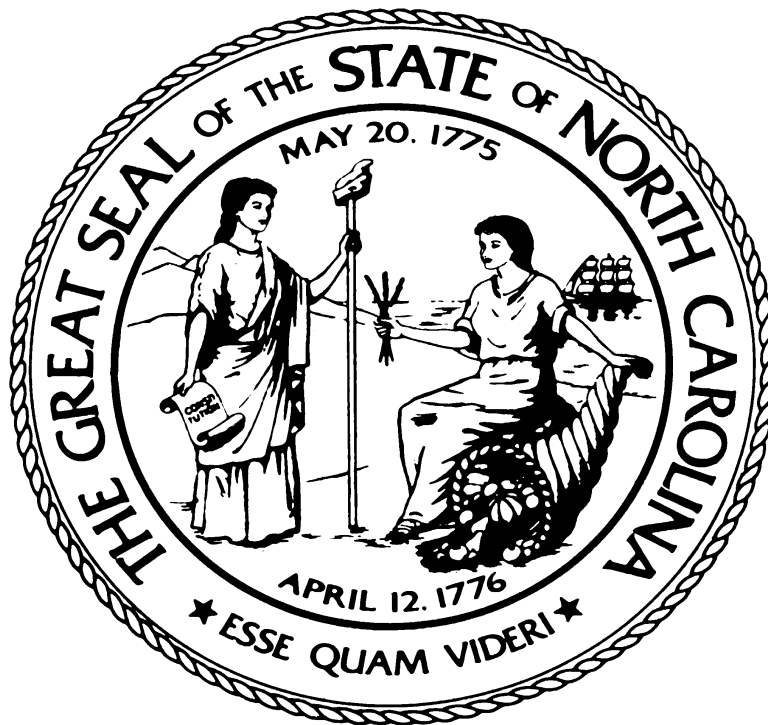


**STATE OF NORTH CAROLINA**

**DEPARTMENT OF ADMINISTRATION**

**STATE CONSTRUCTION OFFICE**



**ELECTRICAL**

**GUIDELINES AND POLICIES**

**2011**

The following guidelines and policies are established to aid the designer during design development and specification writing. Contents herein are not to be included in designer's specification by reproduction, but shall be used as a guide only. Variances of these guidelines and policies shall be discussed with the State Construction Office prior to submitting design to alleviate possible extra work on the designer's part.

***The following replaces the Electrical Guidelines and Policies --2008 in its entirety.***

***Major changes are highlighted in the right hand margin by a bar.***

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**26 01 00 BASIC ELECTRICAL REQUIREMENTS**

- a) AEIC (American Association of Edison Illuminating Companies)
  - b) ANSI C82.11 (American National Standards Institute for Fluorescent Ballasts)
  - c) ASTM (American Society for Testing and Materials)
  - d) ASHRAE/IES (90.1 energy conservation code)
  - e) BOCA (Building Officials Code Administrators)
  - f) ICEA (Insulated Cable Engineers Association)
  - g) ICC (International Code Council)
  - h) ICBO (International Conference of Building Officials)
  - i) IEEE (Institute of Electrical and Electronic Engineers)
  - j) NCCM (N.C. Construction Manual w/G.S. as listed)
  - k) NCSBC (N.C. State Building Code)
  - l) NEC (National Electrical Code)
  - m) NECA (National Electrical Contractor Association)
  - n) NEMA (National Electrical Manufacturers Association)
  - o) NESC (National Electrical Safety Code)
  - p) NFPA (National Fire Protection Association)
  - q) NEIS (National Electrical Installation Standards)
  - r) U/L (Underwriters' Laboratories Inc.)
  - s) OSHA (Occupational Safety and Health Administration)
  - t) SBCCI (Southern Building Code Congress International)
  - u) TCLP (Toxicity Characteristic Leaching Procedure)
2. Non Appropriated Funds Projects, such as: Privately Funded Projects on **State Land**, or **Privately Funded Projects on Private Land** that will be maintained by the state, or Privately Funded Projects on Community College Land shall be designed to meet or exceed requirements of the Electrical Guidelines and Policies issued by this office, the Fire Alarm Guidelines, the State Construction Office manual, and the STS 1000 for the telecommunication systems. Strict adherence to these publications is required. Please see State Construction Manual, Section for the non appropriated funds projects.
3. Specifications for electrical work shall clearly indicate the responsibility of the electrical contractor to notify the State Electrical Inspector with Department of Administration; for state

owned projects, and to notify the local inspectors; for community college & county owned buildings, to schedule required inspections.

4. At the bid document submittal, electrical drawings and specifications shall be sealed, signed and dated by the design engineer of record registered in the State of North Carolina. Professional seal is also required on the electrical plans for the design of the special systems, such as the stage lighting, the audio/video and the like.
5. An electrical symbol schedule and legend shall appear on the first sheet of the electrical drawings. The electrical symbols shown on the bid documents shall consist of standard design symbols. For the purpose of clarification "standard symbols" can be found in current editions of the Architectural Graphic Standards, the American Electricians' Handbook, and in the IEEE Standards. Fire Alarm and life Safety symbols should be based on symbols defined in the American National Standard NECA 100.
6. On the electrical drawings the Designer shall include a Load Tabulation Breakdown in KVA rating for the existing peak demand load, if any, the new connected load, and demand load, and the diversity factor. Where two or more non-coincident loads will be used simultaneously, the largest load only shall be calculated. (See Appendix, Sheet E-8).
7. Special attention is directed to N.C. General Statute 133-3 (Specifications to Carry Competitive Items, Substitution of Materials) for strict adherence thereto (for all equipment where available). See the procedure provided on the SCO web site regarding this issue.
8. The design engineer shall provide a short-circuit study and shall ensure that coordination study is performed between the main protective devices for the system, feeder protective devices for the system, and all downstream protective devices. It is the engineer's responsibility to make sure the system is fully coordinated and properly protected against short circuit, overload & ground fault. The coordination study is required for projects involving the use of protective relays, adjustable circuit breakers and main fuses, and shall be performed in accordance with recommendation of the IEEE standards and NEC. If requested by the SCO, the engineer's basis-of-design sealed studies shall be submitted to the State Construction Office at the time of "working drawing" review. After the design engineer's approval of the vendor "shop drawings" final coordination study based on the protective device vendor chosen for the project should be reviewed, stamped approved and dated by the design engineer of record, if requested, the study shall be submitted to SCO for verification.
9. List for Third Party Agencies Accredited by the NCBCC to Label Electrical and Mechanical Equipment, shall be obtained from Department of Insurance, Electrical Inspection Section. The list can be found on DOI web site.
10. On the electrical drawings the designer shall include an Energy Table showing the method of compliance (prescriptive, performance, or energy cost budget) and the total watts specified VS. allowed for the interior and the exterior lighting. Energy Table shall be signed and dated by the Engineer of record.
11. Thermal detection test shall be performed on the MV equipment connections, preferably July or August, prior to the expiration of the one year contracted warranty.
12. Equipment Installation: The complete electrical installation shall fully comply with all requirements of the regulations, laws, ordinances, the National Electrical Code, referenced Standards, the State Construction Office Electrical Guidelines, and other Codes applicable to this project. In addition, equipment shall be installed in accordance with the manufacturer's

instructions as required by NEC 110.3 (B). While our reviews are intended to be thorough and accurate, they do not include all aspects of the applicable Codes, nor do they relieve the need for the designers to thoroughly check their plans for Code compliance. Therefore, any change order due to not complying with these Codes' requirements is the responsibility of the Engineer of Record.

## **26 02 05 DIVISION OF WORK**

1. This section delineates the division of work between the Electrical Contractor and any other Contractor.
2. Specific work to be done under Division 26 is hereinafter listed or described. All other work necessary for the operation of Division 23 equipment shall be performed under Division 23.
3. All individual motor starters and drives for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 23 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26.
4. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter, VFD or disconnect switch. Under Division 26 line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 23.
5. Duct smoke detectors, if provided per NFPA 90A requirements, shall be furnished and wired by Division 28, installed by Division 23. Fire alarm AHU shut down circuits shall be wired from the fire alarm control panel to a termination point, adjacent to the AHU control, under Division 28. AHU control wiring from the termination point to the equipment shall be under Division 23.
6. Equipment less than 110 Volt, all relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freeze-stats, line and low voltage thermostats, thermals, remote selector switches, remote push-button stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.
7. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 23.
8. Roof exhaust fans with built-in disconnects provided under Division 23, or doors provided with built-in outlets shall be wired under Division 26 to the line side of the disconnect switch, or the outlet. A disconnect switch shall be provided under Division 26 if the fan is not provided with a built-in disconnect switch. In this case wiring from the switch to the fan shall be under Division 23. See sheet E-18 regarding the location and wiring of disconnects for other equipment. The built-in switch for the roof top equipment shall be in NEMA 3R enclosure.
9. The sequence of control for all equipment shall be as indicated on the Division 23 Drawings and specified in Section 23, HVAC Control System.
10. Horsepower for all motors shall be indicated on the Division 23 and Division 26 Drawings.

11. VFD Cable shall be specified under section 23, for the mechanical contractor. The Mechanical Engineer shall specify 3-phase, 3 ground, copper tape spiral shield, galvanized steel interlocked Armor cable for the VFD cable. To ensure system reliability, the cable shall be terminated in connector designed exclusively for ASD/VFD cable.
12. All sprinkler flow and tamper switches shall be furnished and installed under Division 21, and wired under Division 28.
13. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26. Exception to that is the low-voltage control wiring; the use of the J-Hooks to support the low-voltage control wiring system is acceptable; as outlined in Section 4, the Telecom STS -1000 Guidelines.
14. For kitchen equipment, Division 26 contractor shall install wiring from a power source to a termination point, adjacent to the kitchen equipment. Contractor providing kitchen equipment will wire to the equipment from the termination point.
15. The use of combination starter is recommended over the use of individual starter and disconnect switch. Also, the use of VSD for pump and fan motors five H.P and larger is recommended.
16. A diagram clarifying who is to provide and install the termination point, such as (trough, VFD, individual starter, disconnect switch, JB, --- etc.) shall be placed on the electrical and the mechanical plans. (See Appendix, Sheet E-18)
17. Disconnects for the elevator and the elevator's car shall be provided and installed by the electrical contractor.
18. Reports showing the sizes of the maximum overcurrent protection (MOCP) and the maximum circuit ampacity (MCA) and overload setting of the devices for all motors; shall be provided by the contractor providing the equipment to this engineer before project final approval.
19. All electrical work shall be performed by companies properly licensed by the NC State Electrical Board of Examiners.
20. Exit doors & other doors provided with built-in outlets shall be wired by the electrical contractor all the way to the door outlet. Electrical Engineer shall coordinate with the Architect when specifying Door shutters and magnetically held doors to ensure all required fire alarm devices are shown and specified.

## **26 08 00      ELECTRICAL TESTING**

### **FEEDER INSULATION RESISTANCE TESTING**

1. 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 500 volt megger. The procedures listed below shall be followed:



- a) Minimum readings shall be one million (1,000,000) or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conductors and between conductor and the grounding conductor.
- b) After all fixtures, devices and equipment are installed and all connections completed to each panel, the contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel and until the low readings are found. The contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
- c) At final inspection, the contractor shall furnish a megger and show the engineers and State Construction Office representatives that the panels comply with the above requirements. He shall also furnish a hook-on type ammeter and voltmeter to take current and voltage readings as directed by the representatives.

### GROUND SYSTEM TESTING

1. Upon completion of installation of the electrical grounding and bonding systems, the ground resistance shall be tested with a ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, appropriate action should be taken to reduce the resistance to 25 ohms, or less, by driving additional ground rods. (The compliance should be demonstrated by retesting.)

### CIRCUIT BREAKER TESTS

1. For services 1000 amperes and larger, the following tests should be performed on the service circuit breakers and the distribution circuit breakers. Testing shall be performed by a qualified factory technician at the job site. All readings shall be tabulated:
  - a) Phase tripping tolerance (within 20% of U/L requirements).
  - b) Trip time (per phase) in seconds.
  - c) Instantaneous trip (amps) per phase.
  - d) Insulation resistance (in megohms) at 100 volts (phase to phase, and line to load).

### GROUND FAULT PROTECTION SYSTEM

1. The ground fault protection on the new circuit breakers (if provided) shall be performance tested in the field and properly calibrated and set in accordance with the coordination study.

## DOCUMENTATION

1. All tests specified shall be completely documented indicating time of day, date, temperature and all pertinent test information.
2. All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for, final acceptance of the project.

### **26 05 00 MINOR ELECTRICAL DEMOLITION FOR REMODELING**

1. Abandoned conduit/boxes shall have all electrical wiring removed completely and not just made "safe." Conduit/boxes shall be removed where practical without creating additional demolition/restitution work for other trades.

### **26 05 33 CONDUIT**

#### UNDERGROUND RACEWAYS

1. Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of three (3) inches of concrete on all sides.
  - a) Encased raceways must have a minimum cover of eighteen (18) inches, except for raceways containing circuits with voltages above 600 volts, which must have a minimum cover of thirty (30) inches.
  - b) Encased raceways shall be of a type approved by the NEC as "suitable for concrete encasement."
2. Branch circuit raceways run underground external to building foundation walls shall be run in raceways installed in accordance with the NEC, and shall be of a type approved by the NEC as "suitable for direct burial." Minimum raceway size shall be 3/4 inch.
3. All underground raceways shall be identified by underground line marking tape located directly above the raceway at 6 to 8 inches below finished grade. Tape shall be permanent, bright-colored, continuous printed, plastic tape compounded for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.
4. Raceways run underground internal to building foundation walls shall be of a type and installed by a method approved by the NEC.
5. Where underground raceways are required to turn up into cabinets, equipment, etc., and on to poles, the elbow required and the stub-up out of the slab or earth shall be of rigid steel.

6. The raceway system shall not be relied on for grounding continuity. See Section 26 05 26 Grounding and Bonding for clarification.
7. Where passing through a "below grade" wall from a conditioned interior building space, raceways shall be sealed utilizing fittings similar and equal to OZ/GEDNEY type "FSK" thru-wall fitting with "FSKA" membrane clamp adapter if required.

### ABOVE GROUND RACEWAYS

1. Conduit shall be sized in accordance with the latest edition of the NEC unless shown otherwise, with minimum conduit size being 1/2 inch. Flexible metal and watertight ("sealtight") conduit in size 1/2 inch and larger are acceptable for motor, appliance and fixture connections provided green wire is installed and NEC is followed.
2. Conduit, exposed and concealed (except "in-slab"), shall be neatly installed parallel to, or at right angles to beams, walls and floors of buildings.
3. EMT may be utilized as permitted by the NEC, with the following restrictions. EMT conduit, couplings, elbows and fittings shall not be installed:
  - a) Any location outdoors, in direct contact with earth, or underground (in/below slab- on grade or in earth)
  - b) Indoors in wet or damp locations, or in concrete, cinderblocks or bricks.
  - c) Where exposed to severe corrosive influence and/or severe physical damage.
  - d) Encased in concrete.
  - e) For transition between EMT and rigid conduits, use JB.
4. The raceway system shall not be relied upon for grounding continuity. Section 26 05 26 Grounding and Bonding for clarification.
5. EMT conduit provided below roof deck shall be installed 1 1/2 inches away from the deck to allow for screws not to penetrate the EMT conduit during reroofing.
6. Conduits, JBs, Troughs, any enclosure when mounted outside on the walls, shall be off the walls by one inch.
7. The use of "LB's" shall be limited where possible. Where necessary to use "LB's" sized larger than 2 inches, mogul units shall be installed.
8. PVC schedule 40 shall not be used exposed or concealed in gypsum walls, but may be used in CMU walls. PVC schedule 40 may be used in elevated floor slabs and in foundation slabs. Minimum concrete cover shall be 3/4 inch at finished or formed surface and shall be 3 inches at concrete surface cast against earth or for slabs placed on-grade. Greater amounts of concrete cover shall be used in areas subject to damage or corrosion. Installed systems shall comply with the minimum requirements of ACI318 Chapter 6. The placement of conduit in floor slabs must be thoroughly coordinated with, and approved by, the structural engineer of record. Such placement must be clearly addressed by the construction documents. Potential conflicts with steel reinforcing bars, composite slab shear anchors, and reductions in net concrete sections

are among the issues that must be considered by the structural engineer. The effect of closely spaced conduit groups on fire-rated horizontal assemblies shall be addressed by the design team. Post-bid proposals to move under-floor conduit into the slab are subject to approval by the structural engineer and related slab reinforcement or slab reconfiguration could require a credit from the contractor.

### TERMINATIONS

1. IMC and GRC shall terminate with either a double locknut / bushing set, or in a threaded hub.
2. Where concentric, eccentric or over-sized knockouts are encountered, a grounding-type insulated bushing shall be provided.
3. All conduits shall be provided with Insulated throat.
4. EMT terminations shall be made utilizing steel-plated hexagonal compression connectors. No pot metal, set screw or Indented type fittings shall be utilized.

### CONDUIT COUPLINGS

1. Where conduits of any type pass over a building expansion joint, a standard "expansion joint fitting," compatible with the type raceway being used, shall be provided.
2. Conduit couplings for IMC, GRC and PVC shall be in accordance with the NEC.
3. EMT couplings shall be of the plated-steel hexagonal compression type. No pot metal, set screw or Indented type couplings shall be utilized.

## **26 05 43 DUCTBANKS**

**(See Section 26 05 33 Underground Raceways, for additional coverage on underground raceways.)**

1. Excavation and backfill shall conform to "Division 2" of the specifications except heavy-duty, hydraulic-operated compaction equipment shall not be used.
2. Trenches should be cut neatly and uniformly, sloping uniformly to required pitch.
3. Ducts should be pitched to drain toward manholes and hand-holes and away from buildings and equipment. Minimum slope shall be 4 inches in 100 feet. Where necessary to achieve this between manholes, ducts should be sloped from a high point in the run to drain in both directions.
4. Concrete encased nonmetallic ducts shall be supported on plastic separators coordinated with duct size and spacing. Separators shall be spaced close enough to prevent sagging and deforming of ducts. Separators to the earth and to ducts should be secured to prevent floating

during placement of concrete. Steel or tie wires should not be used in such a way as to form conductive or magnetic loops around ducts or duct groups.

5. Waterproof marking cord should be installed 130-pound tensile test (marked at least every foot), equivalent to Greenlee No. 435, in all ducts, including spares, after thoroughly rodding, clearing and swabbing all lines free of any and all obstructions.
6. All ducts should be sealed at terminations, using sealing compound and plugs, as required to withstand 15 psi minimum hydrostatic pressure.
7. The installation of MHs should be in accordance with OSHA requirements.
8. After installation of the raceway system and before pulling the cables, the raceway system shall be air tested to 15 psi hydrostatic pressure.

## 26 05 13 MEDIUM-VOLTAGE CABLE

### CABLE CONSTRUCTION

1. Conductors shall be soft drawn, Type MV-105, Class "B", concentric compact or compressed, stranded copper, single conductor shielded cable. The shielding process shall be one of the following; either a, b, or c:
  - a) A true triple extrusion (done simultaneously, in a common extrusion head which does not expose the EPR insulation to the atmosphere). The cable shielding shall consist of, semi-conducting strand shield, EPR insulation and semi-conducting insulation shield.
  - b) A true triple tandem extrusion process, where the semi-conducting strand shield, the insulation and the semi-conducting insulation shield are EPR.
  - c) Double extrusion process for the non-conducting cable shield and the insulation; the non-conducting cable shield shall be continuously tested for 2kv DC test while the shield is over the conductor and prior to the EPR insulation & the insulation shield being applied.
2. Cable shall be capable of operating at a normal continuous conductor temperature of 105°C, an emergency overload conductor temperature of 140°C, and a short circuit conductor temperature of 250°C.
3. Cable shall be shielded with 5 mil metallic uncoated copper tape helically applied with 25% nominal overlap.
4. The EPR insulation shall be compounded by the cable manufacturer in its own facility.
5. The overall jacket or sheath shall be oil, acid, alkali, and sunlight-resistant PVC compound which shall be rated for use in conduit or aerial construction. Cable identification shall be printed on this jacket using indelible ink. The cable identification shall indicate "the manufacturer, the plant number, cable size, year of manufacture, insulation thickness, insulation type, voltage rating, KV% insulation level & sequential footage number."

6. Primary cable ratings: The primary cable ratings shall be 5,000 Volts; nominal 115 mils thickness, 15,000 volts; nominal 220 mils thickness, or 25,000 volts; nominal 345 mils thickness. Cable thickness shall meet or exceed AEIC and ICEA requirements and shall have 133% insulation.
7. The cable shall be provided with 600 volts grounded neutral.
8. Cable shall pass the flame test in accordance with the IEEE 1202, CSA FT4 & ICEA T-29-520.
9. The cable shall meet or exceed the following standards: ICEA S-93-639, NEMA WC 74, AEIC CS-8, ASTM B-496, UL-1072 (type MV-105) for all cables, IEEE 383 for cables 1/0 AWG and larger.
10. The Quality Assurance Program and the ISO certification shall be provided to State Construction Office upon request.
11. Qualification Test Report for the cable insulation system (conductor-shield, insulation, and insulation-shield) shall be provided to State Construction Office upon request.
12. The cable supplied must have been manufactured within 12 months prior to date of order placement.

## INSTALLATION

1. The approved cable shall be installed in continuous lengths where possible, and shall be fireproofed in each manhole.
  - a) The fireproofing tape shall consist of a flexible conformable fabric having one side coated with a flame-retardant, flexible polymeric coating and/or a chlorinated elastomer.
  - b) The tape shall be 1/16 inch thick by 3 inches wide, wrapped around each conductor spirally with the coated side toward the conductor.
  - c) The tape shall extend for the total length of the conductor in the manhole and 1 inch into the ducts.
  - d) The tape shall be non-corrosive to the cable jacket, self-extinguishing, and shall not support combustion.
2. Splices are to be permitted only at points designated on the plans. All splices and terminations, unless otherwise specified, are to be fabricated in accordance with the cable and termination manufacturer's recommendations, or in accordance with the details of such instructions included on the drawings.
3. M.V Cable pulling tension and side wall pressure calculations shall be performed to assure that all circuits are installed in strict accordance with the physical limits of the cables as stated by the manufacturer.
4. Cable shall be manufactured by General Cable, Kerite, Okonite, Prysmian, or an approved substitute. Before approval by the engineer, any proposed substitution shall be discussed with the State Construction Office prior to the opening of bids.

### MEDIUM VOLTAGE CABLE TEST REPORT

1. The cable shall be tested at the factory. The contractor shall be required to furnish a Certified Manufacturer's Test Report for the "Master Reel" of each cable length shipped, for approval by the engineer. The test report shall include:
  - a) A high voltage test (A.C)
  - b) Corona test.
2. The manufacturer's certified test report shall include all the data. Copy of the test report shall be sent to the owner.
3. After installation, but prior to energizing the system, the contractor shall also high-pot the system in accordance with the design engineer's specified testing procedure, as witnessed and "signed-off" by the design engineer. Copies of this test report shall be sent to the owner, to the engineer, and to the State Construction Office, attention Design/Review Section.

### MEDIUM VOLTAGE CABLE WARRANTY

1. The cable manufacturer shall warrant to the owner that each reel of cable is free from defects in material, design and workmanship and will provide reliable performance for a twenty-five (25) year life from the date of project final acceptance.
2. The warranty assumes the cable is installed, spliced, terminated and maintained in accordance with manufacturer's recommendations.
3. Prior to cable termination or splicing, contractor shall submit the qualifications of personnel directly responsible for completing this work to the engineer. Upon approval by the engineer in writing, contractor may proceed with this portion of the work.
4. Defective cable shall be replaced at no cost to the owner.
  - a) When the manufacturer and the owner mutually determine a portion of or all of the cable is defective, the cable manufacturer shall furnish replacement of said cable without charge.
  - b) The replacement cable shall comply with these requirements and be delivered to the original delivery point free of any charge to the owner or the State of North Carolina.
5. Cable shop drawings shall include said described warranty from the cable manufacturer properly signed, and having the manufacturer's corporate seal affixed thereto.

### REEL HANDLING AND STORAGE:

1. The manufacturer shall ship all reels in an upright position on the flanges. The cable ends shall be sealed to prevent the entrance of moisture, gases or vapors into the cable. After the cutting of any length, the exposed ends of any remaining cable on the reel shall have heat-shrinkable

end caps applied to prevent the entrance of water or vapor. The manufacturer shall be responsible to indicate to any commercial carrier the requirements for shipping the reels of completed cable. The Contractor and the Engineer shall be responsible for the acceptance inspection of the shipped cable reels and shall note any visible damage on arrival in any unacceptable orientation or condition and inform the carrier, distributor and manufacturer of such damage or unacceptable condition. Any movement or lifting of completed reels of cable shall be by the use of a bar inserted through the arbor hole in the cable reel and, as appropriate or necessary, use of a spreader bar to avoid damage to the reel flanges. No completed reel of cable shall be lifted by any force on or connection directly to the reel drum. Completed reels of cable shall be covered with a suitable material to reduce the impact of weather, rain or sunlight on the cable. Reels under the covering should have adequate ventilation to prevent the formation of condensation.

### CABLE IDENTIFICATION:

1. Each reel shall have an identification tag by the manufacturer securely attached to each flange and shall contain the following information, manufacturer's name & location, cable trade name, conductors size and voltage rating, identification of insulation and jacket material, footage, and UL label.

## **26 05 19 BUILDING WIRE AND CABLE**

### GENERAL

1. All wire and cable shall be listed by an "approved" third-party testing agency.
2. Prior to energizing feeders, sub-feeders and service conductor cables shall be tested for electrical continuity and short circuits. A copy of these tests shall be sent to the State Construction Office, the engineer of record, and the owner.
3. All wire and cable shall run in raceway.
4. In special cases, type "AC" and type "NM" cables are permitted provided the State Construction Office has approved the application. Upon consultation with the State Construction Office, Review Section, the use of type MC Cable is approved. The MC: 1) shall not exceed 6 feet in length, 2) shall be minimum ½-inch diameter trade size, 3) conductors shall be provided with minimum #12 AWG solid copper rated at 600 Volts, and 4) shall contain #12 AWG separate green ground wire.
5. Minimum of full size individual neutral wire shall be provided for each circuit; in other words, no sharing of the neutral between circuits is allowed.

### CONDUCTORS

1. Power and lighting circuits #10 AWG and smaller shall have solid copper conductors. Conductor sizes #8 AWG and larger shall have Class B stranded copper conductors. Aluminum



conductor may be used as a service conductor for the main distribution panel, and/or as a feeder conductor for the electrical sub-panel, in situation where the designer and State Construction Office find it to be beneficial.

2. Power and lighting circuits' minimum conductor size shall be #12 AWG, and maximum conductor size allowed shall be 500 Kcmil.
3. Fire alarm and control wiring shall have stranded copper conductors. See the Fire Alarm Guidelines provided on the State Construction Office Web Site.
4. Full size neutral conductor shall be provided for each service panel and sub-panel.

INSULATION The insulation type for interior wiring shall be dual-rated THHN/THWN or XHHW.

### VOLTAGE DROP

1. Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drop on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).
2. If the actual load to be plugged to the receptacles is not known; assume 16amp load for the 20amp circuit breaker, and 12amp load for the 15amp circuit breakers; unless the breakers are rated to carry 100% load.
3. Where the conductor length from the panel to the first outlet on a 277 volt circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.
4. Where the conductor length from the panel to the first outlet on a 120 volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.

### COLOR CODING

1. The secondary service, feeders and branch circuits shall be color coded as follows:

| <u>PHASE</u> | <u>208/120v</u> | <u>480/277v</u> |
|--------------|-----------------|-----------------|
| A            | Black           | Brown           |
| B            | Red             | Orange          |
| C            | Blue            | Yellow          |
| Neutral      | White           | Natural Gray    |

Ground

Green

Green

## SPLICING

1. Joints in solid conductors shall be spliced using Ideal "wirenuts", 3M Company "Scotchlock" or T&B connectors in junction boxes, outlet boxes and lighting fixtures.
2. "Sta-kon" or other permanent type crimp connectors shall not be used for branch circuit connections.
3. Joints in stranded conductors shall be spliced by approved mechanical connectors and gum rubber tape or friction tape. Solderless mechanical connectors for splices and taps, provided with U/L-approved insulating covers, may be used instead of mechanical connectors plus tape.
4. Conductors, in all cases, shall be continuous from outlet to outlet and no splicing shall be made except within outlet or junction boxes, troughs and gutters.

## **26 27 26      WIRING DEVICES**

### SWITCHES

1. Toggle switches shall be single pole, three-way, or four-way as indicated on the drawings. Switches shall be of the grounding type, with hex-head grounding screw, rated 20A, 120/277 volt, A.C only. Lighted handle switches shall have neon lights of the correct voltage rating where indicated on the drawings. All switches shall have quiet operating mechanisms without the use of mercury switches. All switches shall be listed by an "approved" third-party agency, approved for the voltage and amperage indicated.
2. The use of occupancy sensors are not permitted for the interior egress and exit lighting. The exit sign and egress lighting shall not be switched and shall remain on at all times.

### RECEPTACLES

1. Duplex receptacles shall be of the grounding type, arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall be straight blade, rated 20A, 125 volt and the face configuration shall conform to the NEMA Standard No. WD-1, NEMA WD-6, DSCC W-C-596G & UL-498, and shall be "approved" third-party listed. Self-grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a direct, green insulated conductor connection to the equipment grounding system.
2. Receptacles shall be industrial specification heavy duty grade, mounted vertically. Receptacles mounted over counters, back-splashes, etc., shall be mounted horizontally.
3. Special wiring devices shall be shown on the drawings with complete description thereof.

4. GFCI receptacles shall be rated minimum 20amp (NEMA 5-20R configuration).
5. GFCI receptacles shall be provided where installed to serve countertop.
6. GFCI receptacles shall be provided where located within 6 feet of a sink.
7. Breakers feeding sleeping areas shall be provided as required per Code.
8. Arc fault receptacles shall be provided for the "Dormitory" as required per code.
9. Receptacles shall not be mounted back to back.

### DEVICE PLATES

1. Cover plates for flush mounted wiring devices and for telephone outlets shall be Type "302" stainless steel or nylon type, standard size, single or ganged as shown on the drawings. Cover plate mounting screws shall be slotted head oval screws and shall match the finish and material of the plate, and shall be furnished with the plate by the plate manufacturer. Quantity of 2% spare cover plates of each type shall be provided to the owner.
2. Switch and receptacle cover plates on exposed work shall be galvanized cast ferrous metal, standard size, and shall be single or ganged as indicated on the drawings.
3. Exterior mounted switch and receptacle plates, and those noted to be weatherproof, shall be weatherproof PVC cover plates, standard size, single or ganged as indicated on the drawings, and shall be "approved" third party listed as "rain-tight while in use."

### **26 05 26      GROUNDING AND BONDING**

1. Grounding conductors, where insulated, shall be colored solid green. Conductors intended as neutral shall be colored solid white on 120/208 volt circuits and natural gray on 277/480 volt circuits.
2. The raceway system shall not be relied on for ground continuity. A green grounding conductor, properly sized per NEC Table 250-122, shall be run in ALL raceways except for telecommunications, data, and audio systems.
3. Grounding electrode conductor #4 AWG and larger shall be installed in raceway system.
4. Transformer grounding requirements (See Appendix relating to these requirements).
5. Generator and ATS grounding requirements (See Appendix relating to these requirements).
6. The electrical service shall be grounded by three (3) means:
  - a) To the metallic cold water pipe, as per NEC Article 250-52.
  - b) To the steel frame of the building, provided the building frame is effectively grounded.
  - c) To ground rod(s). Ground rods shall be 10 feet long and 3/4 inch in diameter, and shall be of copper-clad steel construction. All ground connections shall be accessible.

7. Boxes with concentric, eccentric or over-sized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC Table 250-122 and lugged to the box.
8. Where one building is feeding another building and a grounding conductor is run with the ungrounded conductors, a metallic conduit shall be provided between the buildings to establish improved grounding system.
9. The gas piping system shall be bonded to the equipment ground as required per the Gas Code Section 309.1
10. Identify each grounding electrode connected to a common ground bus. The height and the thickness of the common ground bus shall not be less than 2" x 1/4".

## **26 05 29      SUPPORTING DEVICES**

1. Conduit shall be supported in a method and at a spacing as approved by the NEC, except as described herein.
2. Conduit shall be supported by approved pipe straps or clamps.
  - a) Conduits installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of 1/4 inch using "clamp-backs" or strut.
3. Pipe straps or clamps shall be secured by means of:
  - a) Toggle bolts on hollow masonry.
  - b) Metal expansion shields and machine screws, or standard pre-set inserts, on concrete or solid masonry.
  - c) Machine screws or bolts on metal surfaces.
  - d) Wood screws on wood construction.
  - e) Powder actuated fasteners are not allowed.

## **26 05 53      ELECTRICAL IDENTIFICATION**

1. Furnish and install engraved laminated phenolic nameplates for all safety switches, panelboards, transformers, switchboards, motor control centers and other electrical equipment supplied for the project for identification. Nameplates shall be securely attached to equipment with self-tapping stainless steel screws; if the screw sharp end is protected; otherwise Rivets shall be used. Letters shall be approximately 1/2 inch high minimum. Embossed, self-adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:

....Blue surface with white core for 120/208 volt equipment.

....Black surface with white core for 277/480 volt equipment.

- ....Bright red surface with white core for all equipment related to fire alarm system.
- ....Dark red (burgundy) surface with white core for all equipment related to security.
- ....Green surface with white core for all equipment related to "emergency" systems.
- ....Orange surface with white core for all equipment related to telephone systems.
- ....Brown surface with white core for all equipment related to data systems.
- ....White surface with black core for all equipment related to paging systems.
- ....Purple surface with white core for all equipment related to TV systems.

2. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.
3. All outlet boxes, junction boxes and pull boxes shall have their covers and exterior visible surfaces painted with colors to match the surface color scheme outlined above. This includes covers on boxes above lift-out and other type accessible ceilings.

### **26 43 13 SURGE PROTECTIVE DEVICES (SPD)**

1. The System shall meet the following standards: IEEE C62.41& IEEE C62.45, NEMA LS 1, UL 1449, NEC Article 285. The TVSS shall be installed on the load side of the overcurrent protective device. SPD category "1" shall be mounted at the service Transformer, Category "2" should be mounted at the service disconnecting means, Category "3" shall be mounted at the branch panel and Category "4" shall cover the entire system.
2. Reference the UL 1449, the Third edition. Also reference the ANSI/ IEEE C62.34.

### **26 11 00 UNIT SUBSTATIONS**

1. The pad mounted transformer shall be of the five-legged core design, filled with "Listed less flammable type" oil for cooling. See Section 16321, Pad Mounted Distribution Transformers for further details.
2. The substation shall be "Metal-clad" type with "draw-out" vacuum breakers for 5 KV, 15 KV or 25 KV, as applicable.
3. Equipment shall meet requirements of the Arc Resistant Standards.

### **26 12 19 PAD MOUNTED SERVICE TRANSFORMERS**

#### **THREE-PHASE PAD MOUNTED TRANSFORMERS (DEAD FRONT)**

(NOTE: For use of "LIVE FRONT" construction, contact State Construction Office.)

Location of the Power Utility's pad mounted transformer shall comply with ANSI/IEEE 979.

### CONSTRUCTION

1. Transformers shall comply with latest applicable standards of NEMA and ANSI, IEEE C57.12.37.
2. Transformers shall be manufactured by General Electric, ETN, ABB, Square D or Cooper Power Systems. Comply with G.S 133-3 when using brand name specifications.
3. The "compartment type" pad mounted transformer shall be three-phase, oil cooled, tamper resistant, 65 degree C temperature rise rated, 60 hertz frequency, 12470 grd. wye 7200 primary voltage, or applicable primary voltage. The KVA and rated secondary voltage (208 grounded wye/120 or 480 grounded wye/277 volts) shall be as specified on the drawings. Oil shall be "R-Temp" or any "LISTED less flammable liquid" similar to BIOTEMP, or FR3 as required per NEC 450-23.
4. The transformer tank shall be of a sealed-tank construction as specified in ANSI Standard C57.12.26. The tank shall be a minimum of 12 gauge sheet steel, and strong enough to withstand a pressure of 7 psi without permanent distortion and 15 psi without rupturing or displacing of transformer components. A removable main cover may be provided over a bolted-on, tamperproof handhold. Handholds shall be provided for access to high voltage isolation links, three-phase switches, neutral connections, etc.
5. The transformer tank, high voltage compartment and low voltage compartment shall be constructed as an integral unit that will limit disassembly, breakage and prying open of any of the doors, panels and sills with the doors in the closed and locked position. There shall be no exposed screws, bolts or other fastening devices which are externally removable. There shall be no openings through which foreign objects such as sticks, rods or wires might be inserted to contact live parts. Lifting eyes and jacking pads shall be provided as part of the transformer and shall be arranged to provide a distributed balanced fit.
6. Each terminal compartment shall be full-height, air-filled with individual doors. The doors shall be constructed with sheet steel (minimum 13 gauge) and braced to prevent distortion. They shall be installed using lift-off type stainless steel hinges of a gauge equal to, or greater, than the door. A three-point latching mechanism with a cabinet-type handle, having provisions for the use of a single padlock, shall be provided on the low voltage door. A 1/2 inch penta-head stainless steel spring-loaded captive bolt shall also be provided with a blind bolt hole. Removal of the penta-head locking bolt may only be accomplished after removal of the padlock. This latching mechanism shall be designed and located to provide access to the high voltage compartment only after the door to the low voltage compartment has been opened. There shall be one more additional fastening device that must be removed before the high voltage door can be opened. Door stops shall be provided to hold the doors open when working in the compartments. The doors and the front sill of the compartments shall be removable to allow sliding the transformer into position over conduit stubs. The high and low voltage compartments shall be separated by a steel barrier. When facing the transformer, the low voltage compartment shall be on the right.

7. Transformer tank grounding provisions shall be in accordance with ANSI standards. The grounding provisions shall be capped before painting the unit.
8. The core and coil assembly shall be of a five-legged design to provide adequate short-circuit strength and heat dissipation. When required, corrugated cooling panels shall be provided on the back and sides of the oil-filled tank to maintain a safe operating temperature. Internal leads shall be insulated, trained and anchored to prevent phase-to-phase flashover.
9. Transformers are to be equipped with four (4) taps rated approximately 2-1/2 percent, with two (2) above and two (2) below normal. The tap changer shall be externally hook stick operated and located in the high voltage compartment. The tap changer shall be designed and marked for de-energized operation.
10. The high voltage terminations and equipment shall be of the dead front construction.
11. Two high voltage bushings per phase shall be provided to permit operating a loop feed dead front transformer from a looped primary cable system. The high voltage bushings shall be one piece type for use with loadbreak elbow terminators. As an optional method to the engineer, provide a radial feed transformer with one bushing well and one loadbreak feed-thru insert per phase. Construction shall conform to ANSI/IEEE Standard 386. Bushings shall be externally clamped and externally removable. High and low voltage winding lead lengths shall be long enough to permit field replacement of bushings or bushing wells. All gasketed joints are to afford a sealed tank in accordance with industry standards. Gasket material must be durable and reusable. Parking stands shall be provided for mounting accessory equipment.
12. The lightning arrestors shall be similar and equal to RTE "M.O.V.E." type. The arrester shall be mounted to the insert (ANSI/IEEE Standard 386).
13. Transformer overcurrent protection shall be a combination of oil-immersed current-limiting fuses in series with bayonet oil-immersed, overload sensing, expulsion fuses coordinated to provide full range protection with the expulsion fuse clearing low-current faults and the current limiting fuses clearing high-current faults up to 50,000 amperes. The fuse assembly shall have an interrupting rating of (3500A at 8.3 KV) or (1800 A at 15.5 KV) single phase, and a loadbreak rating of 125A at 80% power-factor for (8.3 KV or 15.5 KV) single phase. The bayonet fuses must be accessible through the primary compartment. They must be externally removable and field replaceable using a hotstick. This operation must be accomplished without having to remove the transformer compartment top. A welded-on oil dripshield must be located under the bayonet fuse to protect the primary connections.
14. The low voltage bushing shall be molded epoxy and capable of withstanding a load in a vertical direction of 800 inch-lbs. without causing a deflection sufficient to produce a leak. The bushings shall be externally clamped, blade type spade terminals with four (4)-hole NEMA standard spacing for transformers up to 500 KVA. Transformers above 500 KVA shall be equipped with six (6)-hole NEMA spacing. The bushings shall be arranged for vertical take-off.
15. The high voltage neutral shall be connected internally to the low voltage neutral with provisions for opening this connection for testing. The neutral bushing shall be fully insulated but connected to an adjacent ground pad (on the tank) with a detachable strap of sufficient size to carry the maximum fault current available from the transformer.
16. Equipment to be furnished as standard shall include:
  - a) A 1-inch drain valve with sampling device and 1 inch filler plug

- b) Liquid level indicator
  - c) Pressure-relief device equal to a Qualitrol 202-032-01 that will automatically relieve pressure and effectively keep the transformer sealed with no leakage of air or oil or any permanent distortion. Any pressure-relief device must exclude moisture from the transformer and have a life equal to the transformer.
17. Installed inside the low voltage compartment shall be a permanently affixed stainless steel nameplate containing the transformer serial number and style number plus other pertinent information. The transformer must be identified as non-PCB oil cooled unit with the PCB content clearly and permanently marked on the nameplate. The manufacturer is responsible for maintaining adequate documentation of the oil furnished in each unit and must provide copies upon request. All transformers shall be provided with a NEMA Standard Fig. 3 outside warning label on the outside high voltage compartment door, and a NEMA Standard Fig. 4 inside "DANGER" label on the inside of the low voltage compartment door.
18. The transformer(s) shall be designed for flexibility, convenience and reliability. All insulating components, oil, paper and wire enamel shall be made of thermally upgraded materials conforming to industry standards. In preparation of painting the transformer, the metal shall be washed with a solvent to remove rust, oil and grease. A minimum primer coat of 2 mils dry finish shall be applied. The finish coat of paint, with a minimum of 2-1/2 mils dry finish shall be olive green 7GY3.29/1.5, gray or equivalent.

GROUNDING: See Appendix, Sheet E-7.

## **26 18 00 AIR INTERRUPTER SWITCHES**

- 1. Manual air interrupter switches, dead front application type.
- 2. The puffer vacuum air interrupter switch, and/or the gas (SF6) switch.
- 3. Fused cutout switches, air (load-break) type.

## **26 18 01 OIL INTERRUPTER SWITCHES**

- 1. Oil interrupter switches are not acceptable for new construction.
- 2. Existing oil switches "RA" style, which do not have a close-into-fault rating, shall be removed and replaced with manual air switches or gas switches.
- 3. The "non-spring loaded" type switch is not acceptable for new construction.

## **33 71 00 OVERHEAD POWER DISTRIBUTION**

- 1. Bare aluminum "ACSR" conductors shall be utilized for overhead primary distribution systems (5 KV, 15 KV, or 25 KV). Conductors shall be spliced using compression fittings by use of an approved dye and tool compression arrangement.



2. Poles for overhead wiring shall be specified as pressure treated, Southern Yellow Pine, American Standard Class 5 poles. Poles shall be designed to support 125-150 ft. spans, adequate to sustain wind loads that meet or exceed NCSBC for the specific project location and a load in addition created by 1/2 inch of ice on the wire.
3. Crossarms shall be specified as untreated, straight-grain fir, or similar as approved by the State Construction Office. Dimensions shall be as recommended by the Edison Electric Institute Standards. The arms shall have spacing between center pins of 30 inches. Braces shall be made from galvanized flat iron.
4. Guywires shall not be less than 3/8 inch stranded galvanized cable, with appropriate galvanized steel hardware. They shall be heavy enough to sustain wind loads that meet or exceed NCSBC for the specific project location along with typical worst case weather conditions appropriate for the area. Two (2) strain insulators shall be inserted in each guy- one six (6) feet from the pole itself, and the other six (6) feet from the lower end of the guy and at least eight (8)feet from the ground.
5. Insulators shall be made of porcelain with wire grooves on top and sides.

#### **26 24 13      DISTRIBUTION SWITCHBOARDS (600 Volt)**

1. Switchboards shall have proper working clearances per NEC. Attention is directed to Article 110-26.
2. All bussing shall be tin-plated or silver-plated copper.
3. Switchboards identified for use as service equipment shall be so labeled.
4. Switchboards shall be provided with adhesive tape on front of enclosure to depict actual bus arrangement inside cubicles.
5. Switchboards shall be mounted on a nominal four (4) inch concrete housekeeping pad properly anchored in accordance with manufacturer's recommendations.
6. Each switchboard component shall be provided with adequate nameplate on front of cubicle (see Section 26 05 53 Electrical Identification).
7. Design documents shall include plan, side, and top views of switchboards along with adequate schedule locating and describing components therein.
8. Switchboards with bussing 1000 ampere or larger shall contain a metering section to include analog type meters such as ammeters, voltmeters, watt-hour, power factor, or electronic power metering.
9. Upon completion of installation, and prior to final inspection, the contractor shall reduce in size the "as-built" single line diagram (riser), frame same under glass, and mount in a conspicuous place adjacent to the switchboard.
10. Recommend all breakers 600 ampere and larger to be solid state trip type.
11. The flash protection boundary and the incident energy for the electrical equipment shall be determined in accordance with IEEE 1584 and NFPA 70E requirements. Equipment shall be

field marked to warn qualified persons of potential electric flash hazard per NEC 110-16 requirements.

## **26 28 16      ENCLOSED SWITCHES**

1. Safety switches shall be the "heavy duty" type. General duty switches are not acceptable.
2. Safety switches shall be third-party listed.
3. Switches shall have defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position.
4. Switches shall have handles whose positions are easily recognizable in the "on" or "off" position. For safety reasons, padlock shall be provided for switches located in the public areas.
5. Switches shall have nonteasible, positive, quick make-quick break mechanisms.
6. Switches shall be properly labeled. See Section 26 05 53, Electrical Identification.

## **26 22 00      DRY TYPE TRANSFORMER**

1. The use of energy efficient transformer is required. Transformers with load factor up to 35% of their capacity shall have efficiency of 98% and shall meet or exceed NEMA TP-1 requirements. Class 220, 115 ° C transformer shall be used when the load factor is up to 50% of their capacity, otherwise, class 220C, 80 °C rise shall be specified. The transformer overload capability shall be in accordance with IEEE C57.96; for standard transformers, and IEEE C57.110; for K-rated transformers. The K-rated transformer, when used shall also be energy efficient and shall bear the energy star label and shall also meet NEMA TP-1 requirements.
2. The energy policy act of 2005 (EPACT 2005), public Law 109-58, came into effect January 1, 2007, shall be enforced.

## **26 24 16      PANELBOARDS**

1. Panelboards identified for use as service equipment shall be so labeled.
2. Panels 600amp and less shall be specified with bolt-on breakers.
3. Bus bars shall be copper.
4. Full size copper neutral bus shall be included in all panels. Copper ground bus shall be provided with the panel.
5. Feed-through panels are not permitted.
6. A typed directory card shall be supplied, mounted on the inside of each door.
7. An engraved nameplate shall be provided for each panel. See Section 26 05 53, Electrical Identification.

8. "Load Centers" are not acceptable except in certain instances approved by the State Construction Office.
9. The use of series rated breakers is not acceptable.
10. Panelboards feeding electronic equipment shall be provided with a "full size" ground bus, a "full size" neutral bus, or 200% neutral bus, and shall be fed with feeders having a "full size" or larger neutral. Branch circuits shall have individual neutrals, in other words, no sharing of the neutral between circuits is allowed.
11. Panelboards schedules placed on contract documents shall follow the preferred format as indicated (see Appendix, Sheet E-6).
12. Equipment labeling for the flash protection boundary and the incident energy shall be determined in accordance with IEEE 1584, NFPA 70E & NEC 110-16 requirements.
13. Maximum numbers of breakers in a panelboard shall not exceed 42 poles.
14. On large buildings, the electrical panels that feed luminaires shall not feed receptacles and electrical panels that feed receptacles shall not feed luminaires.
15. The number of the branch circuit shall be identified with permanent wire tag attached to the wire.
16. Circuit breakers feeding sleeping areas such as "Dorms" shall be provided as required per Code.

### **26 28 13 FUSES (600 VOLTS OR LESS)**

1. Fuses shall be so selected as to provide a fully selective system.
2. The following criteria shall be followed for fuse selection:

| <u>CIRCUIT TYPE</u>                 | <u>FUSE TYPE</u>                             |
|-------------------------------------|--|
| b) Service Entrance &               | Class L, U/L listed, current limiting with   |
| c) Feeder Circuits over 600A        | 200K Amp interrupting rating.                |
| d) Service Entrance & Feeder        | Class RK1 or J, U/L listed, current          |
| e) Circuits 600A and less           | limiting with 200K Amp interrupting rating.  |
| f) Motor, Motor Controller &        | Class RK5, U/L listed, current limiting time |
| g) Transformer Circuits             | Delay, with 200K Amp interrupting rating.    |
| h) Individual Equipment where fault | Class K5, U/L listed, with 50 KA             |
| i) Current does not exceed 50 KA    | Interrupting rating.                         |

3. Fusible safety switches with short-circuit withstand ratings of 100K Amp or 200K Amp require Class R or Class J rejection fuse block feature.
4. Specify spare set of fuses for the equipment.

## **26 24 19 MOTOR CONTROL CENTERS**

1. Motor control center structure shall be a totally enclosed, free-standing assembly, ninety (90) inches high and not more than twenty (20) inches deep.
2. Motor control center shall be mounted on a nominal four (4) inch high housekeeping pad.
3. A horizontal copper ground bus shall be provided for the entire length of the enclosure.
4. All bus assemblies shall be braced for minimum of 42,000 ampere short-circuit current.
5. The main horizontal and vertical busses shall be tin-plated or silver-plated copper.
6. The main horizontal busses shall run the full length of the enclosures. Provisions shall be made to extend the horizontal bus at either end in the future with standard splice plates. Bus shall be pre-drilled to accept standard splice plates.
7. The motor control center bus compartments shall have horizontal and vertical bus barriers to reduce the hazard of accidental contact with the bus.
8. A minimum six (6) inch high horizontal wireway, with steel covers removable from the front, shall be provided at the top and bottom of each unit. Adequate vertical wiring space, accessible from the front, shall be provided for each section.
9. Factory internal wiring shall be NEMA Class 1, Type B. Each combination starter shall be provided with removable-type terminal strips. A wiring diagram for each starter shall be mounted inside the door of each unit.
10. Unit compartments shall have padlocking provisions for one to three padlocks to lock the disconnect in the "OFF" position.
11. Unit compartments shall have mechanical interlocks to prevent opening of the door unless the disconnect device is in the "OFF" position. This interlock shall be defeatable.
12. Control components shall be provided as required by the mechanical control sequence and shall be powered by individual fused control transformers in each starter assembly.
13. Units shall be properly identified. See Section 26 05 53, Electrical Identification.

## **26 36 00 AUTOMATIC TRANSFER SWITCHES**

1. The automatic transfer switch shall be either four-pole type or three-pole with overlapping neutral. Full-size neutral contactor shall be provided. The ATS shall conform to the requirements of U/L 1008-Standard.

## SEQUENCE of OPERATION

1. Source drops below a range of 70-95% of rated voltage (factory set at 85%) after an adjustable time delay period of .05 to 6 seconds (factory set at 3 seconds) to allow for momentary dips. The transfer switch shall transfer to emergency as soon as the generator voltage has reached a range of 75-100% of rated voltage (factory set at 90%) and generator rated frequency of 85-100% (factory set at 90%).
  - a) After restoration of normal power on all phases to 90% of rated voltage, an adjustable time delay period of 0-30 minutes (factory set at 5 minutes) shall delay re-transfer to normal power until it has stabilized. If the emergency power source should fail during the time delay period, the time delay shall be by-passed and the switch shall return, immediately, to the normal source.
  - b) After the switch has transferred to normal, the engine generator shall be allowed to operate at no load for 5 minutes to allow it to cool before shutdown. The engine cool-down timer may be installed in the generator control panel.

## Components

1. The automatic transfer switch shall include, but not be limited to, the following features and characteristics:
  - a) The transfer switch shall be continuous duty rated.
  - b) Three phase transfer switches shall be 3-pole with overlapping neutral transfer contacts, or 4-pole with neutral contacts of same capacity as phase contacts.
  - c) Transfer Switch Control System:
    - (1) The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be microprocessor-based. The control settings shall be stored in nonvolatile memory.
    - (2) The control module shall have a three-position, key-operated, programming control switch. The key shall be removable in any position.
2. The positions shall be:
  - a) *Off* - Allows all enabled accessories to be monitored only. Settings cannot be changed while in this position.
  - b) *Local* - Allows all enabled accessory settings to be changed locally at the transfer switch control panel
  - c) *Remote* - Allows all enabled accessories to be altered via the remote communications port.
3. Test switch or push button to simulate normal power failure.

4. Generator exercising time switch with load/no load selector switch.
5. Transfer time not to exceed one-sixth (1/6) second.
6. The normal and emergency contacts shall be positively interlocked, mechanically and electrically, to prevent simultaneous closing. The main contacts shall be mechanically locked into position for both the normal and emergency positions without the use of hooks, latches, magnets or springs.
7. In-phase monitoring shall continuously monitor the contactor transfer times, source voltage, frequency and phase angle to provide a self-adjusting, zero crossing contactor transfer signal.
8. Anti single phasing protection shall detect regenerative voltage as a failed source condition.

### Status Indicators

1. Light-emitting diodes shall indicate the following:
  - a) Contactor Position: Normal (Utility) and Emergency (Generator).
  - b) Plant Exerciser Active.
  - c) In Phase Monitor Active.
  - d) A test push button shall light all light-emitting diodes.
2. Auxiliary contacts shall be furnished for the following:
  - a) Contactor in normal positions, 2 sets minimum.
  - b) Contactor in emergency position, 2 sets minimum.

### Construction

1. The transfer switch shall be rigidly constructed to close into and withstand the bolted fault current available at the switch.
  - a) All transfer switch coils, springs, and control elements shall be easily inspectable and conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductors.
  - b) All feeder lugs, relays, timers, control wiring and accessories shall be front accessible.
  - c) The control module and transfer switch shall be physically separated.
  - d) Main contacts shall be of silver alloy composition.

## Electrical Guidelines and Policies-2011

1. The specifying of energy efficient electronic ballasts is required. However, electronic ballasts must meet the following criteria:
  - a) Ballast to be "UL Listed, Class P", "Sound Rated A", and meet or exceed ANSI C82.11 requirements.
  - b) Ballast shall have high power factor (minimum of 90%).
  - c) Lamp current crest factor shall be equal to, or less than, 1.7.
  - d) Input current third harmonics shall not exceed ANSI recommendations (32% total harmonic distortion, 27.5% of the third triplets).
  - e) Flicker shall be 15% or less with any lamp suitable for the ballast.
  - f) Ballast design shall withstand line transients per IEEE 587, Category A and shall meet FCC Rules and Regulations, part 18.
  - g) Ballast case temperature shall not exceed 25 degrees C rise over 40 degrees C ambient.
  - h) Parallel wiring between the ballast and the fixture is recommended.
  - i) Minimum of five (5) years warranty is required with each electronic ballast.
  - j) The listed manufacturers shall have at least five (5) years of experience in manufacturing electronic ballasts.
2. Energy saving lighting shall be specified for fixtures used in State Owned buildings; high efficiency lamps with high efficiency electronic ballasts. Evaluation of the life cycle cost shall be performed as required per SB 1946 (which was SB 668). See Appendix Sheet E-00
3. When LCCA is provided; as required per SB 1946, shall include the followings:
  - a) Provide complete description of each option, the fixture type, the numbers of fixtures, watts per lamp, numbers of lamps per fixture, the total watts per fixture, the lumens per lamp, the lumens per fixture the operating numbers of hrs per day and per year, the total KWH, the power utility energy cost and the maintenance cost.
  - b) Provide the cost per fixture for each option specified in the LCCA, the cost for the occupancy sensor and day-lighting sensor, dimming ballast, and the cost for the electrical equipment used in the study.
  - c) The base fixture for the evaluation shall be the standard T8 32watts. The base fixture shall be evaluated against the energy efficient 4 ft T8 lamp, 25Watts, the T8 28Watts, T5 28Watts, or the T5HO fixture; or any other energy efficient fixture. Approval of the LED fixtures is based on performing LCCA that demonstrates their validity as a prudent investment for the state.
  - d) To calculate the numbers included in the SIR sheet of a particular alternative, in column B include the (capital plus interest plus replacement cost) and in column C include the (energy plus maintenance cost). If the ranking of the options listed in the SIR sheet show (-) or less than one, please do not select this option, as it does not provide the proper savings.

- e) At the end of the study, provide summary of the engineer's conclusion of the best option to be included in the project design.
  - f) Please use Sheet E-00 from the Appendix while performing the LCCA
4. The electronic ballast shall be provided with end-of-life shutdown circuit.
  5. The thickness of the lenses shall not be less than 0.125.
  6. Where a recessed fluorescent, high intensity or downlight fixture replaces a section or part of a ceiling tile, fixture is to be supported at the two (2) opposite ends to the steel frame of the building. Supports shall be provided with the same type of wire as used to support the lay-in ceiling track, and shall be distinguished by color and tag. Attach one end of the wire to one corner of the luminaire and the other end to the building's structural system. The lay-in luminaire shall then be screwed to the main runners of the lay-in ceiling track at all four (4) corners using sheet metal screws. For fire rated suspended ceiling, luminaire shall be supported to the Building Structure as per the Ceiling Design Criteria, luminaire shall then be screwed to the main runners of the suspended ceiling track at all four (4) corners using sheet metal screws. It is the electrical designer's responsibility to make sure this work is coordinated with the work of the ceiling contractor through the ceiling specifications. Also, see the ASTM Section "E-580-02" items 3.3, 4.3, 5.5 & 5.6 and the NEC 300.11 & 410-36(B)
  7. To save energy, the lighting illumination levels shall be designed in accordance with the State Energy Conservation Code and the IES standards. Lighting system shall be controlled utilizing any of the following methods: lighting control panels, occupancy sensors, optical sensors, automatic day-lighting controls, bi-level HID controls, dimming control, and plug load controls, timers, photo cells, or manual control.
  8. Program start or Rapid start ballasts shall be specified when Occupancy sensors are used. It is not recommended to use Instant start ballast with Occupancy sensors as it shorten the life of the Lamp.
  9. Fluorescent lamps shall comply with the EPA Guidelines regarding the Toxicity Characteristic Leaching Procedure TCLP.
  10. Calculations regarding point by point symmetrical and asymmetrical lighting distribution shall be provided to State Construction Office upon request.
  11. Where disconnecting means is required for the double-ended lamps, per NEC 410-130, the disconnect shall be labeled and located next to the room's local switch, and shall be within sight of the lighting fixture, unless UL as part of the fixture package.
  12. For the purpose of energy conservation and in accordance with requirements of Senate Bill #1946 and G.S 143-64.17,
    - a) Specify the installation of occupancy sensors and/or optical sensors as the lighting control method where appropriate for the intended use.
    - b) Specify LED exit signs.
    - c) Specify compact fluorescent lighting for new facilities and existing facilities being renovated.



13. In order for this office to certify the lighting design, provide table showing the designed illumination levels in Footcandles for each functional area of the facility. The provided lighting levels for each functional area of the facility shall comply with tables listed in the North Carolina Energy Conservation Code; Chapter 805.5.2, and/or with tables provided in the IESNA books, whichever is more stringent. The lighting levels shall be part of the building integrated Life Cycle Cost analysis as required per G.S 143-64.15(a)
14. The LCCA shall be submitted to State Construction Office for review in the Schematic phase submittal and amended or updated as needed at the Design Development and working drawing submittals.
15. Lighting fixtures mounted outside, such as in parking deck, shall be listed for the location and be installed according to the listing. Ballast and lamp shall be cold weather rated.
16. Install battery operated unit at the generator to illuminate the control panel, at the fire pump room to illuminate the fire pump controller, and at the sprinkler Riser room to illuminate the main shut-off valves.

### EMERGENCY EXIT LUMINARE

1. It shall be completely self-contained, provided with maintenance-free battery, automatic charger, and other features. No battery is required if the fixture is fed from a generator, or any other emergency power source. Luminaire must be third-party listed as emergency lighting equipment, and meet or exceed the following standards; NEC, N.C. Building Code, Energy Conservation Code, NFPA-101, and NEMA Standards.

### BATTERY

1. It shall be sealed, maintenance-free type, with minimum of 90 minutes operating endurance. Must have a normal life expectancy of 10 years. Batteries shall be a high temperature type with an operating range of 0 degree C to 60 degrees C and contain a resealable pressure vent, a sintered + positive terminal and - negative terminal.

### CHARGER

1. It shall be fully automatic solid state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full rated load. The unit shall be activated when the voltage drops below 80 percent. A low voltage disconnect switch shall be included if LEAD Battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during extended power outage.

### ADDITIONAL FEATURES

1. Pilot light to indicate the unit is connected to AC power. The battery shall have high rate charge pilot light, unless self-diagnostic type. Tests switch to simulate the operation of the unit upon loss of A.C power by energizing the lamps from the battery. This simulation must also exercise the transfer relay.

### WARRANTY

1. The entire unit shall be warranted for three years. The battery must have an additional two more years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

### LED

1. The use of LED is required due to their reliable performance, low power consumption, and limited maintenance requirements. Maximum LED failure rate shall be 25% within a seven (7) year period; otherwise, if exceeded, manufacturer shall replace the complete unit at no charge to the owner.

### UNIT TEST

1. Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes, in accordance with NEC 700. The battery test shall be done 10 days prior to final inspection by the State Construction Office. Any unit which fails the test must be repaired or replaced, and tested again. Copy of the test report shall be sent to the State Construction Office.

### EMERGENCY EGRESS LUMINARE

1. Shall be completely self-contained, provided with maintenance-free 12 volt battery, automatic charger, two lamps, and other features. Luminaire shall be third-party listed as emergency lighting equipment, and meet or exceed the following standards: NEC, N.C. Building Code, Energy Conservation Code, NFPA-101, and NEMA Standards.

### ADDITIONAL FEATURES

1. Pilot light to indicate the unit is connected to A.C power. The battery shall have high rate charge pilot light, unless self-diagnostic type. A test switch to simulate the operation of the unit upon loss of A.C power by energizing the lamps from the battery. This simulation must also exercise the transfer rely. If fluorescent emergency unit is used, an LED charging indicator light must be easily visible after installation and a remote test switch shall be installed adjacent to the fixture.

### BATTERY

1. It shall be sealed, maintenance free type, with minimum of 90 minutes operating endurance. Must have a normal life expectancy of 10 years. Batteries shall be a high temperature type with an operating range of 0 degree C to 60 degrees C and contain a resealable pressure vent, a sintered + positive terminal and - negative terminal.

### CHARGER

1. It shall be fully automatic solid state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full rated load. The unit shall be activated when the voltage drops below 80%. A low voltage disconnect switch shall be included if LEAD battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during extended power outage.

### WARRANTY

1. The entire unit shall be warranted for three years. The battery must have an additional two more years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

### UNIT TEST

1. Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes, in accordance with NEC 700. The battery test shall be done 10 days prior to final inspection by the State Construction Office. Any unit which fails the test must be repaired or replaced, and tested again. Copy of the test report shall be sent to the State Construction Office.

## **26 56 00 SITE and EXTERIOR LIGHTING**

1. Pole bases for site lighting shall be detailed on the construction documents. The designer shall verify that the base detail is adequate to sustain wind loads for the specific project location with the specified pole and luminaire. See Typical Exterior Pole Base Detail, Page E-17 of Appendix, for suggested minimum standards.
2. Branch circuit wiring shall be accessible at each pole by means of a gasketed hand-hole in the pole.
3. Lamps for luminaires specified shall be metal halide or sodium vapor.
4. Control of site lighting fixtures shall be by means of a common photo-cell and/or contactor.
5. The use of solar lighting is recommended for lighting poles.
6. Calculations regarding point by point symmetrical and asymmetrical lighting distribution shall be provided to State Construction Office upon request.

## **26 33 00 STATIC EMERGENCY POWER SUPPLIES**

1. Emergency power supplies with central battery and remote devices shall be warranted for five (5) years.

## 26 32 13      **PACKAGED ENGINE GENERATOR SYSTEMS**

1. These guidelines cover legally required and optional standby power systems and include engine generator sets, and associated auxiliary and control equipment. The engine generator shall provide back-up power for the emergency power distribution system during utility or normal power outage. Power outage sensing, generator starting, transfer of load, re-transfer to normal power, and engine cool down running time shall be a completely automated system and shall not require attended operation. Generator specifications shall reference the generator UL-2200 listing.

### ENGINE REQUIREMENTS

1. The engine shall be a compression ignition model for diesel fueled that has been manufactured and successfully operated in similar service for a period sufficient to thoroughly establish its reliability. In some locations, Natural Gas fuel is also acceptable, check with the AHJ regarding the location. The engine shall be 4 stroke cycle multi-cylinder design. The engine speed shall not exceed 1800 RPM at normal full load operation when equipped with all necessary operating accessories such as air cleaners, oil pump, water pump, generator, etc. In conformance with the requirements of NFPA 110 Standard for Emergency and Standby Power Systems, the engine shall produce sufficient power to pickup 100% of nameplate KW rating in one step, less applicable site condition derating factors. Engine ratings shall not exceed the standby power service rating published by the manufacturer.
2. The engine shall be designed to operate on no. 2 fuel oil.
  - a) The fuel system shall be that which is normally used by the diesel engine manufacturer and shall include secondary fuel filter, water separator, manual fuel priming pump, fuel shut-off solenoid, and all piping and appurtenances required for complete system.
  - b) It shall include a fuel transfer pump (if needed to lift the fuel from the fuel tank) and a replaceable fuel filter element conveniently located for servicing.
  - c) The Tank shall meet EPA and UL 2085 requirements for two hrs. rating. Tank pressure test shall meet UL 142 requirements.
  - d) The sub-base fuel tank assembly shall be welded steel construction and have the structural integrity to support the generator set and associated components. It shall include, but not be limited to: heavy gauge steel, double wall tank, with all welded construction, prime coated and finished painted outside. Minimum capacity shall be 100 gallons. Secondary containment of fuel tank and all other accessories. Lockable fuel filler cap. Low fuel level alarm switch. Fuel level gauge. Inter-tank leak detection alarm switch. Fractional HP thermally protected motor. Fuel line check valve. Tank drain. Threaded pipe connections.
3. Tank vent shall meet NFPA37 requirements (12-ft above grade level) spill containment.
4. If generator designed to operate on liquid propane gas (LPG): The fuel system shall be that which is normally used by the engine generator set manufacturers and shall include a secondary regulator and gas carburetor specifically adjusted for the fuel used. Primary line regulator shall be provided, fuel shut-off solenoid, and flexible section of fuel line for connection between stationary gas piping and the engine components.

### BATTERY CHARGING

1. An automatic, solid-state, current limiting, float equalizing. It shall maintain the battery at normal capacity and recharge battery after cranking. The charger shall be 120 volt input with appropriate output. It shall be capable of automatically switching from one rate to another rate to meet the needs of the discharged batteries. It shall be capable of recharging a completely discharged battery in a maximum of 8 hours. It shall also have: overload protection, voltage surge suppressers, D.C ammeter, D.C voltmeter, low D.C voltage alarm relay; with a minimum continuous output of 10 amperes D.C, battery charger malfunction alarm contact, and third-party listed.

### GOVERNOR

1. The engine governor shall maintain acceptable frequency regulation from no load to full rated load. The steady state operating band shall be within 2%

### LUBRICATING SYSTEM

1. The engine shall have a lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, pistons pins, timing gears, camshaft bearings and valve rocker mechanism. Full flow oil filters, conveniently located for servicing, shall be provided. Lube oil drain extension and valve terminated on the outside of the generator base shall be provided.

### AIR CLEANERS

1. One or more dry type air cleaners shall be provided, as recommended by the manufacturer.

### EXHAUST

1. Critical grade silencer shall be provided to reduce engine exhaust noise to a maximum DBA level of 85 at a distance of 10 feet. If the equipment is located outside, the silencer with piping shall be mounted on top of the weatherproof enclosure, the exhaust silencer outlet shall be terminated with a tailpipe (45 degree cut) or an exhaust elbow and raincap. If the equipment is located inside the building, the exhaust piping shall extend through the building side wall using a ventilated thimble discharge (horizontal discharge with tailpipe 45 degree cut, or vertical discharge with a raincap. Piping shall be schedule 40, black steel; piping inside the building shall be insulated. A seamless stainless steel flexible connector shall be installed on the engine exhaust outlet.
2. Coordinate the generator exhaust diameter and length with the Mechanical Engineer to ensure that the generator's backpressure specification is not exceeded.

### ENGINE BLOCK HEATER

1. A single phase, thermostatically controlled, immersion type engine coolant heater shall be provided. Minimum coolant temperature shall not be less than 120 degree F. Each heater shall

be provided with contactor in a rated NEMA enclosure. Heater(s) shall be disconnected while the engine is running.

### COOLING SYSTEM

1. A closed recovery cooling system with sufficient capacity shall be provided to cool the engine when the generator set is delivering full rated load at minimum ambient temperature of 105 degree F. Radiator, fan, engine-driven centrifugal water pump and thermostatic valve shall be provided. System shall be protected against freezing and corrosion. Radiator duct flange shall be provided for equipment installed inside the building.

### BASE AND VIBRATION ISOLATORS

1. The engine-generator assembly shall be fastened to a welded steel base which shall allow mounting to a raised concrete pad or the sub-base fuel tank. Anchor bolts and vibration isolators shall be used to mount the heavy steel base to the concrete pad. Vibration isolators, either integral or external, shall be provided and installed as recommended by the manufacturer. Vibration isolators shall be one-piece units resistant to corrosion and environmental degradation. When sub-base tanks are specified, vibration isolators shall be located between the generator set and the fuel tank.

### OUTDOOR ENCLOSURE

1. Enclosure shall be tamper resistant, heavy gauge steel or aluminum construction, gasketed with fixed open air louvers, lockable latches, and side and rear doorways to access components. Enclosure shall be primed and finished painted.

### EMERGENCY LIGHTING UNIT

1. Emergency lighting unit, with battery back-up, shall be provided in the generator room.

### GENERATOR

1. The generator shall be 208/120 or 480/277 volt, three-phase, 4 wire for rated KW and power factor. The rating shall be applicable for continuous service in stand-by application.
  - a) Generator shall be revolving field type, close-coupled or directly coupled to the engine flywheel. The generator housing shall have a single ball bearing support for the rotor. The rotor shall be dynamically balanced up to 25% over-speed.
  - b) The generator shall have Class H insulation as recognized by NEMA. The field shall be equipped with full amortisseur windings.
  - c) The voltage regulator shall be of the solid-state design and provide volts-per-hertz operation. It shall be mounted on top or side of the generator and enclosed in a "NEMA

RATED" enclosure. A built-in voltage adjusting rheostat shall provide 10% voltage adjustment. An isolation transformer in the voltage regulator circuit shall be provided.

2. For the purpose of adding a second generator to the same building, Contact State Construction Office for specific requirements.

### GENERATOR SET MAIN CIRCUIT BREAKERS

1. Molded case with solid state trip unit circuit breakers in suitable enclosures for generator shall be provided. Resettable three phase line current sensing circuit breakers with inverse time verses current response, set to open after a 10 second fault condition, shall be provided for generators 1000KW and larger. The generator circuit breakers shall be third-party listed. Emergency system overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices. (See Appendix sheet E-1)
2. The circuit breaker at the generator for the fire pump:
  - a) Provide molded case breaker at the generator, breaker shall be short circuit protection only and shall be sized above 125% of the motor IFL and less than 250% of the motor IFL.
  - b) Provide the short circuit fault available at the motor.
  - c) The breaker at the generator shall be TCC coordinated with the magnetic only MCP breaker at the fire pump.
  - d) After approval of the fire pump shop drawings by the mechanical engineer, the Electrical engineer shall obtain the required electrical information form the mechanical engineered to perform TCC coordination. TCC coordination shall be performed between the MCP breaker at the fire pump and the breaker at the generator.
  - e) The performed breakers TCC coordination shall be sealed and sigend by the Engineer of record.
  - f) The breaker at the generator shall hold without tripping for 30 seconds or longer at the motor locked rotor current.
  - g) The instantaneous trip sitting for the breaker at the generator shall not exceed the calculated short circuit fault available from the generator.
  - h) Copy of the performed breakers TCC shall be submitted to SCO upon request.
3. If only one feeder is provided from the generator to the building to feed emergency and optional/stand-by loads, the feeder shall come to compartmental type panel. The emergency breaker in the panel shall be in separate compartment than the optional/stand-by breaker, and the circuit breaker at the generator shall be short circuit type. (See Appendix sheet E-1)

### GENERATOR PERFORMANCE

1. The voltage regulation from no load to rated load shall be within a 2% band of rated voltage. Steady state voltage modulation shall not exceed one cycle per second.

- a) For any addition of load up to and including 90% of rated, the voltage shall recover to and remain within the steady band in not more than 1.5 seconds. The voltage dip shall not exceed 20% of the rated voltage at any time.
  - b) The frequency regulation from no load to rated load shall conform to the engine governor performance. For any addition of load up to 90% of rated load, the frequency shall recover to the steady state frequency within 5 seconds.
2. Generator's control panel specifications shall be per NFPA 110 requirements.

### CONTRACTOR TESTING

1. Prior to acceptance of the installation, the generator shall be load tested. This test shall be performed at the job site in the presence of the Owner. Testing shall be accordance with NFPA 110, Chapter #7.13 requirements. After testing is complete:
  - a) A full tank of fuel shall be provided, replacing any fuel used for testing (N/A for natural gas). Diesel fuel shall be treated with an alcohol-free additive to disperse water and clean injectors.
  - b) Copy of the generator's load test report shall be sent to the engineer of record, the owner, and the State Construction Office.

### FINAL ACCEPTANCE

1. The installation shall be supervised, checked and tested by a qualified representative of the engine generator manufacturer. Written certification shall be sent to the designer and/or owner prior to final acceptance.

### DOCUMENTATION AND TRAINING

1. Documentation: Prior to final acceptance, the manufacturer shall supply three (3) copies of complete instruction manuals to the owner. The manuals shall include operation and maintenance procedures, complete parts lists, dimensional drawings, unit wiring diagrams and schematics, and interconnection wiring drawings.
2. Training: Prior to final acceptance, the manufacturer shall provide comprehensive training to the owner's designated personnel. Training shall cover, but not be limited to, operation, maintenance and troubleshooting of the equipment.

### Warranty

1. The emergency generator, transfer switch and associated equipment shall be warranted by the manufacturer for a period of five (5) years, from the date of final inspection and acceptance. The warranty shall be included in the contract document. The warranty shall include all parts, labor (including travel), expenses and equipment necessary to perform replacement and/or repairs.



## **26 41 00 LIGHTNING PROTECTION SYSTEMS**

1. System shall be Underwriters' Laboratories certified in accordance with UL-96A Requirements. (See the latest edition of NFPA-780 Lightning Protection Code).
2. Upon completion and review by U/L, contractor shall obtain, and deliver to owner the UL certifications.
3. The system shall be grounded to the steel frame of the building, provided building is effectively grounded. This is in addition to ground grid as required by U/L.
4. If surge protection is installed in project that also includes lightning protection, the surge protection should be rated for "Lightning Surges".

## **28 31 13 FIRE ALARM SYSTEMS**

1. The design engineer is responsible for designing the fire alarm system using State Building Code, Fire Alarm Guidelines, and referenced NFPA Standards.
2. Designers for State projects involving fire alarm systems shall use and follow the document "Fire Detection and Alarm Systems" guidelines and criteria only for the purpose of preparing the designer's plans and specifications for the specific project in their contract. The document is not written in contractual language for bidding purposes and contract enforcement. Therefore the designer is not to insert the document "as-is" into the specifications. The designer is to revise the language to be contractual, make project specific decisions on alternatives and options, and provide device locations specific to the project. This document is available on the SCO web Site.
3. Prior to final inspection, the Designer is responsible for verifying that the fire alarm contractor has fully tested and certified the system in accordance with NFPA 72. Copy of the NFPA 72 Record of Completion shall be sent to the Engineer of record and to State Construction Office.
4. Smoke detector shall be provided in all egress corridors.
5. Strobes shall be provided per requirements of NCSBC Chapter #11 & ANSI 117.
6. Any trouble signal transmitted to the FACP shall be delayed in the FACP for 60 seconds.
7. The numbers of the fire alarm devices in a loop shall not exceed 20 otherwise provide MI modular. IM shall be used every 20 fire alarm devices.
8. The smoke detector in a Handicap accessible room shall also activate the strobe for that room.
9. Addressable devices shall not be installed in unconditioned spaces.
10. Proper installation and physical location of each duct detector and access doors shall be coordinated between the Electrical, the Mechanical, and the Fire Alarm Subcontractors, and approved by the Electrical Engineer prior to equipment installation.

11. If new devices or new Fire Alarm Control Panel is added to an existing system, new certification for the existing Fire Alarm Control Panel shall be issued in accordance with NFPA 72.
12. Fire Alarm devices mounted outside, such as in parking deck, shall be listed for the location and be installed according to the listing.
13. See Appendix E-01 for Fire Alarm System Symbols details

## **27 05 00 TELECOMMUNICATIONS**

1. Please refer to the following publication issued by ITS office: STS-1000, TELECOMMUNICATION WIRING GUIDELINES. The publication can be downloaded from the web site <http://WWW.its.state.nc.us/>
2. Please contact the ITS Office for questions or clarifications regarding the above document.

# APPENDIX

Electrical Guidelines and Policies-2011

| COST ANALYSIS                  | Fixture Description                     | Fluorescent T8 (base option) | Fluorescent T8 (option #1) | Fluorescent T8 (option #2) | Fluorescent T8 (option #3) | Fluorescent T5 (option #4) | Fluorescent T5HO (option #5) | Others (option #6) |
|--------------------------------|---|------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|------------------------------|--------------------|
|                                | Lamp Watts                              | 32                           | 25                         | 28                         | 30                         | 28                         | 54                           |                    |
|                                | No. of Lamps/Fixture                    |                              |                            |                            |                            |                            |                              |                    |
|                                | Lamp life (hrs) 3hrs/start              | 24,000                       |                            |                            |                            |                            |                              |                    |
|                                | Lamp Replacement cycle (year)           | 5                            |                            |                            |                            |                            |                              |                    |
|                                | Ballast Type                            | Electronic Program Start     |                            |                            |                            |                            |                              |                    |
|                                | No. of Ballasts/Fixture                 | 2                            | 2                          | 2                          | 2                          | 2                          | 2                            |                    |
|                                | Ballast/Driver Power Input              | 81                           |                            |                            |                            |                            |                              |                    |
|                                | Ballast Factor                          | 0.88                         |                            |                            |                            |                            |                              |                    |
|                                | Ballast Life (hrs.)                     | 50,000                       |                            |                            |                            |                            |                              |                    |
|                                | Ballast/Driver Replacement Cycle (year) | 17                           |                            |                            |                            |                            |                              |                    |
|                                | Total Number of Fixtures                | 100                          |                            |                            |                            |                            |                              |                    |
|                                | Lumens/Fixture                          | 5,920                        |                            |                            |                            |                            |                              |                    |
|                                | Watts/sf                                |                              |                            |                            |                            |                            |                              |                    |
|                                | Area (sf)                               |                              |                            |                            |                            |                            |                              |                    |
|                                | Initial Fixture Cost (each)             |                              |                            |                            |                            |                            |                              |                    |
|                                | Initial Installation Cost               |                              |                            |                            |                            |                            |                              |                    |
| <b>Capital Cost</b>            | Total Installed Fixture Cost            |                              |                            |                            |                            |                            |                              |                    |
| <b>Repair Replacement Cost</b> | Lamp Replacement Cost                   |                              |                            |                            |                            |                            |                              |                    |
| <b>Repair Replacement Cost</b> | Ballast Replacement Cost                |                              |                            |                            |                            |                            |                              |                    |
|                                | Utility Energy Charge/kwhr              |                              |                            |                            |                            |                            |                              |                    |
|                                | Annual kwhr                             |                              |                            |                            |                            |                            |                              |                    |
| <b>Energy Cost</b>             | Annual Energy Cost                      |                              |                            |                            |                            |                            |                              |                    |
|                                | Special Design Consideration            |                              | Lighting Sensor            | Lighting Sensor            | Lighting Sensor            | Lighting Sensor            | Lighting Sensor              | Lighting Sensor    |
| <b>Maintenance Cost</b>        |   |                              |                            |                            |                            |                            |                              |                    |



Notes:

1. Minimum of two options shall be selected to be evaluated against the base option.
2. Fluorescent fixtures shall be provided with the inboard/outboard feature for multi level switching.
3. No. of hrs per day 8 and no. of days per year 365= 2920 hrs/year. (Hrs can change per project scope of work.)
4. lamp replacement shall be @ 60% of lamp life
5. The fixture selected shall show ranking above unity in the SIR sheet.

6. The above listed options (option #1 to option #6) are only recommendation. Designers shall select fixtures adequate for the project scope of work.

| Lighting Life Cycle Cost Analysis (LCCA) |                                |                  |   |  |               |
|--|--------------------------------|------------------|---|--|---------------|
| REVISIONS:                               | DRAWN BY:<br>FPW<br>GWD<br>LKS | DATE:<br>3/15/10 | NC DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27601-2827 |  | PROJECT NO.:  |
|  |                                |                  |   |  | SHEET<br>E-00 |

## FIRE ALARM SYSTEM SYMBOLS

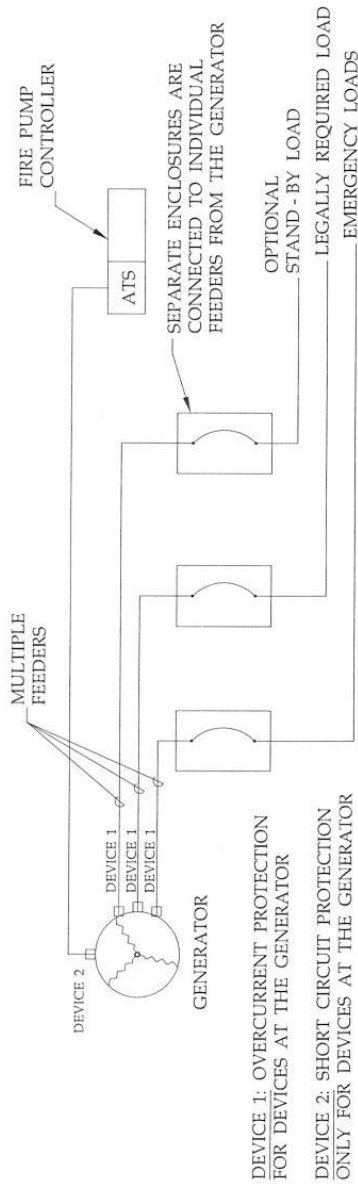
|  |   |
|--|---|
| <p> FIRE ALARM PULL STATION<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: 4'-0"</p> <p> FIRE ALARM BELL ONLY<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM COMBINATION BELL/STROBE<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM HORN ONLY<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM COMBINATION HORN/STROBE<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM VOICE SPEAKER ONLY<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM COMBINATION VOICE/STROBE<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM COMBINATION VOICE/STROBE<br/>MOUNTING LOCATION: CEILING<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM STROBE ONLY<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> FIRE ALARM SMOKE DETECTOR<br/>MOUNTING LOCATION: CEILING</p> <p> FIRE ALARM DUCT SMOKE DETECTOR<br/>MOUNTING LOCATION: DUCT</p> <p> FIRE ALARM HEAT DETECTOR<br/>MOUNTING LOCATION: CEILING</p> <p>RIS \$ REMOTE INDICATOR TEST SWITCH FOR AHU'S<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: AS NOTED</p> <p> BACKFLOW PREVENTOR<br/>MOUNTING LOCATION: AS NOTED</p> | <p> FIRE ALARM DOOR HOLDER<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: FIELD VERIFY</p> <p> FIRE ALARM WATER FLOW SWITCH<br/>MOUNTING LOCATION: SPRINKLER PIPE<br/>MOUNTING HEIGHT: FIELD VERIFY</p> <p> FIRE ALARM TAMPER SWITCH<br/>MOUNTING LOCATION: SPRINKLER PIPE<br/>MOUNTING HEIGHT: FIELD VERIFY</p> <p> FIRE ALARM CONTROL PANEL<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: AS NOTED</p> <p> FIRE ALARM ANNUNCIATOR PANEL<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: AS NOTED</p> <p> FIRE ALARM TERMINAL CABINET<br/>WITH AMPLIFIERS<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: AS NOTED</p> <p> NOTIFICATION APPLIANCE POWER SUPPLY<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: AS NOTED</p> <p> DIALER PANEL<br/>MOUNTING LOCATION: WALL<br/>MOUNTING HEIGHT: AS NOTED</p> <p> FIRE ALARM ISOLATION MODULE<br/>MOUNTING LOCATION: CEILING/WALL<br/>MOUNTING HEIGHT: SEE NOTE 1</p> <p> END OF LINE RESISTOR<br/>MOUNTING LOCATION: HORN/STROBE<br/>MOUNTING HEIGHT: INTERNAL</p> <p> FIRE ALARM ADDRESSABLE MODULE<br/>MOUNTING LOCATION: WALL</p> <p> FIRE ALARM NON ADDRESSABLE<br/>HEAT DETECTOR<br/>MOUNTING LOCATION: CEILING</p> <p> FIRE ALARM POST-INDICATOR VALVE<br/>MOUNTING LOCATION: AS NOTED</p> <p> FIRE ALARM CONTACT/CONTROL RELAY<br/>MOUNTING LOCATION/HEIGHT: FIELD VERIFY</p> |
|--|---|

**NOTES:**

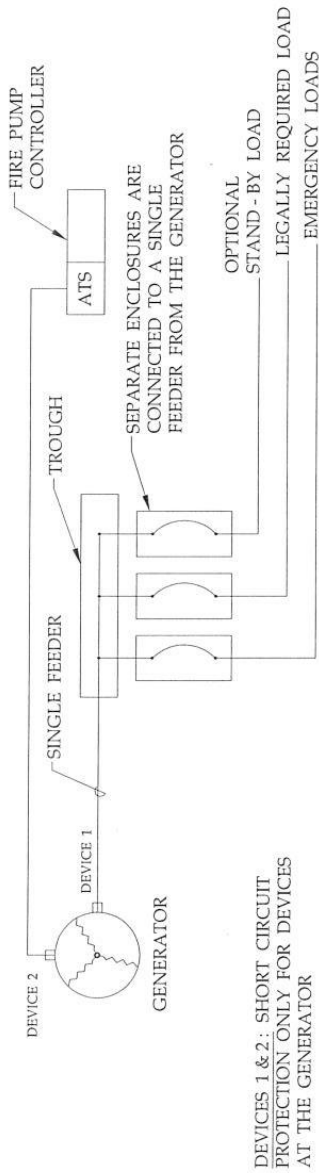
1. 80" AFF TO BOTTOM OF FACEPLATE OR 6" FROM TOP OF FACEPLATE TO CEILING, WHICH EVER IS LOWER.

|   |       |       |               |
|---|-------|-------|---------------|
| <b>FIRE ALARM SYSTEM SYMBOLS</b>  |       |       |               |
| REVISIONS:  | DRWN: | CHKD: | SHEET:        |
|   |       |       | <b>E - 01</b> |
| NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br><b>STATE CONSTRUCTION OFFICE</b><br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27601-2827 |       |       |               |

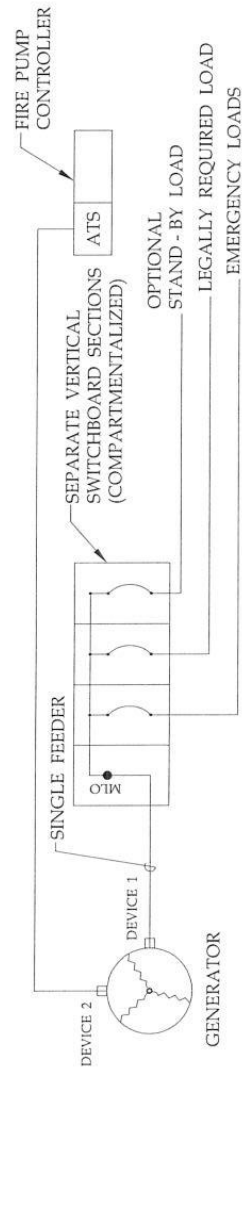
SEPARATE FEEDERS



SINGLE FEEDER TO A TROUGH

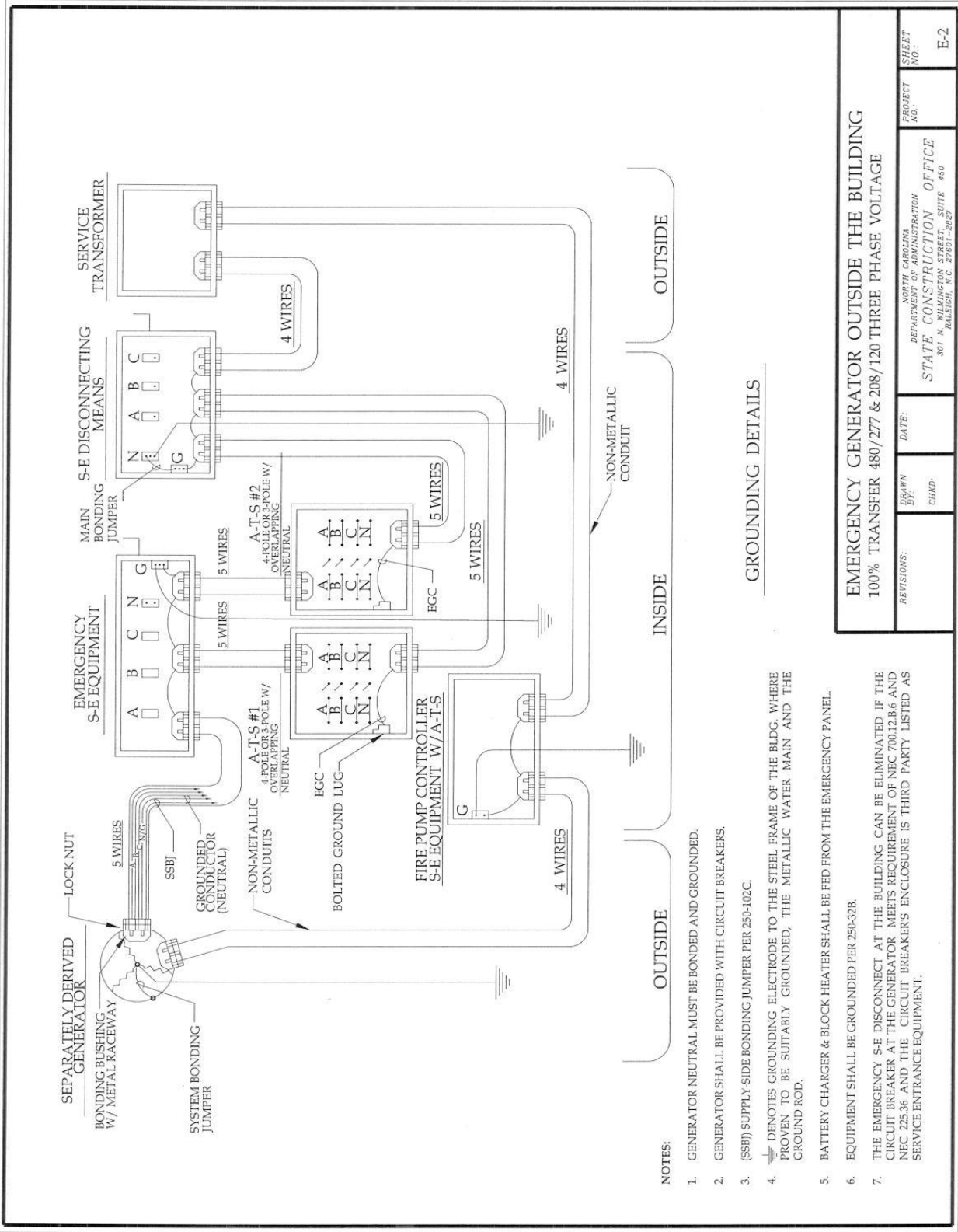


SINGLE FEEDER TO COMPARTMENTAL PANEL



GENERATOR SYSTEM WIRING

|            |                |       |                                  |            |
|------------|----------------|-------|----------------------------------|------------|
| REVISIONS: | DRAWN BY: CHAD | DATE: | PROJECT NO.:                     | SHEET NO.: |
|            |                |       | STATE CONSTRUCTION OFFICE        | E-1        |
|            |                |       | 301 N. WALLACE STREET, SUITE 450 |            |
|            |                |       | RALEIGH, N.C. 27601-2827         |            |



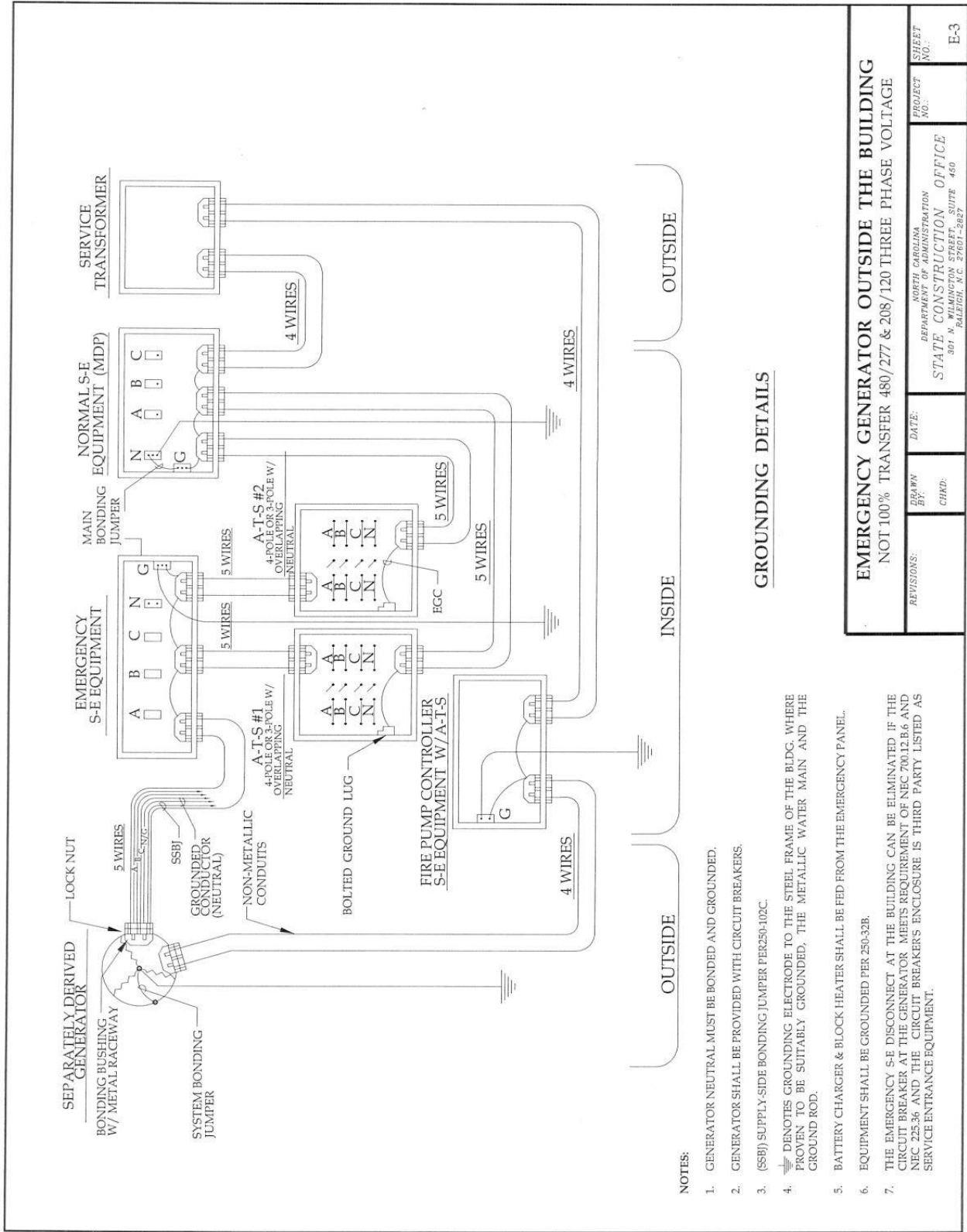
GROUNDING DETAILS

NOTES:

1. GENERATOR NEUTRAL MUST BE BONDED AND GROUNDED.
2. GENERATOR SHALL BE PROVIDED WITH CIRCUIT BREAKERS.
3. (SSBJ) SUPPLY-SIDE BONDING JUMPER PER 250-102C.
4. DENOTES GROUNDING ELECTRODE TO THE STEEL FRAME OF THE BLDG. WHERE PROVEN TO BE SUITABLY GROUNDED, THE METALLIC WATER MAIN AND THE GROUND ROD.
5. BATTERY CHARGER & BLOCK HEATER SHALL BE FED FROM THE EMERGENCY PANEL.
6. EQUIPMENT SHALL BE GROUNDED PER 250-328.
7. THE EMERGENCY S-E DISCONNECT AT THE BUILDING CAN BE ELIMINATED IF THE CIRCUIT BREAKER AT THE GENERATOR MEETS REQUIREMENT OF NEC 700.12.B.6 AND NEC 225.36 AND THE CIRCUIT BREAKER'S ENCLOSURE IS THIRD PARTY LISTED AS SERVICE ENTRANCE EQUIPMENT.

EMERGENCY GENERATOR OUTSIDE THE BUILDING  
100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE

|            |           |       |  |            |
|------------|-----------|-------|--|------------|
| REVISIONS: | DRAWN BY: | DATE: | PROJECT NO.:   | SHEET NO.: |
|            | CHD:      |       | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, NC 27607-2687 | E-2        |



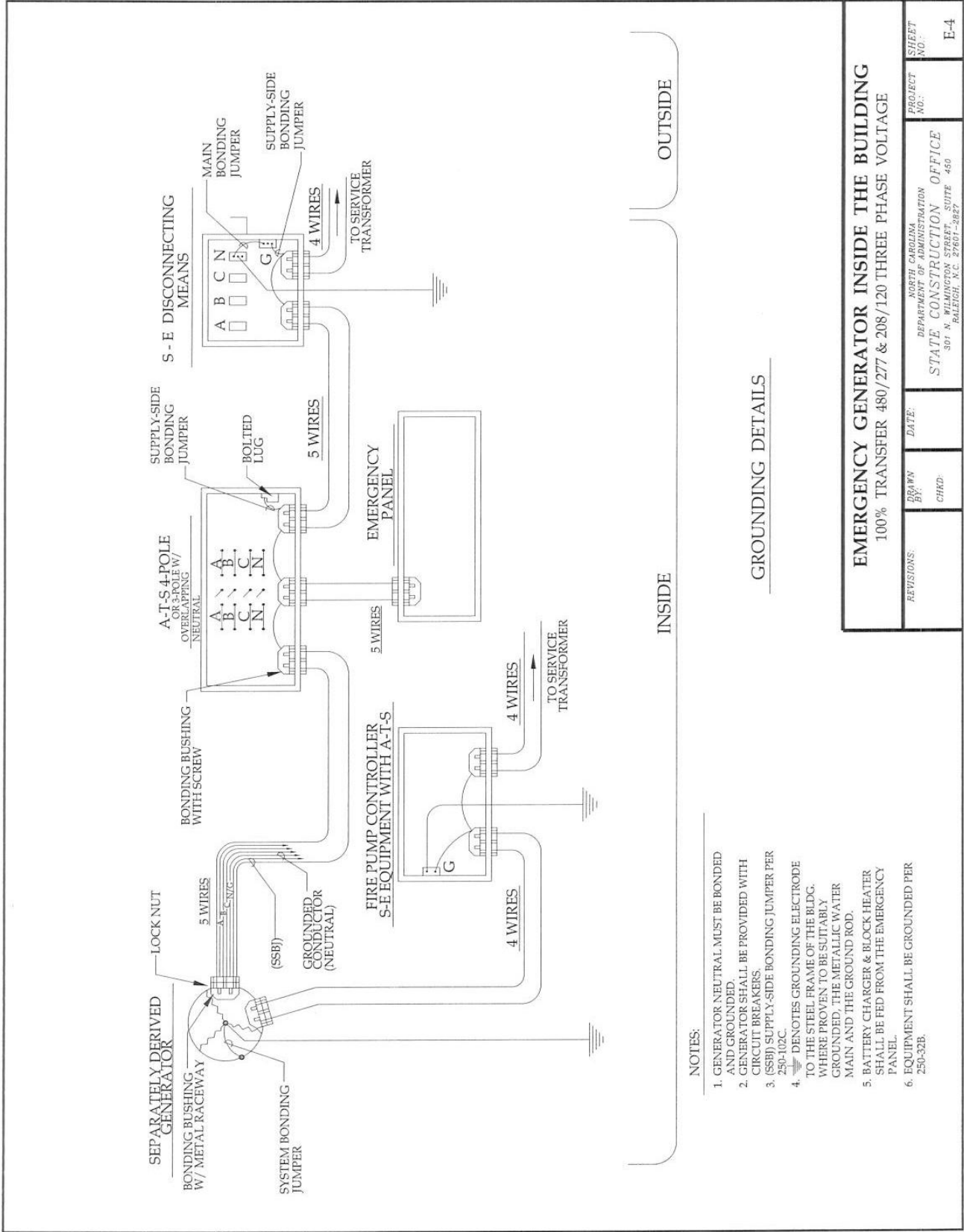
- NOTES:**
1. GENERATOR NEUTRAL MUST BE BONDED AND GROUNDED.
  2. GENERATOR SHALL BE PROVIDED WITH CIRCUIT BREAKERS.
  3. (SSBF) SUPPLY-SIDE BONDING JUMPER PER 250-102C.
  4. ⚡ DENOTES GROUNDING ELECTRODE TO THE STEEL FRAME OF THE BLDG. WHERE PROVEN TO BE SUITABLY GROUNDED, THE METALLIC WATER MAIN AND THE GROUND ROD.
  5. BATTERY CHARGER & BLOCK HEATER SHALL BE FED FROM THE EMERGENCY PANEL.
  6. EQUIPMENT SHALL BE GROUNDED PER 250-32B.
  7. THE EMERGENCY S-E DISCONNECT AT THE BUILDING CAN BE ELIMINATED IF THE CIRCUIT BREAKER AT THE GENERATOR MEETS REQUIREMENT OF NEC 700.12.B.6 AND NEC 225.36 AND THE CIRCUIT BREAKER'S ENCLOSURE IS THIRD PARTY LISTED AS SERVICE ENTRANCE EQUIPMENT.

**GROUNDING DETAILS**

**EMERGENCY GENERATOR OUTSIDE THE BUILDING**  
 NOT 100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE

|            |           |       |                                 |            |
|------------|-----------|-------|---------------------------------|------------|
| REVISIONS: | DRAWN BY: | DATE: | PROJECT NO.:                    | SHEET NO.: |
|            | CHAD:     |       | STATE CONSTRUCTION OFFICE       | E-3        |
|            |           |       | DEPARTMENT OF TRANSPORTATION    |            |
|            |           |       | 301 N. RALEIGH, N.C. 27601-2827 |            |





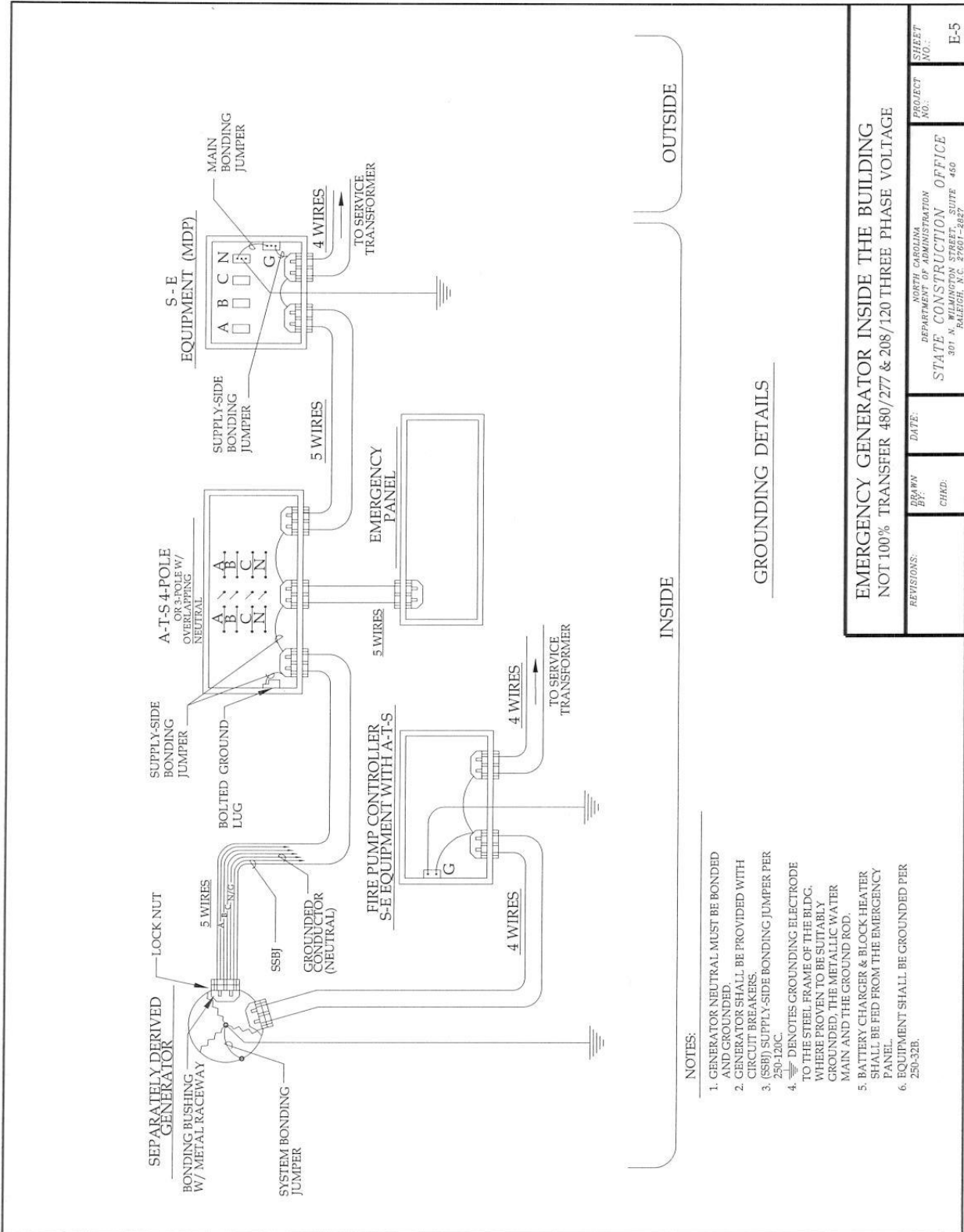
GROUNDING DETAILS

NOTES:

1. GENERATOR NEUTRAL MUST BE BONDED AND GROUNDED.
2. GENERATOR SHALL BE PROVIDED WITH CIRCUIT BREAKERS.
3. (SSB) SUPPLY-SIDE BONDING JUMPER PER 250-102C.
4. ⚡ DENOTES GROUNDING ELECTRODE TO THE STEEL FRAME OF THE BLDG. WHERE PROVEN TO BE SUITABLY GROUNDED, THE METALLIC WATER MAIN AND THE GROUND ROD.
5. BATTERY CHARGER & BLOCK HEATER SHALL BE FED FROM THE EMERGENCY PANEL.
6. EQUIPMENT SHALL BE GROUNDED PER 250-52B.

**EMERGENCY GENERATOR INSIDE THE BUILDING**  
 100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE

|            |           |       |  |            |
|------------|-----------|-------|--|------------|
| REVISIONS: | DRAWN BY: | DATE: | PROJECT NO.:   | SHEET NO.: |
|            | CHAD:     |       | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27601-2887 | E-4        |



|   |            |       |   |
|---|------------|-------|---|
| <b>EMERGENCY GENERATOR INSIDE THE BUILDING</b><br>NOT 100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE |            |       |   |
| REVISIONS:  | DRAWN BY:  | DATE: | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET SUITE 460<br>RALEIGH, N.C. 27601-2827 |
| PROJECT NO.:  | SHEET NO.: | E-5   |   |

| LOAD | KVA OR KW |   | DESIGNATION TYPED ON DIRECTORY | COND. GRND. (" ) | WIRE SIZE | BRKR. RATG. NO. | WIRE SIZE | GRND. COND. (" ) | DESIGNATION TYPED ON DIRECTORY | LOAD        |      |      |      |
|------|-----------|---|--------------------------------|------------------|-----------|-----------------|-----------|------------------|--------------------------------|-------------|------|------|------|
|      | A         | B |                                |                  |           |                 |           |                  |                                | C           | A    | B    | C    |
| 1.8  |           |   | LIGHTING - ROOM #              | 1/2"             | 12        | 20              |           | 1/2"             | RECEPTACLE                     | 2.0         |      |      |      |
|      | 1.8       |   | LIGHTING - ROOM #              | 1/2"             | 12        | 20              |           | 1/2"             | RECEPTACLE                     |             | 2.0  |      |      |
| 7.8  |           |   | SPARE                          |                  |           | 20              |           | 1/2"             | RECEPTACLE                     |             |      | 2.0  |      |
|      | 7.8       |   | TRAY WASH <3>P                 | 1"               | 10        | 40              |           |                  | SPACE ONLY                     |             |      |      |      |
|      | 7.8       |   |                                |                  |           | 11              |           |                  | SPACE ONLY                     |             |      |      |      |
| 7.8  |           |   | TRAY WASH <3>P                 | 1"               | 10        | 40              |           | 1"               | BOOSTER HEATER <3>H            | 15.0        |      |      |      |
|      | 7.8       |   |                                |                  |           | 17              |           |                  |                                |             |      |      |      |
| 3.2  |           |   | TRANSFORMER "T"                | 1/2"             | 10        | 25              |           | 1/2"             | PACKAGE AIR COND. PAC-1        |             | 4.2  |      |      |
|      | 3.4       |   |                                |                  |           | 23              |           |                  |                                |             |      | 4.2  |      |
|      |           |   |                                |                  |           |                 |           |                  |                                | TOTAL RIGHT | 21.2 | 21.2 | 21.2 |
|      |           |   |                                |                  |           |                 |           |                  |                                | TOTAL LEFT  | 20.6 | 20.8 | 21   |
|      |           |   |                                |                  |           |                 |           |                  |                                | TOTAL       | 41.8 | 42   | 42.2 |

S/N

PANEL TYPE: LIGHTING & APPLIANCE  
 SERVICE SUPPLY; 277/480 VOLT, 3-PHASE, 4-WIRE  
 BUSES/NEUTRAL: 250A  
 MAINS: 250A MAIN BREAKER @ BOTTOM  
 FEEDER: SEE "POWER RISER DIAGRAM"  
 PROVIDE COPPER GROUND BUS  
 PANEL SHALL BE RATED 25,000 AIC (INTEGRATED EQUIP. RATING)  
 SPECIAL FEATURES:  
 MAIN BREAKER SHALL BE CURRENT-LIMITING.

PANEL H

| CONNECTED LOAD (KVA)     | DF    | DEMAND LOAD |
|--------------------------|-------|-------------|
| LIGHTING = 3.4 *         | 100 % | = 3.4       |
| HVAC = -- *              | -- %  | = --        |
| HVAC (COOLING) = 12.6 *  | 100 % | = 12.6      |
| HVAC (HEATING) = -- *    | -- %  | = --        |
| LARGE MOTORS = -- *      | -- %  | = --        |
| KITCHEN EQUIPMENT = 95 * | 100 % | = 95        |
| RECEPTACLES = 20 *       | 75 %  | = 15        |
| MISCELLANEOUS = -- *     | -- %  | = --        |
| TOTALS = 131 *           | %     | = 126       |

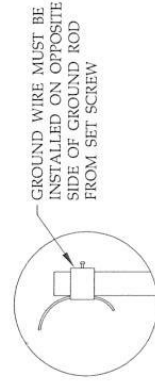
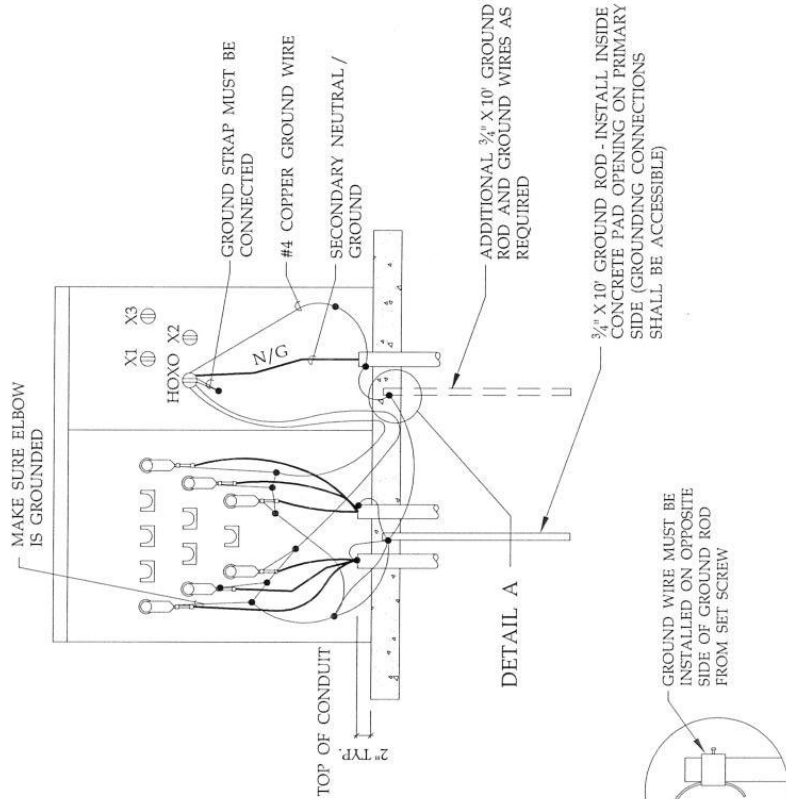
GROSS PHASE TOTALS (KVA) A=41.8 B=42 C=42.2  
 \* FIGURES ARE REPRESENTATIVE ONLY.

### TYPICAL PANELBOARD SCHEDULE

|            |           |       |   |              |            |
|------------|-----------|-------|---|--------------|------------|
| REVISIONS: | DRAWN BY: | DATE: | NORTH CAROLINA DEPARTMENT OF ADMINISTRATION | PROJECT NO.: | SHEET NO.: |
|            | CHECKD:   |       | STATE CONSTRUCTION OFFICE                   |              | E-6        |
|            |           |       | 301 N. WASHINGTON STREET, SUITE 450         |              |            |
|            |           |       | Raleigh, N.C. 27601-2867                    |              |            |

NOTES:

1. THE PRIMARY NEUTRAL CONDUCTOR MUST BE BONDED CONTINUOUSLY TO THE PRIMARY CONDUIT (IF METALLIC), THE GROUND ROD, THE TRANSFORMER TANK GROUND PAD IN THE PRIMARY COMPARTMENT, AND THE HO/XO NEUTRAL BUSHING. THIS STEP SHALL BE REPEATED IF LOOP FEED TRANSFORMER.
2. THE STRESS CONES AND THE PRIMARY CABLE SHIELD MUST BE GROUNDED TO THE NEUTRAL CONDUCTOR. THIS STEP SHALL BE REPEATED IF LOOP FEED TRANSFORMER.
3. A #4 COPPER GROUND WIRE IS TO BE BONDED TO THE HO/XO BUSHING, TO THE GROUND PAD IN THE SECONDARY COMPARTMENT, TO THE SECONDARY CONDUIT (IF METALLIC), AND TO THE GROUND ROD.
4. GROUND STRAP MUST CONNECT THE HO/XO BUSHING TO THE TRANSFORMER TANK.
5. A SUITABLE FLEXIBLE #6 COPPER ARRESTER LEAD SHALL BE INSTALLED FROM EACH ARRESTER DIRECTLY TO THE GROUND ROD (NOT SHOWN).
6. THE PRIMARY & SECONDARY CONDUITS SHALL EXTEND TWO INCHES ABOVE THE CONCRETE PAD.
7. IF THE RESISTANCE OF THE GROUND ROD EXCEEDS 25 OHMS, INSTALL AN ADDITIONAL GROUND ROD AT LEAST 10' AWAY. INTER-CONNECT THE TWO USING #4 COPPER GROUND WIRE.
8. COMPLETE INSTALLATION MUST BE IN COMPLIANCE WITH THE NATIONAL ELECTRICAL SAFETY CODE, ANSI C2.



DETAIL A - 3/4" GRND. ROD  
SCALE

TYPICAL GROUNDING DETAILS FOR THREE PHASE TRANSFORMERS

|            |           |       |   |              |            |
|------------|-----------|-------|---|--------------|------------|
| REVISIONS: | DRAWN BY: | DATE: | NORTH CAROLINA DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WASHINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27601-2687 | PROJECT NO.: | SHEET NO.: |
|            | CHKD:     |       |   |              | E-7        |

| LOAD TABULATION   |               |             |               |             |                  |              |             |                                   |            |
|-------------------|---------------|-------------|---------------|-------------|------------------|--------------|-------------|-----------------------------------|------------|
| LOADS IN KVA      | EXIST. DEMAND |             | NEW CONNECTED |             | DIVERSITY FACTOR | NEW DEMAND   |             | TOTAL KVA EXISTING AND NEW DEMAND |            |
|                   | SINGLE PHASE  | THREE PHASE | SINGLE PHASE  | THREE PHASE |                  | SINGLE PHASE | THREE PHASE | EXISTING                          | NEW DEMAND |
| LIGHTING          |               |             |               |             |                  |              |             |                                   |            |
| AIR CONDITIONING  |               |             |               |             |                  |              |             |                                   |            |
| HEATING           |               |             |               |             |                  |              |             |                                   |            |
| LARGE MOTORS      |               |             |               |             |                  |              |             |                                   |            |
| VENTILATION       |               |             |               |             |                  |              |             |                                   |            |
| KITCHEN EQUIPMENT |               |             |               |             |                  |              |             |                                   |            |
| RECEPTACLES       |               |             |               |             |                  |              |             |                                   |            |
| EMERGENCY         |               |             |               |             |                  |              |             |                                   |            |
| MISCELLANEOUS     |               |             |               |             |                  |              |             |                                   |            |
| FUTURE ALLOWANCE  |               |             |               |             |                  |              |             |                                   |            |
| TOTAL             |               |             |               |             |                  |              |             |                                   |            |

\* SEE NEC 220 FOR MORE INFORMATION

**LOAD TABULATION BREAKDOWN**

|            |            |       |                                 |            |
|------------|------------|-------|---------------------------------|------------|
| REVISIONS: | DESIGN BY: | DATE: | PROJECT NO.:                    | SHEET NO.: |
|            | CHD:       |       | STATE CONSTRUCTION OFFICE       | E-8        |
|            |            |       | 301 N. RALEIGH, N.C. 27601-2827 |            |

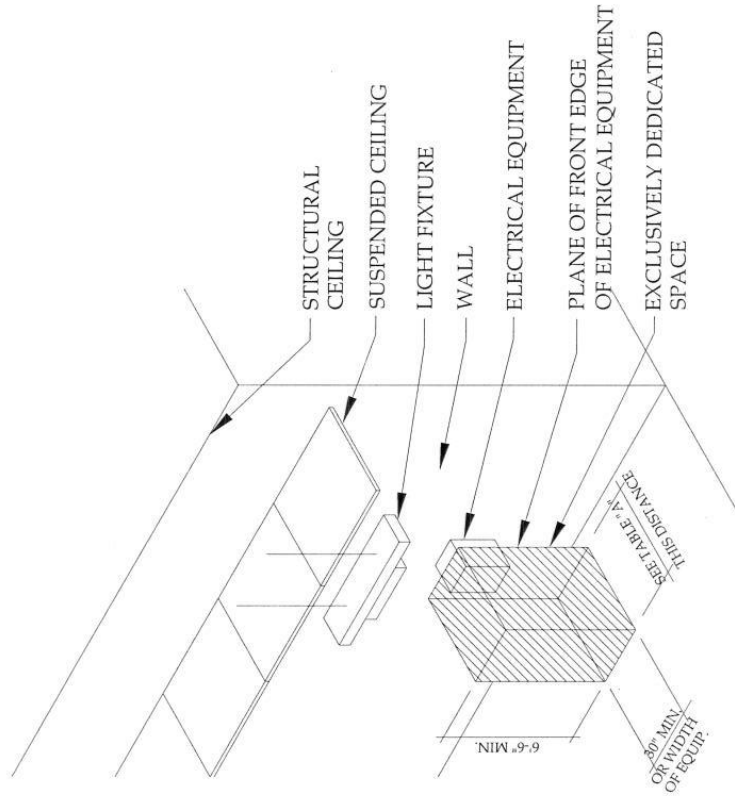
**TABLE A - WORKING CLEARANCES**

| VOLTAGE TO GROUND, NOMINAL | MINIMUM CLEAR DISTANCE (FEET) |    |   |   |
|----------------------------|-------------------------------|----|---|---|
|                            | CONDITION 1                   | 2  | 3 | 4 |
| 0 - 150                    | 3                             | 3  | 3 | 3 |
| 151 - 600                  | 3                             | 3½ | 4 | 4 |

WHERE THE "CONDITIONS" ARE AS FOLLOWS:

1. EXPOSED LIVE PARTS ON ONE SIDE AND NO LIVE OR GROUNDED PARTS ON THE OTHER SIDE OF THE WORKING SPACE, OR EXPOSED LIVE PARTS ON BOTH SIDES EFFECTIVELY GUARDED BY SUITABLE WOOD OR OTHER INSULATING MATERIALS. INSULATED WIRE OR INSULATED BUSBARS OPERATING AT NOT OVER 300V SHALL NOT BE CONSIDERED LIVE PARTS.
2. EXPOSED LIVE PARTS ON ONE SIDE AND GROUNDED PARTS ON THE OTHER SIDE.
3. EXPOSED LIVE PARTS ON BOTH SIDES OF THE WORK SPACE (NOT GUARDED AS PROVIDED IN CONDITION 1) WITH THE OPERATOR BETWEEN.

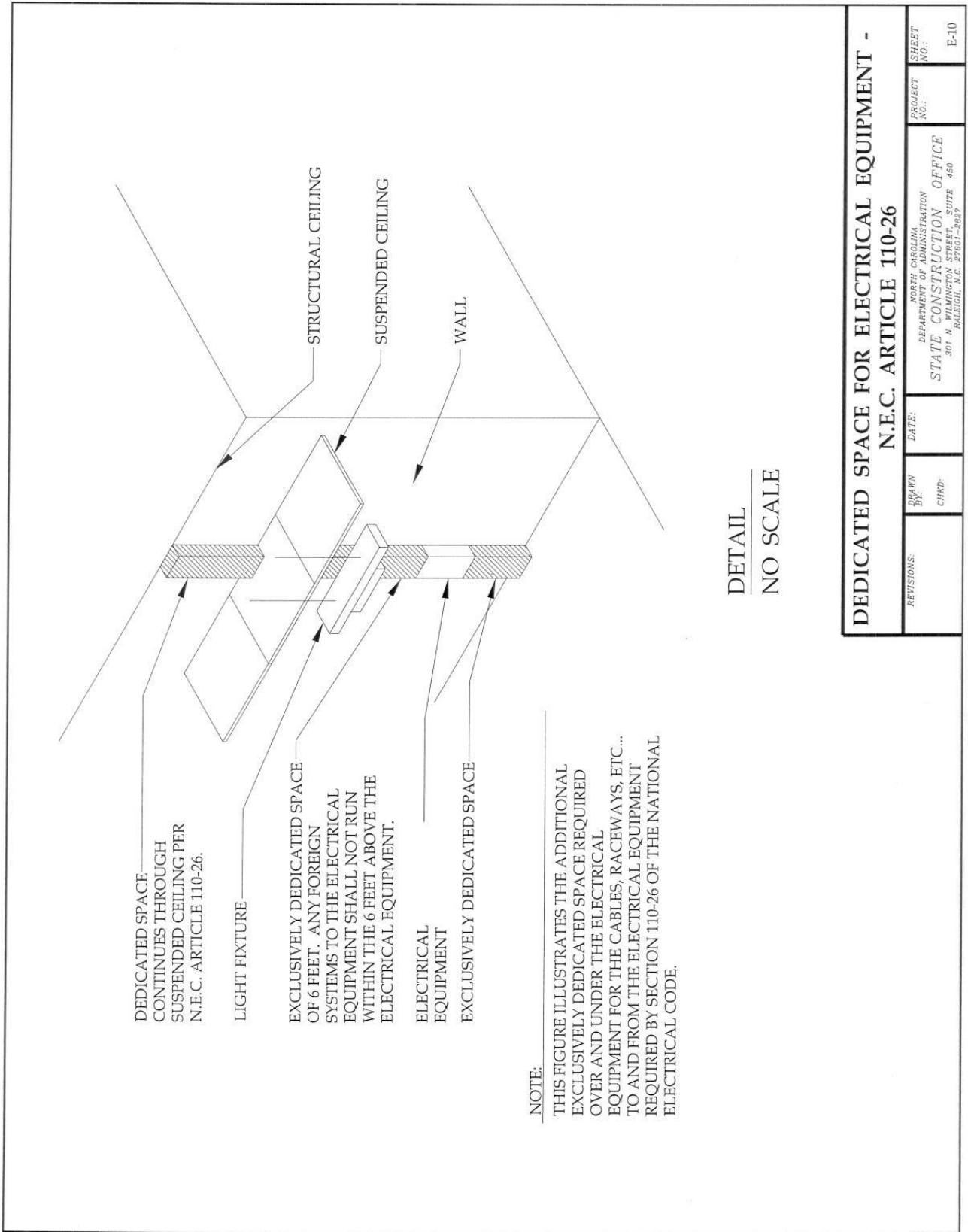
**NOTE:**  
THIS FIGURE ILLUSTRATES THE WORKING SPACE IN FRONT OF THE ELECTRICAL EQUIPMENT REQUIRED BY SECTION 110-26 OF THE NATIONAL ELECTRICAL CODE.



**DETAIL**  
**NO SCALE**

**WORKING CLEARANCE FOR ELECTRICAL  
N.E.C. ARTICLE 110-26 EQUIPMENT-**

|            |        |       |  |            |
|------------|--------|-------|--|------------|
| REVISIONS: | DRAWN: | DATE: | PROJECT NO.:   | SHEET NO.: |
|            | CHKD:  |       | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WASHINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27607-3887 | E-9        |



**DEDICATED SPACE FOR ELECTRICAL EQUIPMENT -  
N.E.C. ARTICLE 110-26**

|            |                    |       |  |            |
|------------|--------------------|-------|--|------------|
| REVISIONS: | DRAWN BY:<br>CHAD: | DATE: | PROJECT NO.:   | SHEET NO.: |
|            |                    |       | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27607-2827 | E-10       |

REPORT OF PRIMARY VOLTAGE CABLE TESTING

PROJECT ID#: \_\_\_\_\_

INSTITUTION: \_\_\_\_\_

DATE OF CABLE INSTALLATION: \_\_\_\_\_

DATE OF ENERGIZATION: \_\_\_\_\_

MANUFACTURER: \_\_\_\_\_

VOLTAGE RATING: \_\_\_\_\_

OPERATING RATING: \_\_\_\_\_

CONDUCTIVITY (AWG OR KCM): \_\_\_\_\_

INSULATION EPR: YES( ) NO( )

CONDUCTOR MATERIAL: COPPER: \_\_\_\_\_

STRAND SHEILDING: TAPE: \_\_\_\_\_ EXTRUDED: \_\_\_\_\_

CONDUCTOR SHIELDING: TAPE: \_\_\_\_\_ EXTRUDED: \_\_\_\_\_

METALLIC SHIELDING: COPPER TAPE: \_\_\_\_\_

HIGH - POTENTIAL TESTING: OPERATING VOLTAGE ( 5 15 25 )  
KV  
TEST VOLTAGE dcKV ( 27 48 75 )

| ELECTRICAL EQUIPMENT INSULATION RESISTANCE TEST - M OHM | NORMAL OPERATING VOLTAGE V | TEST VOLTAGE V dc |
|---|----------------------------|-------------------|
| 100   | 5001 - 13,000              | 2500              |
| 300   | ABOVE 13,000               | 2500              |

CIRCUIT PROTECTED BY LIGHTNING ARRESTORS: YES: \_\_\_\_\_ NO: \_\_\_\_\_

COMMENTS: \_\_\_\_\_

ENGINEER'S SIGNATURE: \_\_\_\_\_

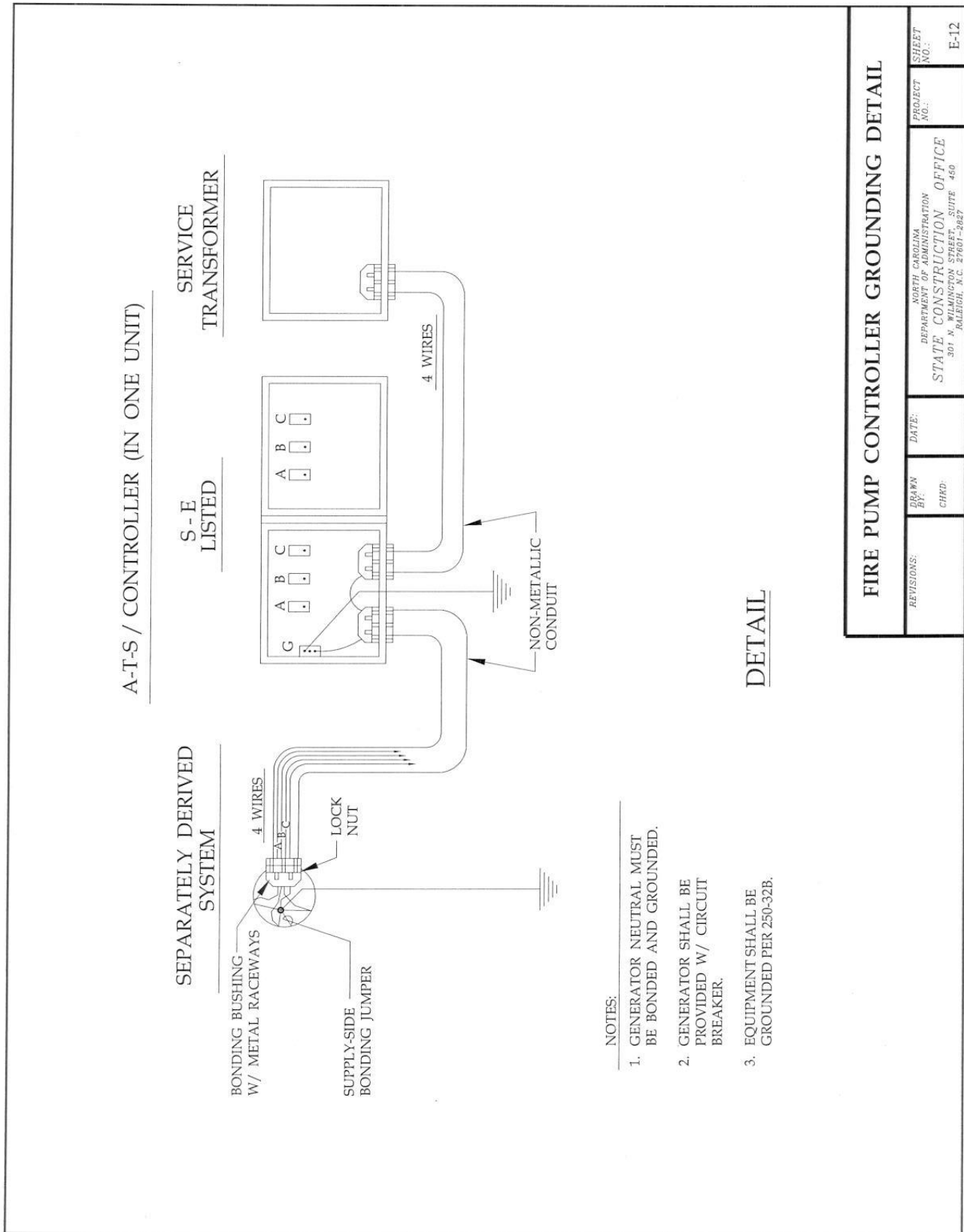
TESTING COMPANY: \_\_\_\_\_

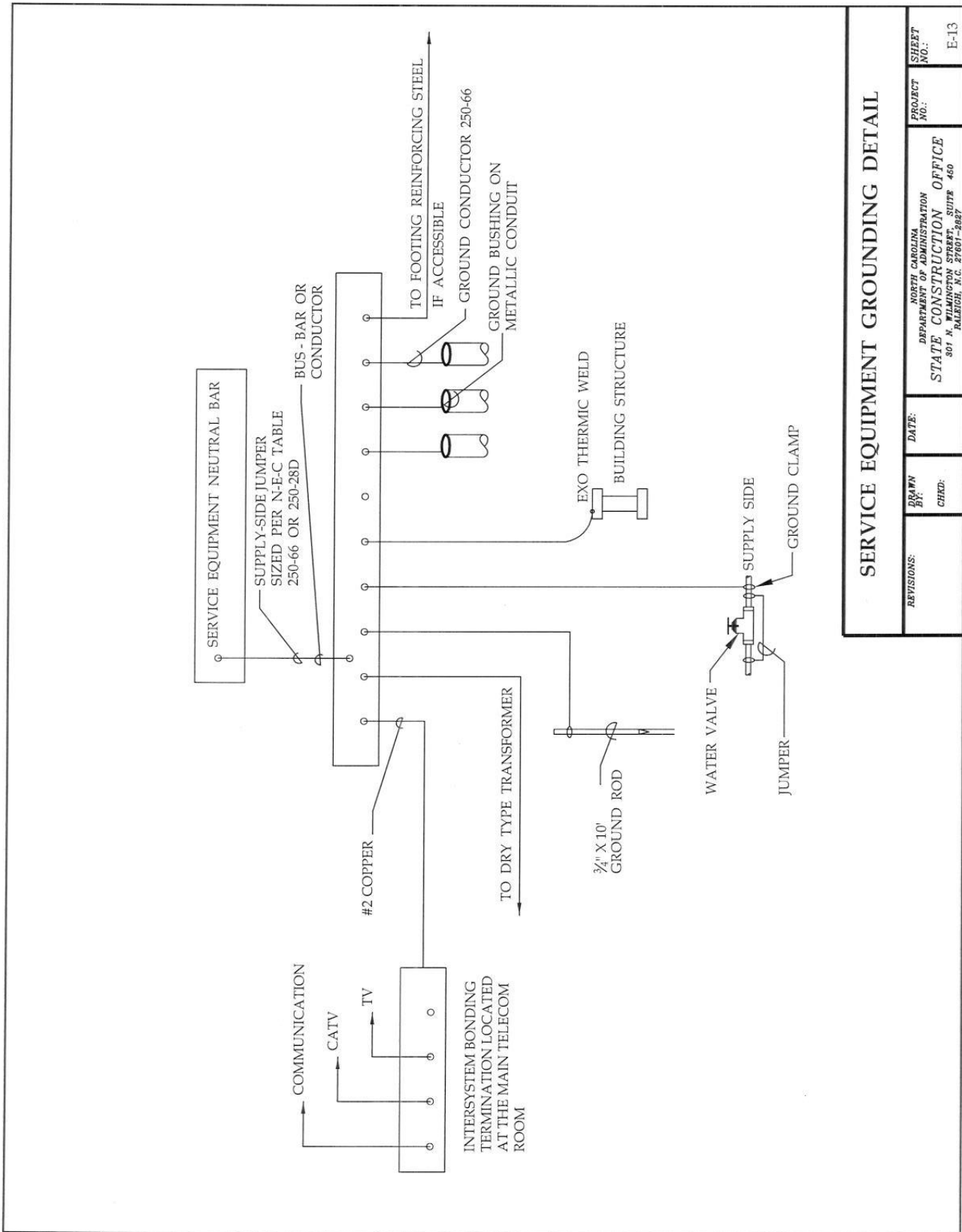
CONTRACTOR'S LICENSE #: \_\_\_\_\_

MEDIUM VOLTAGE CABLE TEST REPORT FOR 5 KV, 15 KV, AND 25 KV

|  |           |       |              |            |
|--|-----------|-------|--------------|------------|
| REVISIONS:   | DRAWN BY: | DATE: | PROJECT NO.: | SHEET NO.: |
|  |           |       |              | E-11       |
| NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27601-2887 |           |       |              |            |

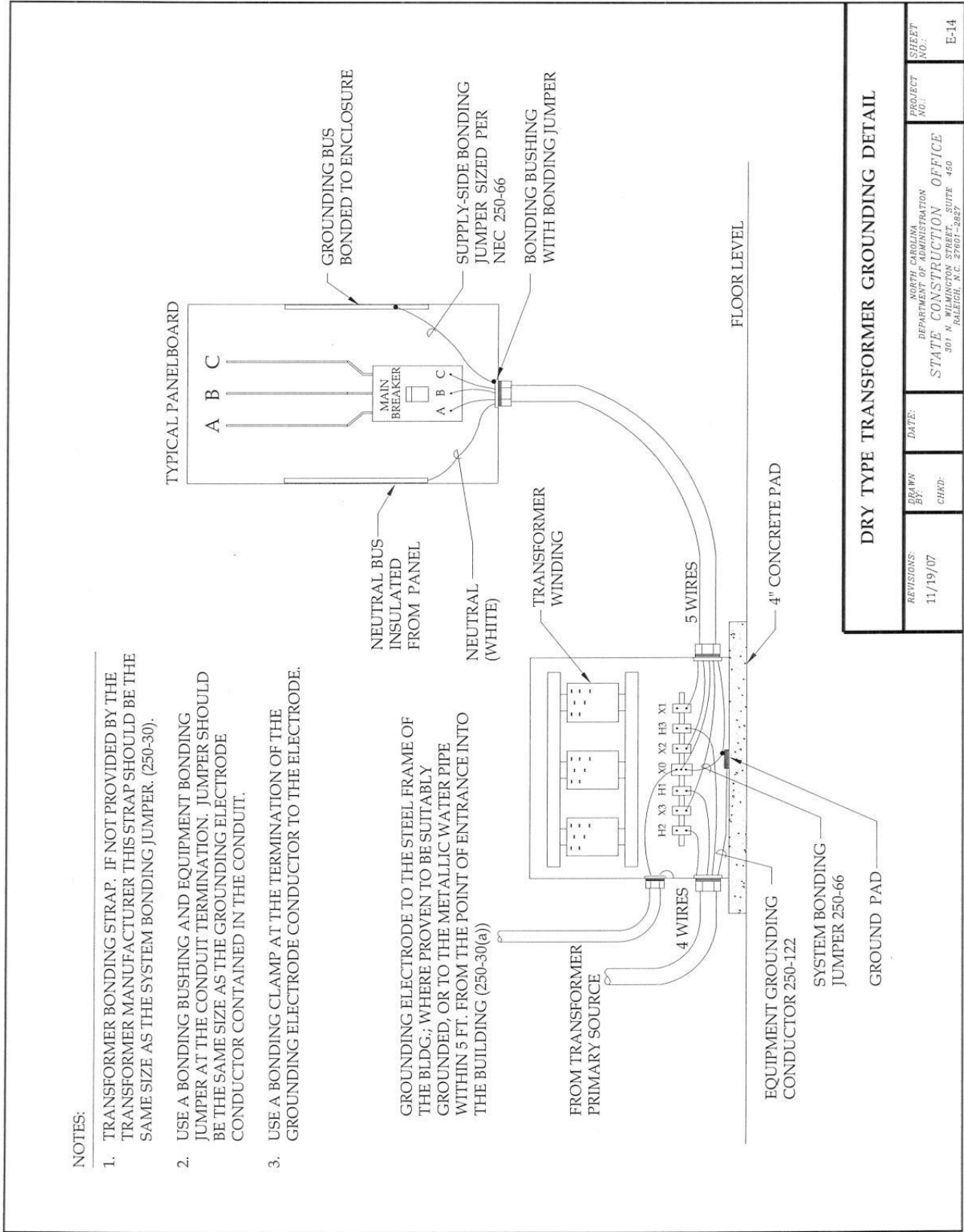




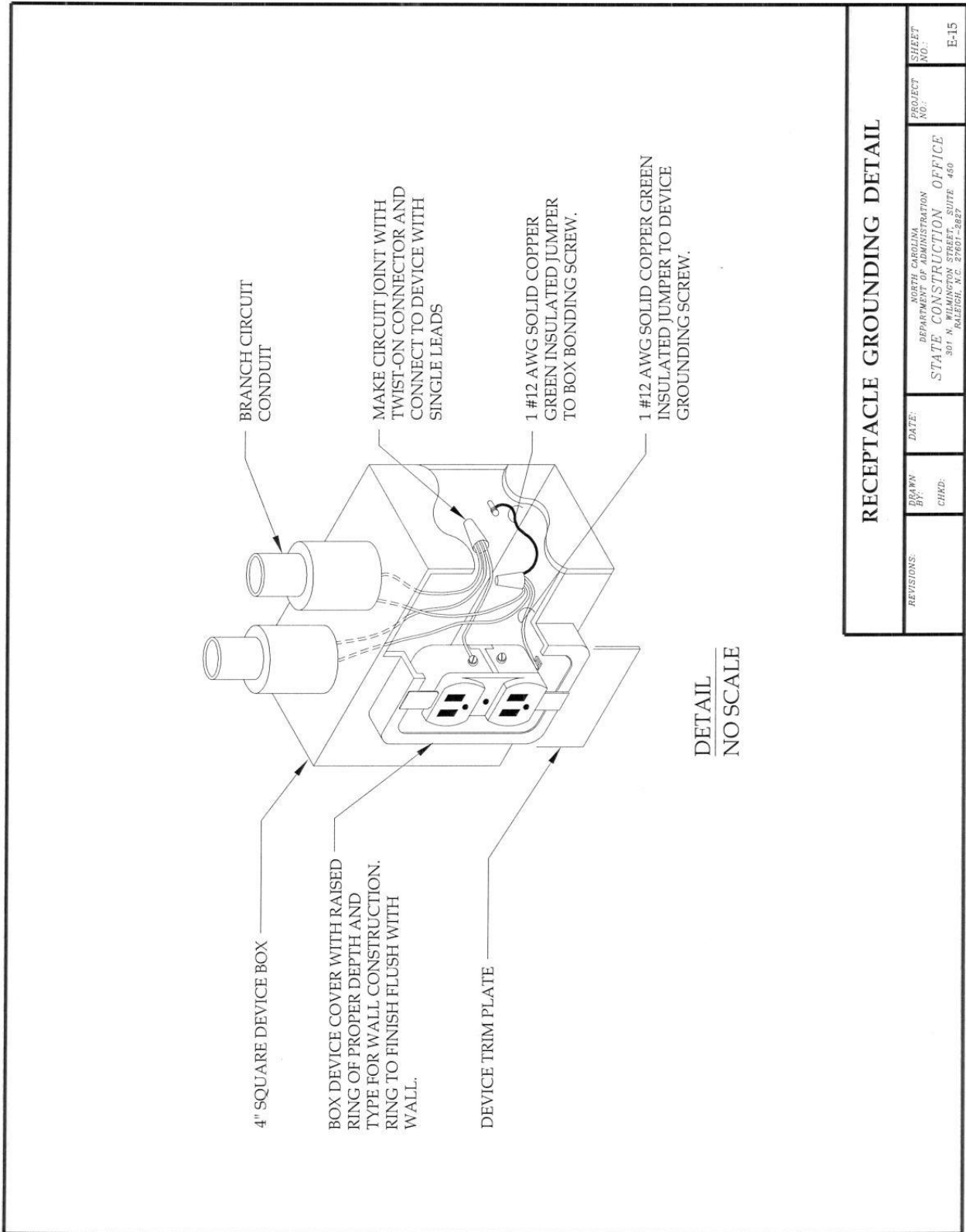


**SERVICE EQUIPMENT GROUNDING DETAIL**

|            |           |       |  |              |            |
|------------|-----------|-------|--|--------------|------------|
| REVISIONS: | DRAWN BY: | DATE: | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27601-2827 | PROJECT NO.: | SHEET NO.: |
|            | CHECKD:   |       |  |              | E-13       |

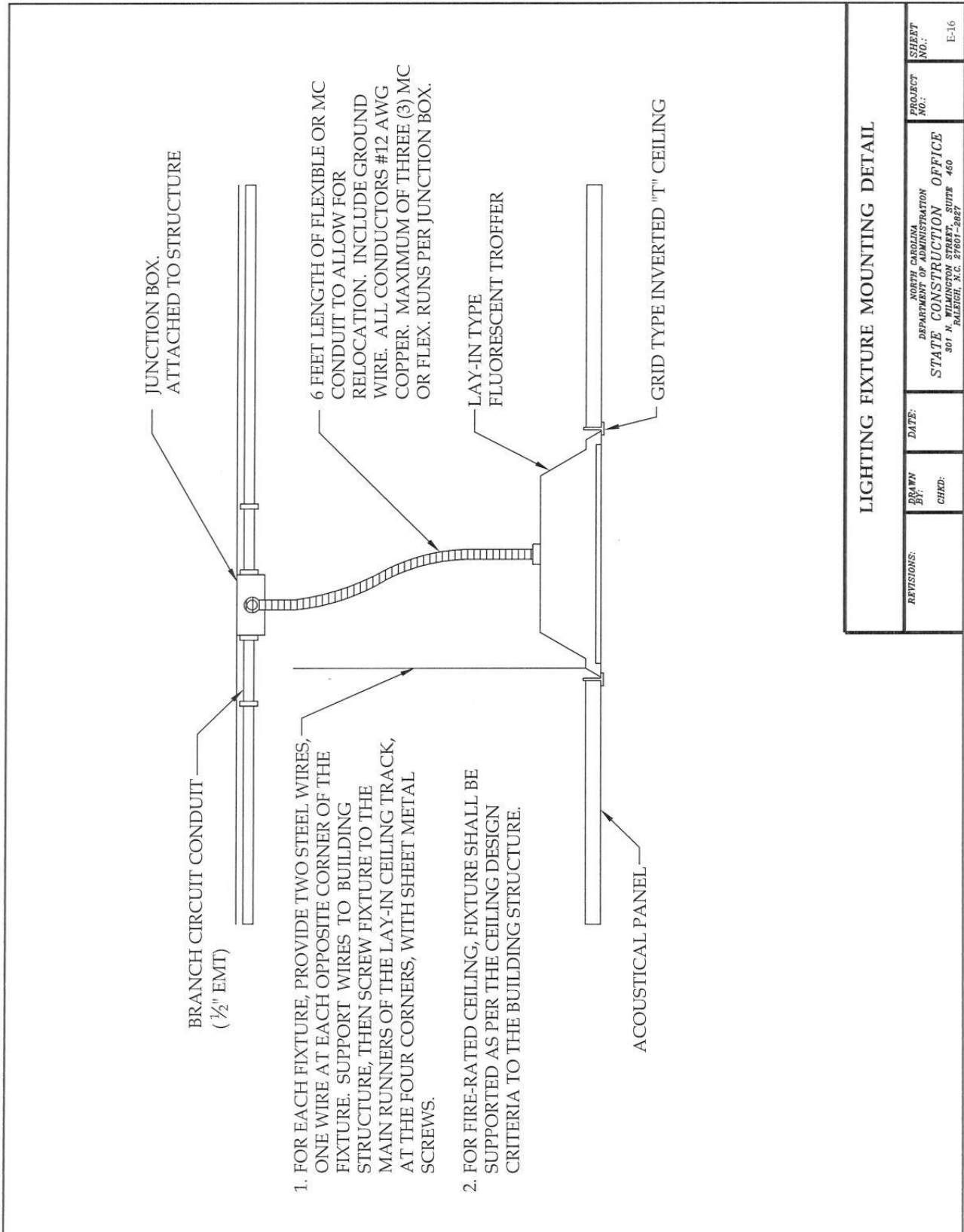


|            |           |       |  |              |            |
|------------|-----------|-------|--|--------------|------------|
| REVISIONS: | DRAWN BY: | DATE: | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. W. RAYBURN DRIVE SUITE 450<br>RALEIGH, N.C. 27601-2827 | PROJECT NO.: | SHEET NO.: |
| 11/19/07   |           |       |  |              | E-14       |



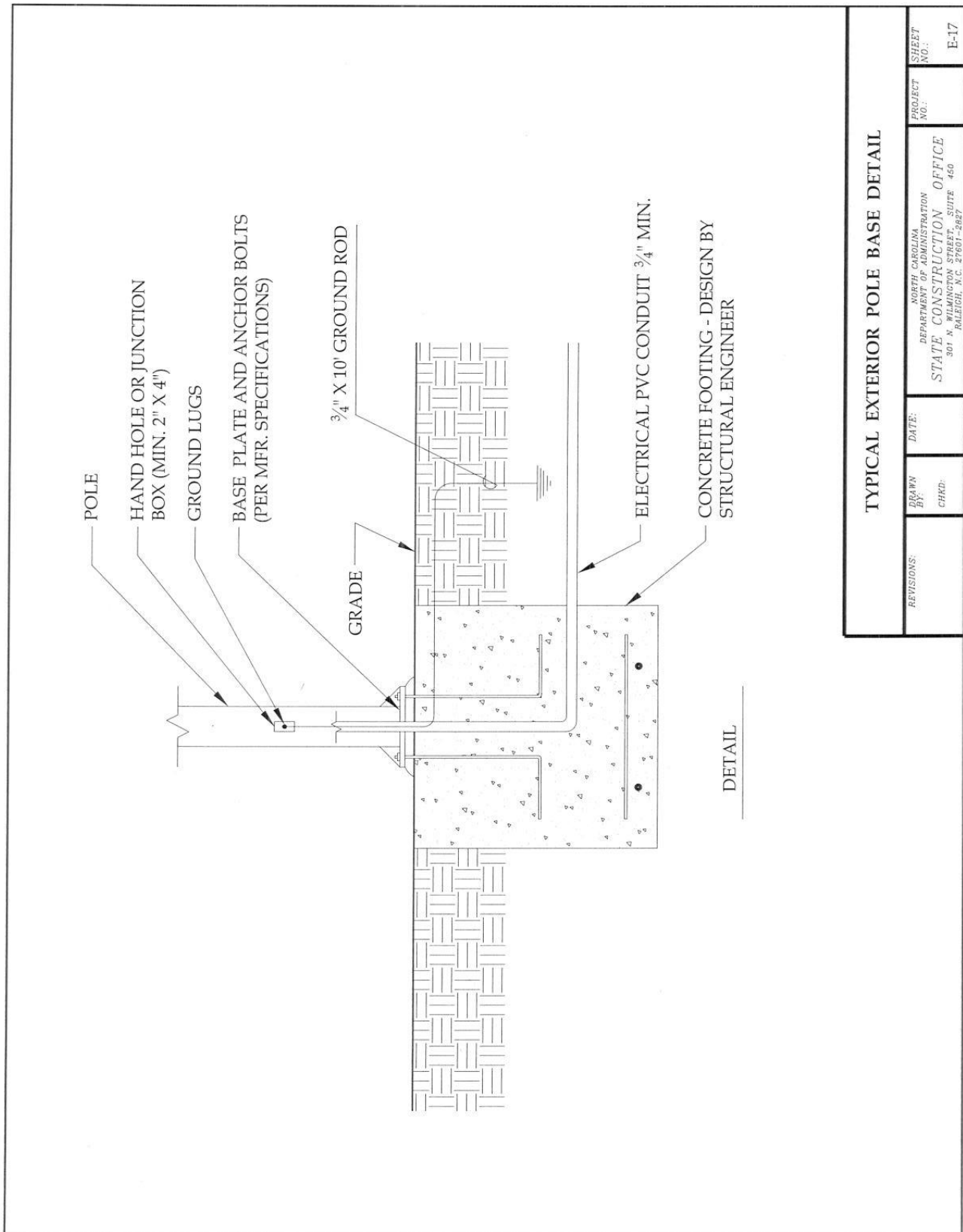
RECEPTACLE GROUNDING DETAIL

|            |                  |       |                                     |            |
|------------|------------------|-------|-------------------------------------|------------|
| REVISIONS: | DESIGN BY: CHAD: | DATE: | PROJECT NO.:                        | SHEET NO.: |
|            |                  |       | STATE CONSTRUCTION OFFICE           | E-15       |
|            |                  |       | 301 N. WILMINGTON STREET, SUITE 400 |            |
|            |                  |       | RALEIGH, N.C. 27601-2827            |            |



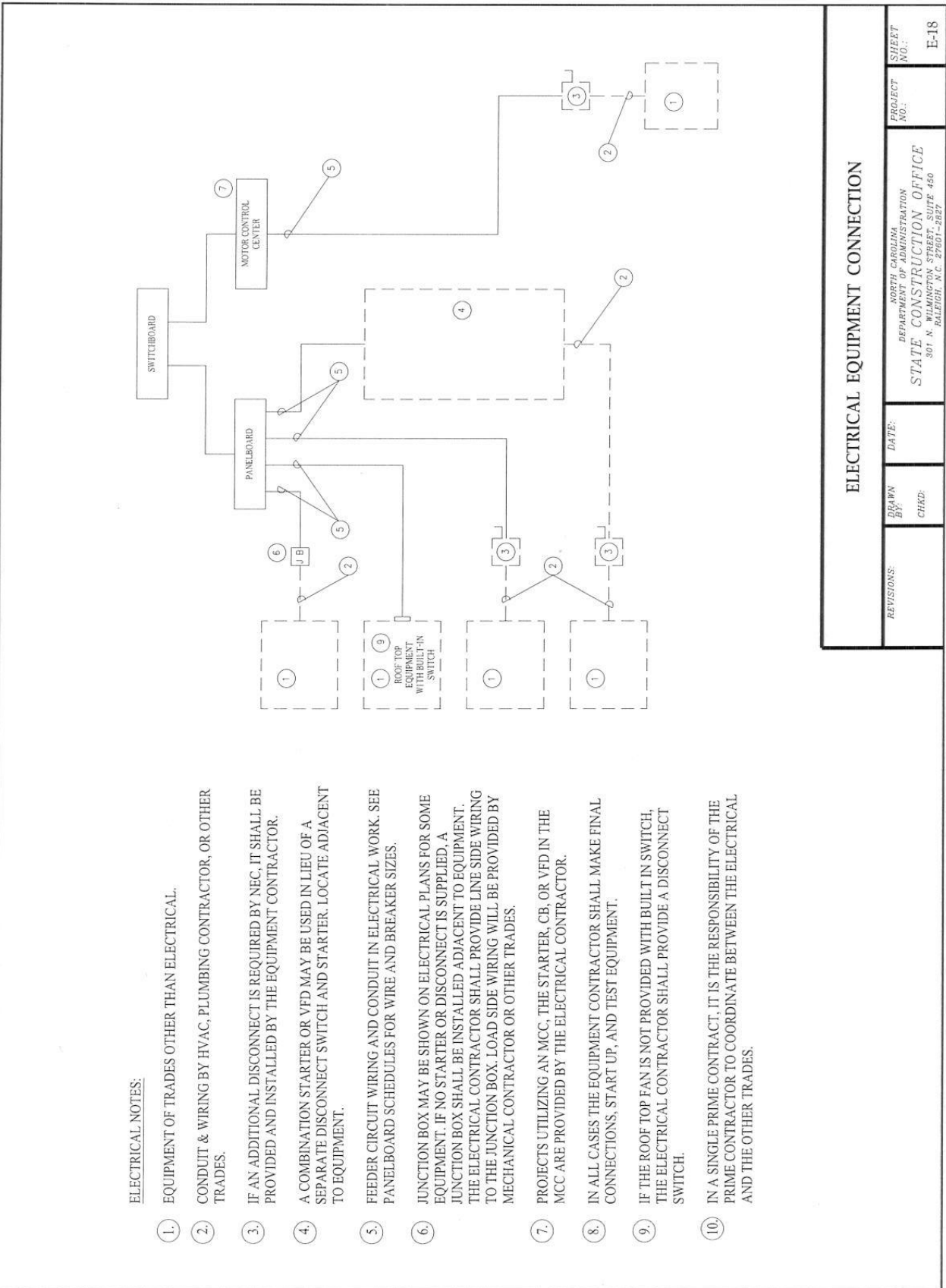
LIGHTING FIXTURE MOUNTING DETAIL

|            |                    |       |  |              |            |
|------------|--------------------|-------|--|--------------|------------|
| REVISIONS: | DRAWN BY:<br>CHND: | DATE: | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. RALEIGH, N.C. 27601-2827 | PROJECT NO.: | SHEET NO.: |
|            |                    |       |  |              | E-16       |



TYPICAL EXTERIOR POLE BASE DETAIL

|            |           |       |   |              |            |
|------------|-----------|-------|---|--------------|------------|
| REVISIONS: | DRAWN BY: | DATE: | NORTH CAROLINA DEPARTMENT OF ADMINISTRATION | PROJECT NO.: | SHEET NO.: |
|            | CHKD:     |       | STATE CONSTRUCTION OFFICE                   |              | E-17       |
|            |           |       | 301 N. WASHINGTON STREET, SUITE 450         |              |            |
|            |           |       | Raleigh, N.C. 27601-2627                    |              |            |



ELECTRICAL NOTES:

1. EQUIPMENT OF TRADES OTHER THAN ELECTRICAL.
2. CONDUIT & WIRING BY HVAC, PLUMBING CONTRACTOR, OR OTHER TRADES.
3. IF AN ADDITIONAL DISCONNECT IS REQUIRED BY NEC, IT SHALL BE PROVIDED AND INSTALLED BY THE EQUIPMENT CONTRACTOR.
4. A COMBINATION STARTER OR VFD MAY BE USED IN LIEU OF A SEPARATE DISCONNECT SWITCH AND STARTER. LOCATE ADJACENT TO EQUIPMENT.
5. FEEDER CIRCUIT WIRING AND CONDUIT IN ELECTRICAL WORK. SEE PANELBOARD SCHEDULES FOR WIRE AND BREAKER SIZES.
6. JUNCTION BOX MAY BE SHOWN ON ELECTRICAL PLANS FOR SOME EQUIPMENT. IF NO STARTER OR DISCONNECT IS SUPPLIED, A JUNCTION BOX SHALL BE INSTALLED ADJACENT TO EQUIPMENT. THE ELECTRICAL CONTRACTOR SHALL PROVIDE LINE SIDE WIRING TO THE JUNCTION BOX. LOAD SIDE WIRING WILL BE PROVIDED BY MECHANICAL CONTRACTOR OR OTHER TRADES.
7. PROJECTS UTILIZING AN MCC, THE STARTER, CB, OR VFD IN THE MCC ARE PROVIDED BY THE ELECTRICAL CONTRACTOR.
8. IN ALL CASES THE EQUIPMENT CONTRACTOR SHALL MAKE FINAL CONNECTIONS, START UP, AND TEST EQUIPMENT.
9. IF THE ROOF TOP FAN IS NOT PROVIDED WITH BUILT IN SWITCH, THE ELECTRICAL CONTRACTOR SHALL PROVIDE A DISCONNECT SWITCH.
10. IN A SINGLE PRIME CONTRACT, IT IS THE RESPONSIBILITY OF THE PRIME CONTRACTOR TO COORDINATE BETWEEN THE ELECTRICAL AND THE OTHER TRADES.

**ELECTRICAL EQUIPMENT CONNECTION**

|            |           |       |  |            |
|------------|-----------|-------|--|------------|
| REVISIONS: | DRAWN BY: | DATE: | PROJECT NO.:   | SHEET NO.: |
|            | CHKD:     |       | NORTH CAROLINA<br>DEPARTMENT OF ADMINISTRATION<br>STATE CONSTRUCTION OFFICE<br>301 N. WILMINGTON STREET, SUITE 450<br>RALEIGH, N.C. 27601-2827 | E-18       |

