# CHAPTER V
# TECHNICAL DESIGN & PERFORMANCE STANDARDS

Table of Contents

# DIVISION 16 – ELECTRICAL

**16050 General**

**Description**

Refer to Chapter III, Paragraph 18, Building Systems for Mechanical, Plumbing, and Electrical Building Spaces for Schematic and Design Development design considerations.

This division provides information on basic materials and methods for providing and installing electrical service, distribution, lighting, special systems, communications and controls for new construction and renovation projects at The University of North Carolina, Chapel Hill.

**Applicable Codes, Regulations, and Standards**

- The following codes (latest edition) shall apply:
  - National Electrical Code
  - National Electrical Safety Code
  - The State Building Code
  - North Carolina State Construction Office 2005 Electrical Guidelines
  - Occupational Safety and Health Act of North Carolina (OSHANC)
  - Code of Federal Regulations (CFR) 1910.269
  - Illuminating Engineering Society (IES)
- The following standards shall apply:
  - Underwriters Laboratory (UL)
  - Electric Testing Laboratory (ETL)
  - National Fire Protection Association (NFPA)
  - National Electrical Manufacturers Association (NEMA)
  - American National Standards Institute (ANSI)
  - Requirements for Fire Detection and Alarm Systems/Smoke Detectors Meeting State Requirements, Department of Insurance, State of North Carolina, Latest Edition.
  - Institute of Electrical and Electronic Engineers (IEEE)

Local utility regulations governing connections and metering require an electrical inspection certificate from the State Electrical Inspector, Department of Insurance prior to approval for final payment and before energizing any new transformers and electrical service.

Where above guidelines conflict with this specification, the more stringent of the two shall prevail.

Any and all work in streets or sidewalks will require proper permits and traffic control plans should be submitted to NCDOT, Town Engineer and UCD DPS for approval.

**Premises Wiring System Tests**

Upon completing the installation, the electrical contractor shall conduct an electrical load balance test, a system and equipment ground resistance test (maximum of 5 ohms), and system continuity tests and shall submit reports documenting such tests. Panel phases shall be balanced within 10%.

**Equipment Identification**

All equipment shall be properly identified with equipment identification, equipment controlled, electrical ratings and date of installation.

The following are recommended general notes to include in the specifications.

**Performance Tests**

Should the Designer have any reasonable doubt as to the proper functioning of any equipment installed under this Contract, at any time during the guarantee period; the Owner and/or Designer has the right to perform any test deemed practical to determine whether such equipment is functioning properly and performing at required capacity. If such tests show proper functioning, the cost of the test will be paid by the Owner. If the test indicates a deficiency in equipment capacity or performance, the Contractor shall pay the cost of the test and also make good any deficiencies shown by the test to the full satisfaction of the Owner and the Designer.

**Comment [JS1]:** This may change based on commissioning.

**Electrical Systems Training**

The instruction time periods shall be approved by the Owner and conducted during normal working hours, Monday through Friday, at the job site. Owner's facilities staff will be trained in proper maintenance and how to operate and make adjustments on all equipment. Training on specialized equipment shall be by manufacturer's authorized representative.

The Owner reserves the right to request replacement of any instructor who, in their opinion, does not demonstrate sufficient qualifications as an instructor. Final acceptance of the project will not be given until all specified training is completed.

**Acceptance Criteria**

After completion of specified training, the Contractor shall conduct the specified operation acceptance test, witnessed by the Owner's representative.

**16111 Conduits-Primary Service (15 kV)**

**Approved Contractors**

UNC-Chapel Hill Electric Distribution Systems has special requirements for any contractor or subcontractor installing duct-banks, transformer pads, switch pads, and similar facilities that will ultimately be part of its joint electric/telecommunications distribution system.

Any such contractor or subcontractor must have a North Carolina General Contractor's License with a Public Utility - Electrical - Ahead of the Point of Delivery - Unlimited Classification per the North Carolina Licensing Board for General Contractors, Rules and Regulations, North Carolina Administrative Code, Title 21; Chapter 12.

All such contractors must also be able to demonstrate to the satisfaction of the Manager - UNC-CH Electric Distribution Systems and/or his or her appointees, through references or prior project work at UNC-CH, that they have adequate, directly related experience to properly perform the ductbank work requested.

The contractor possessing the required license and meeting the experience test described must perform the work themselves.

**Applicable Codes, Regulations, and Standards:**

- The following codes (latest edition) shall apply:
  - National Electrical Code
  - National Electrical Safety Code
  - The State Building Code
  - North Carolina Construction Manual, Division of State Construction, Department of Administration, Section 112.4 Electrical.
  - Occupational Safety and Health Act of North Carolina (OSHANC)
  - Code of Federal Regulations (CFR) 1910.269
- The following standards (latest edition) shall apply:
  - Underwriters Laboratory (UL)
  - Electric Testing Laboratory (ETL)
  - National Fire Protection Association (NFPA)
  - National Electrical Manufacturers Association (NEMA)
  - American National Standards Institute (ANSI)
  - UNC-CH Electric Distribution Systems Material, Design, and Construction Specifications

**Detailed Ductbank Specifications:**

**Trenching and Excavations**

- Excavation and backfill shall conform to NC State Construction Office Guidelines except that heavy-duty, hydraulic-operated compaction equipment shall not be used.
- A tree protection plan shall be approved by the UNC Grounds Department prior to excavation. (Add Link to standard.)
- Trenches should be cut neatly, uniformly and as straight as field conditions permit, sloping uniformly to required pitch with smooth walls.
- Bottom of trenches to be smooth; uniform and free of loose dirt, rocks or other debris. Mud shall be mucked out and replaced with dry dirt or stone as needed. The bottom of the trench shall be properly compacted.
- Trench walls that have collapsed or where large rocks have been removed shall be formed with plywood to maintain a uniform side of the concrete encasement and to reduce concrete overflow.

**Back Filling**

- All back fill material shall be clean, dry, and free of rock, concrete, and other construction debris.
- Backfill shall be tamped in layers per NC State Construction Office Guidelines.
- When a ductbank is installed through cut rock; at least 3 inches of clean backfill such as sand, fine gravel or crush and run shall be placed in the bottom of the trench and properly compacted before conduits are installed.
- Any ductbank through existing or proposed asphalt or concrete must be completely back filled with flowable fill to avoid future settling.

**Rock Removal**

Rock excavation includes removal of rocks or boulders larger than ½ cu. yard in volume and that occurs in beds, ledges, stratified or unstratified masses or in singular deposits. Qualifying rock or boulders are those which cannot be removed by heavy-duty rock excavating machinery or equipment without the use of a ram hoe, symmetrical drilling, blasting or ripping.

Removal costs for rock shall be on the basis of unit prices included in the Contract Documents. A specific rock allowance may be requested on a project by project basis.

**Conduits**

All conduit runs used for primary voltage (15 kV) cables shall be PVC Schedule 40 or rigid galvanized steel as specified in project documents. Typical conduit shall have a nominal (minimum inside) diameter of six inches. Other size conduits may be required depending on the project needs. All conduits shall have one belled end per length.

Terminate all conduit end points in switching cabinets and at transformer pads no less then 2 inches and no more than 4 inches above grade or a finished slab. Use of steel conduit when required coverage is unattainable shall be approved by the UNC Project Manager and UNC-CH Electric Distribution Systems Engineering.

Terminate all PVC conduit end points in utility holes, switching cabinets, transformers, hand holes and buildings with end bells. The bell end of the conduits that enter manhole and handhole walls shall be flush with the wall. Seal conduit entrances into utility holes, hand holes and buildings on the end bell side of the entry. Plug all conduit entry end points with expandable reusable conduit plugs capable of withstanding 15 PSI minimum hydrostatic pressure. As an example, UNC Electric Distribution Systems uses blank plugs made by Jackmoon USA Inc. a division of Tyco Electronics.

**Bends and Sweeps**

All conduit field bends and factory elbows must be equivalent in strength to the attached conduit. All factory elbows shall have a minimum “standard” radius by size, as prescribed by NEMA. All field bends shall be made only with approved equipment identified for that purpose and have a minimum standard radius by size, as prescribed by NEC Articles 346 and 347.

Use of special radius bends and elbows is encouraged. Special radius bends and elbows are those which have a larger (more gentle) radius than the standard radius. Schedule 40 PVC shall be used for field bends.

The inside of conduits shall be beveled slightly when conduits are cut or when joining two different schedules of PVC conduit to prevent conductors from snagging on the inside edge.

**Dimensions**

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.

Design depth for the top surface of all duct banks is 36 inches (minimum) below finished grade or concrete.

Encase all PVC conduit in concrete, with a minimum 3 inch spacing between the outside of adjacent conduits, a minimum of 3 inches to the outside of the concrete ductbank on the sides and top, and a minimum of 3½ inches of concrete on the bottom of the ductbank . This is accomplished using only approved duct bank conduit spacers. Do not use other means, material or devices to achieve the required spacing. The UNC-CH Electric Distribution System approved duct bank spacer is the Underground Devices, Inc. “WUNPEECE” spacer, web site www. Udevices.com. No other spacer is acceptable.

Apply duct bank conduit spacers along each level of conduits no more than 5 feet apart. To provide required support in a manner which will minimize the creation of sheer joints, spacers at any given conduit level shall be staggered 1 foot relative to spacers at conduit levels above and below. Sheer joints are created when the spacers per each conduit level are applied all at the same point along the duct bank run. This creates a weak “joint” (wall of spacers) in the duct bank, due to the lack of concrete. Conduit spacers to the

earth and to ducts should be secured or anchored to prevent floating during placement of concrete. Steel or tie wires shall not be used as they may form conductive or magnetic loops around ducts or duct groups.

Electric automation and control conduits shall be placed within the open space of the conduit spacers and secured with plastic tie wraps.

All duct bank runs where the cumulative effect of field bends and factory bends or elbows exceeds 180 degrees must be approved by the UNC Project Manager and UNC-CH Electric Distribution Systems Engineering. Under no circumstances should the cumulative effect of field bends and factory elbows between termination points exceed 270 degrees.

**Concrete**

All concrete shall be 3000 PSI or greater, 28-day compressive strength, with a slump at point of placement of 4 inches maximum and 3 inches minimum.

The top surface of the concrete ductbank envelope shall be raked smooth and level.

At the end of each day's pour, stop concrete at a 45 degree angle and install reinforcing bars (minimum of six) to strengthen the transition to future duct extensions.

**Marking, Testing and Inspecting**

Mark all duct bank runs with a warning tape, installed no less than 6 inches and no more than 12 inches above the top of the duct bank concrete. Place warning tape along the approximate center line of the duct bank run. Warning 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.

Waterproof marking cord shall be installed using ½ inch wide 1250 -pound tensile test cord (marked at least every foot), equivalent to NEPTCO Inc. MuleTap Part # WP1250P, in all ducts, including spares, after thoroughly rodding, clearing and swabbing all lines free of any and all obstructions. DO NOT splice, tie or otherwise join shorter lengths together. Only a whole, unbroken length of tape to be installed in each duct.

As part of acceptance testing, all conduits, including spares, shall be mandrelled using an appropriately sized steel mandrel approved and witnessed by UNC-CH Electric Distribution Systems.

In addition to the State Electrical Inspector, UNC Electric Distribution Systems shall inspect all 15 kV primary conduit installations prior to concrete encasement or backfill. Failure to receive this inspection could result in demolition and rebuild of the duct bank.

**Telecommunications Duct Systems**

All specifications noted above in Detailed Ductbank Specifications apply to telecommunications duct systems.

Telecommunications conduit needs vary. Telecommunications utilizes multiple conduit bundles designed to fit standard size conduit spacers. These bundles are to be secured together utilizing plastic tie wraps to prevent conduit sagging, bending, and movement.

All duct banks installed for the sole use of telecommunications cables shall include a suitable locating wire.

Refer to Section16130 – Conduits Telecommunications for details associated with use of multi-cell conduits in telecommunication duct systems used as service laterals to buildings, etc. Multi-cell conduits will typically not be used between manholes and in joint electric/ telecommunication duct banks.

**Manholes**

Telecommunication, electric distribution and electric transmission manholes shall consist of preformed concrete top and bottom elements with knockouts for ductbank installations. Each manhole shall be consistent with the specifications provided by UNC-CH Electric Distribution Systems for each new installation.

Minimum cover over manholes shall be 36 inches from finished grade.

Manholes shall be left clean of debris with all ductbank entrances sealed as per specifications.

**16120 Wire and Cable**

The minimum size wire conductor is #12 AWG for premises wiring. Exception: #16 and #14 is acceptable for control and/or signal circuitry as allowed by the National Electrical Code and the Department of Insurance. Branch circuit wiring shall be sized for a maximum of 3 % voltage drop. Fully loaded multi-outlet receptacle circuits shall be assumed in sizing wiring for receptacle outlets.

- Insulation for premises wiring is THHN for dry locations; THWN for wet.
- All conductors, without exception, shall be copper. Aluminum is strictly prohibited.
- Size all neutral wires for 3 phase systems equal to or larger wire size than the phase conductors. 120/208 volt branch circuits in all labs and offices shall have a separate neutral conductor for each circuit
- No more than one conductor for each phase plus individual neutrals and an equipment grounding conductor is allowed in a conduit.
- All wireways shall contain code sized equipment grounding conductor. All power wiring shall be in conduit. Conduit shall not be run in slab except where specifically approved and indicated in plans.
- **MC, AC or "BX" cable is not allowed, .**

Electric Distribution Systems' will furnish, install, terminate, splice and test all high voltage (15 KV) cable. Cable will be single conductor, copper shielded, ethylene propylene rubber (EPR) insulated power cable rated 15 KV. Installation will include separate 600 volt neutral.

Although not prohibited by the National Electrical Code, do not mix conductors serving two separate power systems (i.e., 208/120 volt and 480/277 volt) in the same raceway, pull box or junction box. Exception: Where control wiring is a different voltage from power for the same system.

- Color code system wiring for standard clockwise rotation is shown below:
  - 208/120 volt systems 408/277 volt system
  - Phase A -- Black Phase A -- Brown
  - Phase B -- Red Phase B -- Orange
  - Phase C -- Blue Phase C -- Yellow
  - Neutral -- White Neutral -- Gray
  - Ground -- Green Ground -- Green

**16130 Conduits**

Minimum conduit (including flexible) size is 3/4" (interior) and 1" (exterior) for premises wiring (system). Exception: 1/2" flexible metal conduit not exceeding six feet may be used for fixture and small equipment drops.

Telecommunications Conduits must comply with the following:

All specifications noted in 16111 Conduits-Primary Service (15 KV) apply, except as altered by the characteristics of the Carlon Multi-Guard product line. Conduit systems for Telecommunications include at least one Multi-duct conduit for each three empty conduits installed.

In addition to standard PVC and galvanized steel conduits, Telecommunications utilizes Carlon Multi-Guard MXSS4S. This is a multi-cell conduit system inclusive of flexible bends, factory bends and accessories such as spacers, standard coupling kits, slip coupling kits, and terminator kits.

Install as per the manufacturer's instructions. All installation requirements as stated in 16111, for handling, supporting, terminating, testing and sealing procedures, apply.

**16130 Outlet Boxes**

All outlet and switch boxes used for interior wiring shall be metallic and a minimum volume of 18 cubic inches. Exception: Special application such as moisture proof or hazardous location.

**16140 Wiring Devices**

Furnish all wiring devices (i.e., receptacles and switches) of best quality manufactured by Hubell, Leviton, or equal. Snap switches shall be rated 20 amp, 120-277 volts, 60 Hertz A.C. All duplex receptacle shall be rated 20A, NEMA 5-20.

Ground each receptacle by means of a separate code size conductor connecting the receptacle ground terminal to the branch circuit panel-board ground bus. Do not rely on the conduit system for grounding.

All receptacles and fixed equipment shall have a permanent label indicating circuit and panel number.

Do not use device as junction or feed-through. Pigtail branch circuit to attach device.

**16231 Generator Systems**

Refer to Chapter III, Part C (e) 11 – Mechancial, Plumbing and Electrical Building Spaces for important information on sizing generator.

**General**

Generator system shall be Onan, Caterpillar, Spectrum Detroit or approved equal, supplied by the factory authorized distributor of the engine. The supplier shall have a parts and service facility located within 100 miles of the job site with factory-trained technicians in full time employ and a stock of spare parts.

The Contractor shall submit all data necessary to evaluate equipment suitability. Data submittal shall include, at a minimum, the manufacturer; model and catalog numbers, dimensions, construction materials, operating and performance characteristics, controls, finish any other pertinent information, and typical shop drawings.

The Contractor shall provide the Owner with three (3) copies of technical literature on all system components. The technical literature shall consist of a manual of sequential operations, recommended preventive maintenance, parts lists with recommended spares, and all pertinent controls manuals and wiring diagrams. This instruction shall include three (3) copies (minimum) of a written, bound summary of items covered for future reference. In addition, the Contractor shall have a factory-authorized service representative inspect, test and instruct the Owner's designated employees in the proper system operation and in all required periodic maintenance. Testing shall be in accordance

with NFPA 110-2002, including cycle crank and performance tests. The owner shall be given advance notification in order to witness testing. Testing shall be performed using all installed generator loads supplemented with additional load to generator's nameplate rating. Where more than one building is on a generator, all buildings' loads will be utilized. The maintenance instruction shall include three (3) copies (minimum) of a written, bound summary of items covered for future reference

**Engine Generator Set**

The prime mover (engine) shall be diesel or natural gas where approved by DOI and UNC interested parties. Diesel tank shall be sized to run 68 hours at demand load.

Equip all diesel units with a day tank unless otherwise approved by the Facilities Services Department. Day tank shall have secondary containment with audible alarm,

Furnish a liquid cooled (radiator cooling system) engine with thermostatic temperature control and high coolant temperature shutdown.

The engine is the product of an established United States of America engine manufacturer and is a model that has been manufactured and successfully operated in similar service for a period sufficient to thoroughly establish its reliability.

Exhaust silencer shall be rated critical grade.

Locate exhaust away from the air intake area of the building and adjacent buildings.

The governor shall be electronic, adjustable isochronous, with speed sensing.

Electronic fuel ignition control shall be provided.

Provide permanent magnet excitation.

Provide a 4-pole alternator, with drip-proof construction, revolving field type, protected and sized for maximum motor starting loads. Insulation shall be Class F per NEMA MG1-1.65. Rotor is dynamically balanced and permanently aligned to engine by flexible disc coupling. Voltage regulation shall be solid state temperature compensated with phase controlled sensing. Provide heavy duty ball bearings, permanently lubricated.

Voltage regulator shall be solid-state type, separate from exciter.

The generator engine shall have subtransient reactance of 12 % maximum.

Two-thirds pitch stator winding and fully linked amortisseur winding shall be provided.

Location of remote annuciator and/or data link shall be determined with the building occupant and Project Manager.

Contain the engine-generator controls in a shock mounted cabinet; use digital controls and metering where practical. Provide the following minimum controls and metering:

- AC Voltmeter (2% accuracy) 3 1/2"
- AC Ammeter (2% accuracy) 3 1/2"
- Phase Selector Switch/Current Transformer each Phase
- Frequency Meter

- Running Time Meter
- Oil Pressure Gauge
- Water Temperature Gauge
- Battery Charging Ammeter
- Voltage Adjusting Rheostat
- Auto-Start-Stop Control
- Safety Shutdown and Alarm Light for:
    - Highwater temperature
    - Low oil pressure
    - Engine overspeed
    - Engine overcrank
- Auto-Off-Reset Switch
- Panel Lighting
- Molded Case Main Circuit Breaker

Provide 4-pole automatic transfer switch solid state controlled, rated for all classes of loads, both inductive and non-inductive, and mechanically held on normal and emergency. Transfer switch shall have bypass isolation for all critical loads. Closed transition transfer switch is optional, to be determined during design with building representative.

- The transfer switch solid state control system shall include the following minimum features:
- Time delay on engine starting - adjustable from 0 to 6 seconds.
- Time delay on transfer from normal to emergency adjustable 0 to 120 seconds.
- Time delay on retransfer from emergency to normal adjustable from 1 to 30 minutes.
- Time delay on stop - adjustable 0 to 8 minutes
- Under frequency - under voltage relay for emergency source. Prevents transfer until generator output reaches pre-set levels.
- Test switch to simulate power outage.
- Main shaft auxiliary contacts: Minimum 1-N.O. and 1- N.C.
- Solid state battery charger. 3 ampere minimum charge rate with automatic adjustable float setting.
- Load shed feature shall be provided on transfer switches serving optional loads. Priority of optional load shedding shall be determined during design and indicated on plans.

Install diesel fuel tanks above ground; provide secondary containment with audible alarm.

Filling of Fuel Oil Tanks: The Contractor shall fill fuel oil tanks immediately after installation, and refilled immediately prior to acceptance of the building.

**16269 Variable Frequency Drives**

**Quality Assurance**

Provide warranty period for VFDs and any bypass for 18 months minimum, inclusive of parts, travel, labor and shipping required for repair from date of startup

The power converter section of every VFD shall be tested with an actual AC induction motor while loaded and temperature cycled within an environment chamber at 40˚ C (104˚ F).

Power line conditioning shall be provided for VFDs.

**Products**

If more than one VFD is included in this project, all VFDs shall be products of the same manufacturer, VFDs shall be by Square D Company, Class 8839, Type ATV-56, or equivalent as manufactured by ABB, or Danfos-Graham.

The Manufacture must provide to the University, on digital disk, the programming software which will enable the University service personnel the use of a laptop computer to set up any and all of the parameters of the drive. The software must provide all the capabilities which are provided by the unit keypad as a minimum. The drive must be equipped with all equipment and software to accommodate laptop connection.

The Manufacture must ensure the University service personnel has unlimited access to the manufacturer's technical support staff.

The VFD shall include a power converter to convert the input AC power to an adjustable frequency and voltage, as defined in the following sections.

The input power section of the power converter shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency AC line power to fixed DC voltage. This power section shall be insensitive to phase rotation of the AC line.

The output power section of the power converter shall change fixed DC voltage to adjustable frequency AC voltage, utilizing insulated gate bipolar transistors (IGBTs).

Pulse type VFDs shall be a minimum 12 pulse type where significant VFD load is present on an emergency generator or in other sensitive electronic equipment environment. As an alternative, harmonic mitigation that complies with IEEE 519 analysis may be specified. Specifications for the acceptable mitigation will be discussed and agreed to with user.

**Construction**

The VFD shall be composed of the power converter section and the associated combination enclosure, and each shall be housed in NEMA Type-1 enclosures. Both shall be mounted on a single panel, with the power converter section mounted above the combination enclosure.

The combination enclosure shall provide dedicated user terminals for power and control device connection. It shall include the disconnect, current limiting fuses, operator controls, user terminal strip connections, and bypass controls and contactors. User power termination within the power converter section is not acceptable.

Provisions shall be included for padlocking the disconnect in the OFF position.

Current limiting fuses shall be wired to the power converter input, and shall be installed in the combination enclosure.

The power converter section shall include an internal cooling fan (with dual ball bearings), with a MTBF rating of at least 40,000-hours.

**Application Data**

The VFD shall be sized to operate a Variable Torque load.

The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

- Environmental Ratings

- The VFD shall be designed to operate in a pollution Degree-2 environment. The VFD shall meet IEC 664-1 and NEMA ICS 1 Standards.
- The storage temperature range shall be -25˚ C to 70˚ C (-13˚ F to 158˚ F).
- The maximum relative humidity shall be 95% at 40˚ C (104˚ F), non-condensing.
- The VFD shall be rated to operate at altitudes less than or equal to 3,300 ft (1000m). For altitudes above 3,300 ft (1,000 m), de-rate the VFD by 1.2% for every 330 ft (100m).
- The VFD shall meet the IEC 68-2 operational vibration specification.

o Performance Ratings
- The VFD shall be designed to operate (±) 10% of rated voltage
- The VFD shall operate from an input frequency range of 47.5 to 63-Hz.
- The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.
- The efficiency of the VFD at 100% speed and load shall not be less than 96%.
- The variable torque rated VFD over current capacity shall be not less than 110 % for 1-minute.
- The output carrier frequency of the VFD shall be programmable at 2, 4 or 10-kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency. VFDs with an operable carrier frequency above 10-kHz shall not be allowed.

o Protection
- Upon power-up, the VFD shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.
- The VFD shall be UL 508C listed for the available fault as determined available by the designer, but no less than 22,000-A rms fault current for 460 V drives. For 208-VAC distribution systems, the UL508C listing shall be for 8,800-A rms of minimum available fault current. The Power Converter shall meet the short circuit specifications defined by NEMA ICS 7.1.09, and have the value listed on the VFD nameplate.
- The VFD shall be protected against short circuits between output phases and to ground.
- The VFD shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds (12 cycles).
- The VFD shall have a programmable ride through function which will allow the logic to maintain control for a minimum of one second (60 cycles) without faulting.
- For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 5 programmable restart attempts. The programmable time delay before restart attempts will range from 1 second to 600 seconds.
- Upon loss of the analog input speed reference signal, the VFD shall fault and / or operate at a user-defined speed set between programmed low- and high-speed settings.
- The VFD shall include solid-state protection that is UL listed and that meets UL 508 C as a Class 10 overload protective device and meets IEC 947. The minimum adjustment range shall be from .45 to 1.05% of the current output of the VFD.
- The output frequency shall be software -controlled to reduce frequency (fold back) when the motor is overloaded.
- There shall be three skip frequency ranges that can each be programmed to a bandwidth of 2 or 5 Hz. The skip frequencies shall be programmed independently, back to back, or overlapping.
- The VFD shall include 'output phase imbalance' fault indication.

o Adjustments & Configurations
- The VFD will be factory programmed to operate all specified optional devices.
- The acceleration and deceleration ramp times shall be adjustable from 1 to 999 seconds.
- The memory shall retain and record run status and fault type of the past 8 faults.
- The software shall have a no load function that, when selected, will reduce the voltage to the motor for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.

o Keypad Display Interface
- The keypad display interface shall enable adjustments to the VFD via a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics shall be in plain English.

- The display will be a high resolution, LCD back-lit screen capable of displaying graphics such as bar graphs as well as six lines of 21 alphanumeric characters.
- The VFD model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification portion of the LCD display.
- The keypad display shall be configured to display one or two bar graphs with numeric data that are programmable by the operator. As a minimum the programmable outputs shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference and machine speed.
- The keypad display shall consist of programmable function keys that allow both operating commands and programming options to be preset by the operator. A hardware selector switch shall allow the terminal keypad to be locked out from unauthorized personnel.
- A RUN key and a STOP key will command a normal starting and stopping as programmed when the VFD is in keypad control mode. The STOP key must be active in all control modes.
- The VFD shall have three LEDs mounted on the front panel to indicate functional status. A green LED will verify that the VFD power supply is on. A red LED indicator will indicate an VFD fault. A yellow LED indicator will designate a pending fault condition.

**Operator Control Interface**

The control power for the digital inputs and outputs shall be 24 VDC.

The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.

Pull-apart terminal strips shall be used on all logic and analog signal connections in the power converter.

Input requirements; four isolated digital logic inputs and two isolated analog inputs (one 0 - 10VDC speed potentiometer and one 4-20mA speed reference).

Output requirements; two digital logic outputs, two voltage-free relay output contacts (fault status and a programmable drive run), and two isolated 4 – 20 mA analog outputs that can be selected and assigned in the software (and be proportional to the following motor characteristics: frequency, current, power torque, voltage and thermal state ).

The combination enclosure shall have the following dedicated operator controls:

- Hand-Off-Auto switch
- Manual Speed Potentiometer
- VFD-Off-Bypass switch
- The hands-off-auto function which provides seamless transfer from EMCS control to hand control and back, without interruption of motor speed on transfer...

The optional 120 VAC smoke purge relay shall be installed in the combination enclosure, and shall enable the VFD to be sequenced in accordance with local fire protection codes. A user-supplied 120 VAC signal will switch the VFD to 60 Hz operation for maximum fan motor speed. If drive bypass is supplied, the smoke purge relay will isolate the VFD and run the fan motor full speed on bypass

The combination enclosure shall also include terminal point connection for fire /freeze stat interlock, to prevent drive or bypass [if supplied] operation.

VFDS shall be furnished with a LonTalk compatible FTT-10A compatible transceiver

**Drive / Bypass Contractors**

VFS with bypass mode shall a drive disconnect, a two contactor bypass for full speed operation, and isolation barriers between the VFD and bypass. Specify VFD's with bypass when installed on pump or fan motors.

The combination enclosure shall include a pair of IEC rated bypass contactors (complete with thermal overload relays) to isolate the VFD output during the bypass mode and to coincidentally provide line power directly to the motor. It shall also include fuses on the line side of the VFD to enable isolation, a circuit breaker disconnect, control circuit transformer, motor flux decay timer and VFD/OFF/BYPASS switch. The operator shall have full control of the bypass contactors by operation of the combination enclosure mounted selector switch. The bypass contactors shall be in the same enclosure as the drive.

**Harmonic Analysis**

Refer to IEEE 519. A harmonic analysis has been performed by the electrical design engineer to approximate the total harmonic voltage distortion (THD) at the point of common coupling (defined to be on the secondary side of the transformer). If input line reactors are required to ensure a maximum harmonic voltage distortion level of 5%, they shall be provided in separate NEMA-1 enclosure, and sized as follows; [input line reactor size]. The following table can be used as a quick-check to approximate the need for line reactors:

| THD (Voltage) of 5% or Less | |
|---|---|
| Utility Transformer KVA Ratings | Max. % Load Ratio =<br><br>Total VFD HP / Transformer KVA |
| 112.5 | 44 |
| 150 | 40 |
| 225 | 35 |
| 300-750 | 40 |
| 1000 | 37 |
| 1500 | 28 |
| 2000 | 24 |
| 2500 | 22 |

**Execution**

Verify that the location is ready to receive work and the dimensions are as indicated.

Do not install the VFD until the building environment can be maintained within the service conditions required by the manufacturer.

Before and during the installation, the VFD shall be protected from site contaminants.

Installation shall be in compliance with manufacturer's instructions, drawings and recommendations. Do not install the VFD in the air handling unit.

The VFD manufacturer shall provide a factory certified technical representative to inspect the contractor's installation, and to test and start-up the VFD(s) furnished under this specification for a maximum total of ONE-HALF day per VFD. The start-up service shall be quoted as a separate line item.

All pilot devices shall be tested to verify proper operation. Documentation shall be furnished at the engineer's request.

**Training**

A one-day on-site training course shall be provided by a representative of the VFD manufacturer to plant and/or maintenance personnel.

**Documentation**

The VFD manufacturer shall supply a comprehensive 8-1/2" x 11" spiral bound instruction-installation manual that includes wiring diagrams, layout

**16271 Transformers - Pad Mounted**

Transformers shall be dead front, loop feed, pad mounted design. UNC Electric Distribution Systems shall provide transformers for connection between the UNC 15 kV primary cable system and the building service. These transformers will be in accordance with the latest version of UNC Electric Distribution Systems General Specification No. E0006.

- UNC Electric Distribution Systems shall provide and install connectors to terminate contractor installed service conductors on the transformer secondary spade terminals.
- UNC Electric Distribution Systems shall make the final service conductor connections to the transformer secondary spade terminals.

The costs of service transformers are included as part of the project cost. Electric Distribution Systems will provide the cost for the installation to the project designer for inclusion in the project.

The contractor is responsible for:

- Proper installation of the secondary/ service conductors which shall include accurate cable phasing and marking, cutting conductors to the proper length, and megometer testing for any insulation problems, short circuits, or cross phasing connections.
- For contractor installed direct buried ground loop, grid, or counterpoise requiring buried connections, these connections shall be exothermic weld type connections. This applies to both transformers and primary voltage switchgear grounding.

**16341 Primary Voltage Switchgear**

Normally, new connections to the electric distribution system are made at switches. Locate these switches in utility holes or surface mounted on a concrete box pad. Information regarding the switch type and location will be provided to the project designer at or near Schematic Design review time.

Since these switches are part of the electric distribution system, the design associated with switch installations is the responsibility of Electric Distribution Systems. Coordinate any proposed connection to the system with Electric Distribution Systems. The costs of system connections, including additional switches needed for the connection, are included as part of the project cost. Electric Distribution Systems will provide and install system switches and will provide the cost for the installation to the project designer for inclusion in the project.

**16431 Alarm and Detection System Central Alarm Receiving System**

The University has a Central Alarm Receiving System (CARS) located in the UNC Security Services Office capable of supervising fire, security, equipment or other system signals from any campus location. All fire, security, equipment signals shall transmit an alarm signal to this location by means of a digital communicator.

All security alarm systems and any special monitoring systems shall report to the CARS via a Digital Communicator. All fire detection and alarm systems shall report to the CARS via a dual line Digital Communicator. Equip all communicators with a locking cabinet and battery back up system. The report shall contain both alarm and trouble conditions. Fire detection and alarm systems shall report general alarm, system trouble, water flow and supervisory signal. Wire the communicator to the nearest building telephone closet using a four wire cable (2 pair, 22 gauge) in 3/4" conduit with ten feet (10') of excess at the closet end, terminated in the communicator, and identified at both ends. The University shall connect to telephone lines. For interconnections, notify the Facilities Services Electronics Shop (919-962-1076) to program the central receiver and perform a joint acceptance test to ensure proper operation.

**16441 Service and Distribution**

Equip main distribution panel with digital metering to measure the following:

- Voltage: Phase to neutral and phase to phase.
- Amperage: (True RMS) - each phase and neutral. Fundamental and harmonics through 19th.
- Kilowatt Demand
- Power Factor

Mount one copy of the electrical riser diagram near the main switchgear in the M.E. Room under clear protective material. For partial renovations an updated copy of the complete electrical riser shall be provided in plans and mounted in main switchgear room by contractor.

**Temporary Services**

Standard temporary service is provided for the sole purpose of providing construction power for only the duration of the construction project. All such services shall comply with NESC, Section 1 and NEC Article 230. Such service does not alter service entrance code and safety requirements and shall not be used as a replacement for permanent service.

Standard Temporary Services are typically overhead, but may be underground, depending upon the construction site location. UNC Electric Distribution Systems' preferred temporary service is 120/240 single phase, furnished from an overhead transformer. Overhead three phase 120/208, 120/240 and 480 volt service can be made available. In addition, underground three phase 120/208 and 277/480 volt service can be made available. Although underground 120/240 volt single phase service can be made available, it is highly discouraged due to the associated cost.

Temporary service costs, payable in advance, are based upon all non-reusable materials, labor to install and remove and appropriate overheads. This cost is a fixed cost, i.e., it is a lump sum cost and must be paid prior to UNC Electric Distribution Systems providing the temporary service.

Temporary services 200 amperes and under are metered with self contained meters. Therefore they only require a standard meter base, which is furnished by UNC Electric Distribution Systems. Temporary Services over 200 amperes require current transformers for metering. This will require a CT cabinet, furnished by the contractor.

The contractor should contact UNC Electric Distribution Systems for the location of temporary service equipment, the appropriate size of any CT cabinets, and associated costs for this service. Temporary service is provided at a location just inside the construction site fence at an agreed point of delivery as approved by UNC Electric

Distribution Systems. Any damage to or relocation of the temporary service required by the contractor is at the contractor's expense.

Electric Distribution Systems will provide one temporary service per site, unless the site qualifies for more than one as described in NEC Article 230. If more than one temporary service is required, the cost for the second service is payable in advance.

The contractor is responsible for coordinating and acquiring all local inspections and filing an application for service with the Energy Services Business Office. This filing date must allow adequate time for Electric Distribution Systems to provide the desired service. The contractor who applied for each temporary service will be solely responsible for paying all monthly billing associated with that service. No allowance for such billing will be assumed in the overall electrical bid for any project.

The contractor shall provide a structure of sufficient strength and height to accept the appropriate overhead or underground supply conductors and to comply with appropriate local and NEC codes for height, voltage, clearances and utilization of power.

**Utility Metering**

All electrical installations are typically metered for KWH/KWD for utilities billing purposes at the transformer. Electric Distribution Systems will furnish and install all pad mounted transformer metering equipment including meter, meter base, current transformers, potential transformers and wiring. Cost of this installation will be included in the project cost.

Submit all electrical installations requiring special metering, to Electric Distribution Systems for approval.

**16442 Panelboards**

All panelboards are bolt-in type best quality as manufactured by Square "D", ITE, General Electric, Cutler Hammer or Siemens. Panels that could accept plug-in or piggy-back style breakers shall not be accepted. All current carrying components shall be copper.

Do not install single phase panels in a three phase system.

Panelboards serving power loads in office, computer facilities, and laboratories shall have full size neutral with neutral and grounding bars sized to accommodate individual neutals and equipment grounding conductors..

Design distribution panelboards for laboratory spaces to allow for 66% growth (e.g. 40% space breaker slots). Other panelboards shall allow at least 50% growth (e.g. 34% spare breaker slots). In this regard, the spare breaker slots are very important. Use of 42 circuit panelboards is encouraged.

Where flush panels are approved by the Project Manager, a spare 1 in. conduit shall be provided for every three spaces or spare circuits remaining in panel.

**16461 Transformers, Dry Type**

**General**

Dry type transformers shall be Nema TP-1 rated, tested per Nema TP-2 and labeled per Nema TP-3. If a large amount of non-linear load is expected to exist, transformers K –rated transformers may be specified. Do not specify transformers with K rating greater than 13.

Transformer coils shall be of the continuous wound construction and impregnated with nonhygroscopic, thermosetting varnish.

Transformers 15KVA and larger shall have a minimum of 6-2.5% full capacity primary taps for 480V primaries. Designate exact voltages and taps on the plans or the transformer schedule.

**Ratings**

Transformer insulation shall be a UL recognized 220 deg. C system. Neither the primary nor the secondary temperature shall exceed 220 deg. C. at any point in the coils while carrying their full rating of non-sinusoidal load. Transformers are to be UL listed and labeled for (K-4) or (K-13), defined as the sum of fundamental and harmonic 1h (pu)2 h2 per UL 1561. Transformers evaluated by the UL K-Factor evaluation shall be listed for (115 deg C) or 80 deg C average temperature rise only. Manufacturers rating K-factors with temperature rise of 150 deg. C. rise are not acceptable.

K-Factor rated transformers shall have an impedance range of 3% to 5%, and shall have a minimum reactance of 2% in order to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

**Construction**

Construct all cores with low hysteresis and eddy current losses. The core flux density shall be well below the saturation point to prevent core overheating and excessive sound level caused by harmonic voltage distortion.

Transformers shall be common core construction. Transformers utilizing more than one core, or Scott T-connections, are not acceptable.

For K-rated transformers, size transformer secondary neutral terminals for 200% of the secondary phase current.

Ventilate the transformer enclosures and fabricate of heavy gauge, sheet metal construction. Finish the entire enclosure utilizing a continuous process consisting of degreasing, cleaning, and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking cycle to insure uniform coating of all edges and surfaces. The coating is UL recognized for outdoor use. The coating color shall be ANSI 49.

The maximum temperature of the top of the enclosure shall not exceed 50 deg C. rise above a 40 deg. C. ambient.

For K rated transformer, supply transformers with a quality, full width electrostatic shield resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits.

- Common Mode: 0 to 1.5 KHZ-120 dB; 1.5 KHZ to 10 KHZ - 90 dB; 10 KHZ to 100 KHZ - 65 dB, 100 KHZ to 1 MHZ - 40 dB
- Transverse Mode: 1.5 KHZ to 10 KHZ - 52 dB, 10 KHZ to 100 KHZ - 30 dB; 100 KHZ to 1 MHZ - 30 dB.

Sound levels shall be guaranteed by the manufacturer not to exceed the following:

- K-4 rating: 15 to 50 KVA - 45 dB; 51 to 150 KVA - 50 dB; 151 to 300 KVA - 55 dB; 301 to 500 KVA - 60 dB.
- K-13 rating: 15 to 50 KVA - 43 dB; 51 to 150 KVA - 47 dB; 151 to 300 KVA - 52 dB; 301 to 500 KVA - 57 dB.

**Standards**

All insulating materials are in accordance with NEMA ST20 standards for 220 deg C. UL component recognized insulation system. Manufacture and test transformers in accordance with ANSI Standard C57.12.91 and NEMA ST20. Energy efficient transformers shall be considered.

Transformers of 500 KVA or smaller shall be listed by Underwriters Laboratory.

## 16511 Interior Lighting Fixtures

**General**

Interior spaces should not be over lit. Over lighting is a primary complaint among office workers. Day lighting shall be incorporated to the greatest extent possible in all applications and combined with daylight and occupancy sensors to minimize the use of electric lighting and reduce building cooling load. Where fluorescent tubes are provided without dimmers, inboard/outboard systems should be incorporated to provide greater lighting flexibility. Minimum ambient lighting levels should be coupled with task lighting as needed.

Luminaire enclosures shall be designed with acrylic or other UL approved plastics. Glass globes are not acceptable in any application.

Provide high impact plastic light globes, for inside or outside use; avoid glass. Do not use "egg-crate" louvers.

Linear fixtures shall be modular in design, such that fixtures are capable of being field-converted to individual 8 foot lengths or connected end-to-end, with manufacturer provided end caps and associated hardware.

**Interior**

Use 277V for lighting where 480Y/277V is available. This is the most cost effective approach.

Do not mix 120V and 277V for lighting applications for safety considerations.

Provide local control capable of dimming or capable of reducing lighting levels by 1/2 and 2/3 in all building areas, except in corridors, MEP closets and other areas agreed to with the Project Manager.

Appropriate automatic cutoff for interior lighting per ASHRAE 90.1 shall be discussed during schematic design phase and agreed to by all interested parties no later than Design Development submittal. Interested parties include UNC Project Manager, Building Representative and UNC Facilities Services. Wall mounted occupancy sensors shall only be used in small individual spaces where any arrangement of furniture would not block sensor.

Designer shall consider using photocells and dimmable ballast in perimeter rooms to turn off lights when the available daylight augments the lighting level. Consider using occupancy sensors, automatic time clocks or other automatic cut-off controls in all buildings.

**Lighting Fixture Applications**

All applications where occupants use visual display terminals use indirect lighting fixtures, indirect linear and/or pendant types with multiple switching or dimming capabilities. For example:

- General offices
- Classrooms

- Laboratories
- Locate a fixture over the edge of the lab bench on each side of the aisle
- Use batwing or bilenteral lenses for under-cabinet or shelf-hung luminaries

For all new construction and renovation projects that require lighting fixture replacement in the above applications, use fixtures with T-5 or T-8 fluorescent lamps.

**Lighting Level Guidelines**

Unless safety and security requirements dictate greater illumination or specific visual tasks require either more or less illumination, lighting designs shall conform to the recommendations of the Illuminating Engineering Society Lighting Handbook. Typically the lower to mid-range recommended IESNA level is required. Where needed, task lighting can be added to systems furniture. Specific footcandle level goals for spaces shall be agreed to by interested parties no later than DD submittal.

**Lighting of Large Interior Areas**

Use High Intensity Discharge (HID) lighting for all warehouse, For gymnasium and similar applications, use metal halide High Intensity Discharge (HID) luminaries. Design shall conform to the recommendations of the Illuminating Engineering Society of Lighting Handbook.

For warehouse and similar areas, use metal halide or color corrected high-pressure sodium with a temperature rating of not less than 2500 Kelvin. Design for an illumination level of 30 foot-candles with special allowances for specific tasks.

**Lighting Control**

For indirect and direct fluorescent fixtures, use two tubes or three tubes to achieve multiple light level capabilities where dimming is not provided. Provide wall-mounted switches for local control.

In lengthy open office areas, provide separate lighting control for every four or five workstations.

Where dimming is provided, dimming system shall be capable of interfacing with photocells, time clocks and occupancy sensors for additional automatic cut-off of lights.

Design automatic cutouts with the following criteria:

Small classrooms, individual offices, conference rooms, auditorium, library stacks and other areas with direct line of sight – provide infrared motion detectors to automatically turn off lights after a specific period of time when not in use. Ceiling mounted ultrasonic detectors shall be considered in areas without direct line of sight such as warehouses.

Public areas such as reception rooms, waiting rooms and main offices – use occupancy sensors to control only the outboard tubes of two-tube and three-tube fixtures. This will avoid the appearance of these spaces being “closed for business” when the sensor has simply not detected motion and has turned off the lights. The other tubes of these fixtures will be controlled by switch only in these installations.

Buildings having regularly occupied hours shall be provided with time clocks or equal programmable timed control.

Provide local occupant override of all automatic shut-off control with override time as agreed to by Project Manager and building occupant.

**Lighting Maintenance Considerations**

The lighting design must address accessibility for re-lamping, cleaning and other maintenance procedures. Design to the following guidelines:

Do not locate fixtures directly over hazardous chemicals or mechanical equipment. Install fixtures on the perimeter of such equipment and properly directed.

The Designer shall make special provisions for solving the maintenance problem associated with lamps located in high ceiling areas.

Mount stairwell fixtures so that maintenance personnel can reach them safely from an 8' or shorter ladder.

**General Use Fluorescent Fixtures**

Linear fluorescent lighting fixtures are preferred for general interior lighting. Provide electronic ballasts that conform to the following specifications:

- Provide ballasts that are electronic type and operate lamps at a frequency above 20 k hz.
- Provide ballasts that are specifically designed to operate lamps specified.
- Ballasts shall operate from 60 Hz input source of 120 or 277 volts, as appropriate and tolerate sustained variations of +/- 10% with no damage to the ballasts.
- Ballasts shall provide transient immunity as specified by ANSI C82.41, Location Category A1.
- Ballasts shall provide starting sequence consistent with ANSI standard C82.11.
- Ballasts shall operate lamps with no visible flicker (less than 5% flicker index).
- Ballasts shall operate as a parallel circuit allowing remaining lamp(s) to maintain full light output if one or more lamps fail (except T12 High Output).
- Ballasts shall tolerate sustained open circuit and short circuit output conditions without damage to the ballasts.
- Provide ballasts that are: UL listed as Class P and for indoor use or zero degrees rated for outdoor applications
- Ballasts shall tolerate operation in ambient temperature up to 105 deg F (40 deg C) without damage.
- Ballasts shall comply with limits of FCC Part 18, Subpart C Limits for Non-Consumer Equipment for EMI and RFI.
- Ballasts shall have Power Factor greater than .90. Power Factor for High Performance (HP) models shall be greater than .98.
- Lamp Current Crest Factor (ratio of peak to RMS lamp current) is 1.7 or less in accordance with lamp manufacturer's recommendation and ANSI C82.11.
- Ballasts shall have a Ballast Factor greater than .85 per ANSI C82.11. Ballast Factor for Low Wattage (L) models is greater than .77.
- Input current Total Harmonic Distortion shall not exceed .10.
- Provide fully encapsulated (potted) ballasts to ensure maximum thermal and structural integrity.
- Manufacturers shall provide written warranty against defects in material or workmanship, including replacement, for five years from date of manufacture.
- Manufacturers shall have manufactured electronic ballasts for at least ten years with a documented low failure rate.
- Provide ballasts manufactured in North America by Magnetek, Motorola, Osram/Sylvania, GE/Valmont (or approved equal).

- All lamp types specified shall be available on State Contract. See www.doa.state.nc.us/PandC/285b.pdf

For general use indoor building applications not using visual display terminals, use the following fixtures:

- 2' x 4' lay-in fixtures equipped with listed components:
  - T8 3500 deg. Kelvin fluorescent tubes.
  - Electronic ballast(s) with input wattage (for two lamps) equal to less than 61 watts each.
- 2' x 2' lay-in fixtures, equipped with listed components:
  - T17, 3500 deg. Kelvin fluorescent straight tube
  - Electronic ballast.
- Indirect Lighting equipped
  - T8 or T5, 3500 deg Kelvin fluorescent tubes.
  - Electronic ballast(s) with input wattage (for two lamps) equal to less than 61 watts each.

**Office, Classroom and Computer Lab Fluorescent Fixtures**

For all spaces using visual displace terminals use the indirect lighting as indicated above is preferred where ceiling height is available. If there is insufficient ceiling height for indirect lighting, confirm acceptable fixture with project manager.

Provide dual level switching where dimmable fixtures are not used.

**Exit Lights**

Continuously illuminated Exit signs shall utilize LED- technology with red diffuser to give appearance of full stroke lettering (similar to those manufactured by Exitronix, Emergilite, Trace Lite Corporation or approved equal).

The fixture is designed for single or double face requirements, universal wall surface, end or ceiling mounting, and all directional arrow needs. The housing shall be white or black with stencil red lettering.

Where battery provides the emergency back-up, lighting shall be self-diagnostic. Centralized battery back-up versus individual battery backup to be agreed upon during design by interested parties. Where emergency generator backup is available, battery backup shall not be added, unless agreed to by all interested parties.

**No other light sources are acceptable.**

**Classrooms for Multimedia Presentations**

Current teaching methods use a variety of media to present course material. Slide projections, personal computer displays, overhead projections, VCR tapes and video laser disc projections are a few of the technologies currently used. The classroom lighting system must be versatile to provide an appropriate environment for these technologies as well as the traditional lecture in front of a chalkboard. At the same time, the design of the lighting system must be simple enough to allow rapid and intuitive adjustment of lighting levels to suit this variety of media. All multimedia classrooms, auditoriums and conference rooms shall have lighting systems that allow for various lighting levels and control glare with highlighting features necessary to present the material. Double switched indirect linear fluorescent fixtures described above constitute the primary source of lighting in these rooms

Make provisions for dimming to enhance the use of various projected materials. Use fluorescent dimming ballasts in architectural dimming applications, capable of dimming to 1% of full light output. Ballast and controls must be by the same manufacturer.

Provide separate controls for appropriate fixtures to eliminate over lighting of projection screens and to provide proper highlight illumination of marker boards and lecterns.

To provide simplicity of operation, eliminate standard 3-way and 4-way switching systems. Provide multiple zone, multiple scene preset, and programmable lighting controls in all multimedia rooms. For less than six zones, wireless controls shall be used.

**16521 Site Lighting**

Exterior lighting constitutes the first line of defense in the overall security and safety plan of the campus. It provides the needed visibility for vehicles and more importantly, pedestrians to safely travel around the campus. At the same time, lighting that illuminates perimeter neighborhoods or the night sky is actively avoided.

Exterior lighting typically falls into the following categories:

- Streets
- Parking lots
- Walkways
- Athletic
- Common areas surrounding buildings.

It is the goal of the University to preserve the ambiance of the campus while ensuring well-lit areas of travel about the campus. This requires the consistency, as is feasible, of fixture types and luminaries. The availability of several voltages requires special attention in design. There may be multiple voltages within any one particular area. Typical voltages are 120, 208 and 277.

All street and large surface parking lot lighting is high-pressure sodium (HPS) unless otherwise approved by UNC Campus Lighting Master Plan Committee (CLMPC). New and or replacement fixtures shall confirm to existing fixtures in and around the general area under consideration and shall be of equal or better quality. As a minimum, lighting levels should conform to those put forth by the Illuminating Engineering Society of North America. Temporary lighting may be required during the construction phase to ensure a safe area at night. Temporary lighting will be the responsibility of the project.

All pedestrian pole lighting is ceramic metal halide with “Old Standard” style approved by CLMPC.

Athletic field lighting shall be metal halide fixtures. The poles, fixtures, operating voltage, and power sources or feeds shall be specifically designed for each particular installation.

All outdoor fixtures shall be photocell relay operated. Multiple lighting fixtures should be on a contactor that controls all lights within an area.

**Lighting Fixture Types**

Lighting in relationship to a new or remodeled facility may typically involve:

- Removal and replacement of existing fixtures
- Addition of new self standing fixtures
- Addition of new wall mounted fixtures

**Removal of Existing Fixtures**

It may be necessary to remove some existing fixtures to facilitate the transition between a new fixture and the existing fixtures or to improve the illumination level. UNC Electric Systems personnel accomplish removal of all existing fixtures. Associated cost for this work is to be included within the project budget.

There are many fixtures on campus that are very old and almost impossible to replicate. Great care needs to be exercised when handling these fixtures.

Fixtures may or may not be all on one circuit. Use appropriate breakers and contactors in conjunction with rated photocells.

**Addition of New Free Standing Fixtures**

When the need arises for adding new freestanding fixtures, care must be given to ensure uniformity in fixtures and lighting levels with surrounding fixtures and lighting levels. Detail should be given to all obstructions that result in a "cutoff" of the required light pattern. All new freestanding fixtures to be approved by CLMPC. UNC Electric Distribution prefers that power be supplied to all fixtures from the respective building load center.

**Addition of New Wall Mounted Fixtures**

When the need arises for mounting fixtures on an outside wall of a building, design the lighting system to ensure adequate lighting levels without creating glare or nuisance lighting into residential rooms or other areas. Mount these lights for ease of maintenance and connect to a source in the building load center. Coordinate with UNC Facilities Planning and UNC Electric Distribution, prior to preliminary design, regarding the following:

- Available voltages and sources.
- Fixture styles and types.
- Pole placement and heights.

The UNC Campus Lighting Master Plan Committee (CLMPC) approves all selections for site lighting. UNC Electric Distribution Systems provides standards, approves selections and ultimately maintains all outside, pole mounted area, walkway, parking lot, street, and athletic lighting on the UNC campus properties. For projects which involve typically less than five lights, UNC Electric Distribution Systems may elect to provide materials and installation using project funding. Projects involving larger numbers of lights should be included in the requirements for the electric contractor and are subject to Electric Distribution Systems approval and inspection. For more details on lighting, see relevant section of the University's Development Plan at http://www.fpc.unc.edu/DevelopmentPlan/

Consideration shall be given to specifying exterior lighting such that exterior luminaries with more than 1,000 initial lamp lumens are shielded and all luminaries with more than 3500 initial lamp lumens meet the Full Cutoff IESNA Classification. In addition, consideration shall be to specifying luminaries within a distance of 2.5 times its mounting height from the property boundary to have shielding such that no light from those luminaries crosses the property boundary. (IESNA RP-33-99).

Furthermore, lighting should be designed to reduce light pollution to the night sky. For more details on light pollution and light trespass, see the Illumination Engineering Society of North America's Recommended Practices for outdoor lighting (IESNA RP-33-99) or reference the presentation by the Northwest Energy Efficiency Alliance and the Lighting Design Lab at:

http://www.lightingdesignlab.com/commercial/LEED_Exterior.pdf

All outside lighting, except athletic lighting, shall be high pressure sodium (HPS) fixtures.

Operating voltage for pole mounted lighting shall be 120 volts. Voltages up to but no more than 277 volts may be used with special approval by the Manager of UNC Electric Distribution Systems.

The electric source or feed for outside lighting shall be a minimum of one 60 amp, 240 volts, two pole circuit wired from a breaker in the building to a weather proof enclosure mounted on the exterior of the building. Within the enclosure shall be an electrical contactor that is controlled by a photocell. With special approval from the Manager of UNC Electric Distribution Systems, the electrical contactor(s) may be located inside an easily accessible electrical/mechanical room. No other building or landscaping lights shall be served from this system.

Athletic field lighting shall be metal halide fixtures. The poles, fixtures, operating voltage, and power sources or feeds shall be specifically designed for each particular installation.

**16750 Telecommunications**

Basic telecommunications requirements for all new structures include service entrance ducts, Telecommunications rooms a conduit riser system between floors, a floor cabling distribution system, and building horizontal and riser cabling Qualified Communications Contractors shall be required to procure, terminate, test and provide documentation for telecommunications wiring as specified by the UNC-CH Telecommunications Office. For general design requirements refer to web site http://www.telecom.unc.edu/services/engineering/DESCON03.doc The information found at the aforementioned web site is NOT intended to be a Telecommunications performance specification. Each project designer will be expected to write a performance specification for the Telecommunications work on each project.