

## DIVISION 26 – ELECTRICAL SYSTEMS

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**26 00 00 Pre-Design Requirements**

Electrical Load Monitoring: Investigate the existing electrical service/distribution system and determine if sufficient capacity is available to accommodate the new loads. Meter readings are required per NEC.

Existing Electrical Installation: Investigate all existing electrical installations such as existing concealed conduit runs, conduit types/sizes, cable types/sizes, panelboard types/sizes, electrical equipment locations, etc., which potentially impact the new installation.

Compliance with NAU Technical Standards: the Design Professional shall submit these Technical Standards to the NAU Electrical Shop prior to design and development of project specifications, with ‘comply’ or ‘non-comply’ marked next to each applicable provision. Provide justification for all ‘non-comply’ provisions.

**Calculations**

The Design Professional shall prepare and submit calculations as required by the type of design work performed. Calculations shall justify or support the following:

- Lighting designs
- Size of each conductor
- Size of each overcurrent protective device
- Size of each equipment bus
- Size of each transformer
- Size of each generator and transfer switch
- Setting of each overcurrent protective device with adjustable characteristics
- Required PPE to meet arc flash incident energy levels

It is the responsibility of the Design Professional to determine which calculations are performed by the DESIGN PROFESSIONAL, and which calculations are to be specified by the Design Professional and performed by the Contractor. Not all calculation types will be required for all projects. NAU reserves the right to request additional calculations to suit the project.

The Design Professional shall submit the following calculations to NAU during the design process:

- Lighting calculations
- Fault current calculations
- Protective device coordination study
- Arc flash calculations (when not required to be performed by the Contractor)
- Load calculations
- Generator and/or UPS sizing calculations

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- Voltage drop calculations
- Harmonic distortion calculations
- Lightning protection system risk analysis

**Fault Current Calculations:** Prepare and submit calculations for all new projects and renovations to existing electrical distribution systems. The available fault currents shall be included on the riser diagrams, and shall show the available fault current (expressed in amperes, RMS symmetrical) at each overcurrent protective device and transformer in the system. Supporting calculations (such as those resulting from a SKM PowerTools™ analysis) that justify the summary available fault currents on the riser diagrams may be submitted separately in 8.5 x 11 format.

**Coordination Study:** Prepare coordination curves to determine the required settings of overcurrent protective devices with adjustable trip characteristics. The Design Professional shall verify field settings at time of project completion.

**Arc Flash Calculations:** Perform, or specify, an arc flash analysis in accordance with IEEE Std 1584a. For each bus analyzed, determine the following: Flash Hazard Protection Boundary, Incident Energy Level, Required Personal Protective Equipment Category, Type of Fire Rated Clothing, Limited Approach Boundary, Restricted Approach Boundary, and Prohibited Approach Boundary. Present, or specify to be submitted, the data determined by the analysis in a tabular format, and submit, or specify to be submitted, the preparation of arc flash warning labels for each piece of electrical equipment, showing the items listed above as well as the date of issue.

**Load Calculations:** Prepare and submit load calculations that justify the size of each branch circuit and feeder, overcurrent protective device, transformer, and equipment bus (panelboard, switchboard, switchgear, automatic transfer switch, etc.). Calculations shall be performed at all voltage levels. The method of calculation, including all applicable NEC diversity factors and non-coincident loads and their employment at various levels of the electrical system, as well as capacity reserved for future load, shall be clearly presented in the drawings. Calculations may be in panel schedule and switchboard schedule format. It shall be possible for the NAU reviewer to follow the load flow from the lowest level to the highest level of the riser diagrams.

**Generator Sizing Calculations:** Prepare and submit calculations that justify the size of each generator, including all loads downstream of the generator set(s) and the sizing impacts of proposed load steps, significant motor loads, non-linear loads, and capacity reserved for future loads.

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Voltage Drop Calculations: Prepare and submit calculations demonstrating compliance with the following voltage drop limits: 2% for feeders, and 3% for branch circuits, taken at design load.

Harmonic Analysis: Prepare and submit calculations estimating the voltage and current total harmonic distortion (THD) for buses rich in non-linear loads. Use these calculations to justify active or passive components to mitigate harmonic distortion.

Lighting Calculations: Lighting calculations shall include the room name, room number, fixture type chosen for the room, number and type of lamps to be used in the room, required illumination level, calculated illumination level, and light loss and reflectance assumptions used. Calculations for most interior spaces may be performed using the zonal cavity method. Perform and submit point-by-point footcandle-level calculations for areas of greater architectural or luminous sophistication, and outdoor areas. The Design Professional shall submit exterior outdoor point-by-point footcandle-level calculations and accompanying luminaire cutsheets to the Dark Sky Committee for review. Calculations shall include demonstrated compliance with energy conservation measures and codes.

### **Design Requirements**

Refer to the Codes and Standards adopted by NAU.

Sustainability: Provide metering and submetering as required to accomplish measurement and verification goals. Provide conduit path(s) from the roof to the electrical service entrance equipment to facilitate connection of roof-mounted photovoltaic systems. Perform life cycle analyses where required to support project goals.

All materials shall be new, listed by Underwriters Laboratories.

Electrical equipment spaces shall not be located beneath toilets, showers, laboratories, kitchens, sinks, open courtyards, planters, roof drain leaders, or other areas where water service is provided. Electrical equipment spaces shall be designed to allow maintenance equipment access, and to facilitate equipment replacement without demolition and reconstruction other than removal of a door centerpost.

The Design Professional shall show electrical equipment footprints and accompanying NEC working clearances on the drawings. Provide the same working clearance for non-fused switches as is required for fused switches.

Any pipe or duct system foreign to the electrical installation shall not enter or pass through an electrical equipment space. The Design Professional shall ensure that foreign piping such as water pipes, steam pipes, medical gas pipes, sanitary waste

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pipes, roof drains, A/C ducts and other unrelated piping systems containing liquids or gases are not installed or pass through electrical equipment spaces. Sprinkler piping shall not be routed through electrical rooms, unless it serves to protect the electrical installation.

Electrical equipment spaces shall have the necessary mechanical ventilation or cooling system to maintain the indoor temperature range required for proper operation of the equipment within its UL listing.

Electrical equipment spaces that contain freestanding electrical equipment shall be sized such that sufficient space is provided to add one additional section to each unit of freestanding equipment. Provide extended pad space

and spare conduits that will facilitate future installation of equipment and conductors. Spare space shall be indicated on drawings.

Electrical closets shall have 20% spare wall space for future installation of similar electrical equipment.

The Design Professional shall coordinate electrical metering and submetering requirements with NAU during design. NAU may wish to submeter separate occupancies or areas within a building.

Sustainability: Building electrical service equipment shall have breaker space to accept connection of grid-tied photovoltaic systems.

### **Installation Requirements**

All electrical equipment, disconnects, starters, panels, devices and plates shall be installed plumb and true.

All electrical work shall be inspected and approved by the NAU Electrical Shop or its designee before being covered. All tests are to be observed by the NAU Electrical Shop or its designee.

Any electrical work that will interfere with or interrupt the operation of existing building electrical and/or telecommunications services must be scheduled with the NAU Project Manager at least one (1) week in advance. Such work may be required to be performed during non-working hours. Preparation work shall be complete prior to service outage. Emergency generators will be required at the discretion of NAU.

Switchboards, panelboards, transformers, transfer switches, gutters, junction boxes and other electrical equipment with doors or removable covers shall not be painted other than with original factory paint and necessary touch-up paint.

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Ground fault protection for personnel per NEC shall be provided and used by personnel during construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment or similar activities.

### **Submittals**

Any substitutions or equivalent products to those specified herein shall require prior approval by the NAU Electrical Shop.

Provide complete submittals of all electrical and electronic equipment. Diagrams shall show installed component model numbers; block diagrams do not constitute an acceptable schematic.

### **Licenses**

The electrical contractor shall furnish copies of State of Arizona high voltage license to NAU before proceeding with any work over 600 volts, including but not limited to conduits and ductbanks for medium voltage cables, switchgear, transformers, cabling, splices, or terminations.

### **Record Documents**

Contractor shall thoroughly mark the construction drawings to show as-installed circuiting, locations of major electrical components, panel schedules, and locations of major underground conduit and ductbank runs dimensioned from fixed surface features.

### **Electrical Systems Software**

All software installed as part of an electrical system shall be licensed to NAU. The NAU Project Manager will direct the Contractor as to the details of software licensing, update notifications, and locations where the software is to be installed.

26 05 13 Medium Voltage Cables

### **Part 1 – General**

NAU's campus primary electrical distribution system is a 12.47kV underground system, installed in ductbank or in the tunnel network. The topology is looped on South Campus, and primary-selective on North Campus. Any modification to the primary distribution system shall maintain the existing topology.

Each new building shall provide the necessary box pad mounted switchgear for its connected load. Transformer(s) shall be provided on necessary concrete pads for its connected load.

A fault current indicator shall be provided on each cable at the source of each feeder to help operators locate system faults.

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All modifications to or extensions of the existing NAU medium-voltage electrical system require the approval of the NAU Electrical Shop at the Schematic Design level.

### Part 2 – Products

Medium voltage cable shall be shielded ethylene-propylene-rubber (EPR) insulated, 133% insulation level, copper conductor, as manufactured by Okonite, Kerite, Prysmian, or approved equivalent, with a 40 year warranty.

All cable utilized in a pull shall have been manufactured during the same production run from the factory. All cable on the project shall be new, shall have been manufactured within 12 months of the date of receipt at the job site, and shall be shipped with original manufacturer's cable end seals. Cable reels shall be shipped and stored with end flanges vertical. Storage of cable prior to installation shall comply with the recommendations of the manufacturer.

### Part 3 – Execution

The installing contractor shall have an Arizona high-voltage license. Installing personnel shall be qualified and certified by the manufacturer in the installation and testing of cable, splices, and terminations.

Medium volt cable shall be installed using a tension meter. DP to provide lbs. of pulling force.

New cables shall be tested after installation by insulation resistance testing and partial discharge testing, or hi-pot testing. Service-aged cables shall be tested after installation by insulation resistance testing and online partial discharge testing.

Testing shall be performed by an independent 3<sup>rd</sup>-party testing agency; the Design Professional shall coordinate with NAU to properly specify whether NAU or the installing contractor will be responsible for hiring the testing agency.

Insulation-resistance Test: Test all new and service-aged cables with respect to ground and adjacent conductors. Test data shall include megohm readings and leakage current readings. Cable shall not be energized until insulation-resistance test results have been approved by the NAU Electrical Shop. Test voltage shall be 2,500VDC. Minimum acceptable resistance value shall be 5,000 megohms. Provide a comprehensive report that describes the identification, length, terminations and location of cables tested, the test equipment used, and the date tests were performed; identifies the persons who performed the tests; and identifies the insulation resistance for each cable section tested. The report shall provide conclusions and recommendations for corrective action.

Online Partial Discharge Test: Test all new and service-aged cables. Perform tests after cables have passed the insulation-resistance test, and after successful

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energization. Testing shall use a time or frequency domain detection process incorporating radio frequency current transformer sensors, with a partial discharge detection range of 10kHz to 300Mhz. Provide a comprehensive report that describes the identification and location of cables tested, the test equipment used, and the date tests were performed; identifies the persons who performed the tests; and identifies numerically and graphically the magnitude of partial discharge detected for each cable section tested. The report shall provide conclusions and recommendations for corrective action.

Hi-pot test: Maximum test voltage shall be 55kV, or maximum as allowed by cable manufacturer. Apply voltage in approximately 8 to 10 equal steps. Raise the voltage slowly between steps. At the end of each step, allow 5 minutes for the charging currents to decay. Time and record the interval of decay. Make leakage current readings at 1 minute intervals for each voltage step. Read the leakage current and plot a curve of leakage current versus test voltage on graph paper as the test progresses. Stop the test and replace the cable if leakage currents increase excessively or a “knee” appears in the curve before maximum test voltage is reached. Upon reaching maximum test voltage, hold the voltage for five minutes for fifteen minutes. Read the leakage current at 30 second intervals and plot a curve of leakage current versus time on the same graph paper as the step voltage curve. Stop the test if leakage current starts to rise, or decreases and again starts to rise.

Leakage current should decrease and stabilize for good cable. Terminate test and allow sufficient discharge time before starting the next conductor.

### 26 05 19 Low Voltage Electrical Power Conductors and Cables

#### Part 1 – General

Grounded (neutral) conductors shall be minimum #10 AWG where two or more 15 or 20 amp circuits share a common neutral.

#### Part 2 – Products

All wire shall be 600V soft-drawn annealed copper, of the type specified herein, and shall be brought to the job in unbroken packages showing the date of manufacture. Manufacture date to be within the past year. Approved manufacturers are Caltec, Hi-Tec, Capitol, Rome, Essex, or General.

Wire shall be type THHN (THWN in damp locations).

Minimum wire size for power and lighting wiring is #12 AWG, except for controls wiring. Wire of size #10 AWG and larger shall be stranded. All motor-related power and control wiring shall be stranded, regardless of size.

Type MC Cable shall be used only when approved by the NAU Project Manager and NAU Electrical Shop for specific uses on a particular project.



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Integral-color insulation shall be used up through #6 AWG. Conductors #4 AWG and larger may be integral-color insulation, or phase-coded with multiple bands of 1/2" wide color coding tape at all accessible locations. Grounded wires (neutral) and ground wires shall have a continuous color coding at all accessible locations.

Color code all wire throughout as follows:

PHASE	120/208 VOLTS	277/480 VOLTS
A	BLACK	BROWN
B	RED	ORANGE
C	BLUE	YELLOW
NEUTRAL	WHITE	GRAY
GROUND	GREEN	GREEN
ISOLATED GROUND	GREEN/ORANGE STRIPE	GREEN/ORANGE STRIPE

Wiring for switches shall be the same color as phase wire.

Prewired fixture whips, maximum six feet long, are acceptable when approved by the Design Professional.

Splices in wire #8 AWG and larger shall be made with compression-type connectors only. Twist-on connectors may be used for wire #10 AWG and smaller.

Thermoplastic electrical insulating tape shall be 7 mil flame retardant and weather resistant, resistant to hot and cold weather, applies well at 0 degrees F, has an operating range up to 220 degrees F, and meets the requirements of ASTM D-3005-72 Type 1, UL 510, HHI-595C, and CAS Bulletin No. 561A (105 degrees C.).

Approved wire lubricants shall be used for pulling. Lubricants shall not have a deleterious effect on wire or cable insulation, or on cable labeling.

Part 3 – Execution

All wiring for all systems shall be installed in conduit.

Splices shall not be made in condulets.

No more than six circuits shall be in a single conduit, subject to NEC deration requirements.

Do not combine homeruns where shown separately on the drawings.

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Splices shall be covered with a layer of rubber tape, then a layer of thermoplastic tape. When using twist-on wire connectors, wires shall be twisted together with pliers before applying connector.

Carefully train all wire in electrical enclosures in a neat arrangement. Leave wire loops not less than 6" long in each outlet box, even if wires do not stop in the box.

26 05 26	Grounding and Bonding for Electrical Systems
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Part 1 – General

All conduit and raceway systems that contain power and lighting conductors shall contain a ground wire, sized per NEC.

The non-current-carrying metal parts of all outlet boxes, pull and junction boxes, gutters, motor controllers, switchboards and switchgear, transformers, panelboards, and any other electrical enclosure shall be bonded to an equipment grounding conductor by a properly-sized bonding jumper.

Separately derived systems shall have the secondary neutral grounded to building steel with an exothermic weld at the first downstream disconnecting device.

Part 2 – Products

N/A

Part 3 – Execution

N/A

26 05 29	Hangers and Supports for Electrical Systems
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Part 1 – General

Support raceway systems per NEC. 16.5 gauge tie wire and ironworkers tie may only be used for securing horizontal conduit runs within stud walls.

Perforated strap iron or plumbers tape, drive-it straps, plastic sleeve anchors, lead anchor, or power-driven anchors shall not be used for hanging conduit or boxes.

Single suspended conduits shall be on rings with rod hangers with self-drilling anchors or other approved methods. Runs of more than one suspended conduit shall be clamped to a strut trapeze with 300 lb. nut & bolt clamps. All- thread must be backed on both sides with washers, lock-washers and nuts (floating strut or hangers are not acceptable). Trapeze supports shall be 1-5/8" x 1-5/8" channel supported by minimum 3/8" rods.

Part 2 – Products

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N/A

### Part 3 – Execution

N/A

26 05 33 Raceway and Boxes for Electrical Systems

### Part 1 – General

N/A

### Part 2 – Products

#### Conduit

Minimum size of conduit is  $\frac{3}{4}$ " , except that  $\frac{1}{2}$ " may be used for dead-end runs in walls, and for fire alarm system wiring.

All fittings for all metallic conduit types shall be steel. All bushings and connectors shall be insulated throat type.

Rigid Galvanized Steel Conduit (RGS) or Intermediate Metal Conduit (IMC) fittings shall be threaded; running threads are not permitted. Union fittings may be used as necessary. RGS threadless connectors or couplings, split couplings that bolt together, self-threading fittings, or couplings permanently attached to conduit shall not be used unless specifically approved by the NAU Electrical Shop.

Electrical Metal Tubing (EMT) fittings may be compression or setscrew type.

Rigid Non-Metallic Conduit (PVC) shall be Schedule 40 minimum.

Surface metal raceway (Wiremold™ or similar) shall be installed with manufacturer's accessory fittings. Field-made fittings are not allowed.

FD or FS cast boxes with cast lugs shall be used for exposed wiring in buildings or where subject to weather. Covers shall be FD/FS type. Use WLRD/WLRS covers by Crouse-Hinds, Arrow-Hart, or similar for outlets subject to weather.

All conduits shall terminate with a box except communications, data, phone, etc. lines may terminate with metallic insulated throat threaded bushings at TTB or cable tray. Fasten conduit to cable trays with GEDNEY CTC or approved equal clamp.

The following materials are not allowed: flexible metal tubing, electrical non-metallic tubing (ENT), liquid-tight nonmetallic flexible conduit (LFNC), offset connectors, conduit bodies larger than 1-1/4", and SLB fittings.

#### Boxes

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Boxes shall be galvanized steel, minimum 4" square. Use a plaster ring with boxes for receptacles, switches, telecommunications outlets, and fire alarm devices. Use of more than one extension ring is not acceptable.

FS/FD boxes with cast lugs and FS/FD covers shall be used where exposed to moisture or subject to mechanical damage.

Use masonry boxes of the proper depth in unplastered masonry walls. The face of all boxes shall be vertical and not more than 1/4" in from the finished surface. The mason and electrical contractor shall be mutually responsible for the proper execution of masonry work.

Ceiling outlet boxes shall be equipped with 3" round plaster rings. Provide fixture studs if fixture is to be mounted directly on box.

Handy boxes or handy box extension rings shall not be used.

All surface-mounted fire alarm pull station devices shall be mounted on red boxes specifically made for this purpose.

Pendant outlet boxes shall be Daniel Woodhead 3000 series or approved equal with cord strain relief. Plates shall match box and outlet used.

### Part 3 – Execution

#### Conduit

Metal conduit shall be used above grade.

Rigid Galvanized Steel Conduit (RGS) or Intermediate Metal Conduit (IMC) shall be used where exposed to weather or subject to mechanical damage, in tunnels, to house medium-voltage conductors in all above-ground locations, and in mechanical rooms below 10' above finished floor.

Flexible metal conduit shall be used only for connection to equipment which is moveable for adjustment, mounted on vibration isolation bases, or for connection to lay-in light fixtures in an accessible ceiling. Maximum length shall be six feet.

Conduit shall be installed concealed except as noted on plans, or in equipment rooms and tunnels.

All feeder conduits for panels, switchgear, gutters, and pullboxes shall be terminated with grounding bushings bonded to the equipment grounding conductor.

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	Different electrical systems shall be run in separate, independent raceway systems. A common conduit shall not be used for housing conductors from two separate/independent panels.
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	Examples of different systems are as follows: 120/208Vs, 277/480V, fire alarm, emergency electrical system, telephone and data, intrusion detection system, and building automation system.
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	Conduit bend radius shall be per NEC. Ninety degree bends in conduit 1-1/2" and larger shall be made with manufactured elbows or by hydraulic bender.
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	No more than three 90 degree bends (270 degrees) shall be used between pull, or junction, boxes on data, communications or phone conduits.
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	Change from one conduit type to another shall be at a box or enclosure.
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	Sleeves are required for floor penetrations. Sleeves shall extend a minimum of 1" above finished floor. Firestop penetrations through rated walls and floors per requirements of other Sections.
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	Conduits shall be installed such that no wrench or tool teeth marks are evident. Conduit ends shall be cut square, reamed to full size, shouldered in fittings, and fully seated in connector and couplings. Roller type tubing cutters shall not be used.
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	Conduit installation shall be such that conduits are not abraded, scraped, flattened, dented or wrinkled and the interior diameter is not effectively reduced. Install conduit in such a way that condensation or water cannot be trapped.
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	Above flush-mounted panelboards, extend spare conduits to above suspended ceilings. For hard (non-accessible) ceilings, spare conduits shall extend to an accessible location and terminate in a labeled junction box with suitable blank cover. A minimum of (1) 1" spare conduit shall be provided for each 3 (or fraction thereof) one-pole spares/spaces, with minimum 3 spare conduits provided.
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	Surface-mounted conduit shall be painted to match the surface. Conduits concealed or installed in tunnels or equipment rooms shall not be painted.
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	Exposed conduits shall be grouped in neat parallel lines, properly supported, following the lines of the building structure as closely as possible.
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	Provide moisture-tight hubs for conduit entries to top or sides of exterior boxes, gutters, panelboards, switchboards, and other electrical enclosures.
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All empty or spare conduits for all systems shall have a pull string installed, and be labeled at each as to the location of the other end. When spare conduits stub up from a floor slab, they shall extend 6" above finished floor.

Metallic conduit shall not touch any plumbing pipe, or pipe of other systems. Where contact between dissimilar systems is unavoidable, approved insulation shall be used between the piping systems.

Where telecommunications conduits terminate at a cable tray, a threaded bushing and connector shall be used. An O-Z/Gedney CTC clamp or approved equal shall be used to clamp conduit to cable tray.

Any conduit run that does not allow conductors to be pulled readily will be condemned and replaced with conduit whose workmanship is satisfactory to the NAU Electrical Shop.

All fire alarm system conduit shall be inspected and approved by NAU Fire and Life Safety prior to covering the work. Inspection request shall be in accordance with Division 01.

Refer to Section 26 05 53, IDENTIFICATION OF ELECTRICAL SYSTEMS, for mandatory identification of fire alarm system conduits.

Depending on project size and cost considerations, NAU may consider the following conduit colors (factory- or field-painted, or color & text labeled every 10' and at changes of direction):

- Silver – power and lighting
- Orange – security systems
- Yellow – data and telephone
- White – controls

### Boxes

All boxes shall be grounded to the conduit system, and bonded to the equipment grounding conductor with a ground screw in the box.

Boxes shall not be installed back to back, even if associated with different systems.

Conduit runs shall not exceed 90 feet between boxes.

Bar hangers shall be used to support boxes in accessible ceilings.

Telecommunications outlet boxes shall be located at heights to match adjoining receptacles, unless otherwise noted.

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In renovation work, box mounting heights shall match heights of nearby existing boxes, unless existing heights violate ADA requirements.

Do not compromise integrity of FD/FS boxes by drilling fastening holes in boxes.

In non-combustible walls or ceilings, boxes shall not be set back more than 1/4". In combustible walls, boxes shall be flush with the finished surface. There shall be no broken surfaces, gaps or open spaces at the edge of boxes.

Conduit shall enter boxes at right angles without binding. Offsets shall be used as necessary for proper fit.

When boxes are installed in acoustic walls, the Design Professional shall verify the required STC rating with NAU.

26 05 36	Cable Trays for Electrical Systems
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Part 1 – General

All buildings except dormitories shall have cable tray for telecommunications wiring. Cable trays shall terminate in designated communication rooms. There must be adequate tray from the communications room(s) to the tunnel entry to the building, and adequate raceway from floor to floor.

Part 2 – Products

All cable trays are to be continuously grounded.

Support for cable tray shall be every 5 feet and within 1-1/2 feet of terminations or changes of direction.

Part 3 – Execution

N/A

26 05 43	Underground Ducts and Raceways for Electrical Systems
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Part 1 – General

N/A

Part 2 – Products

Underground pullboxes and lids for 120VAC to 480VAC systems shall be polymer concrete.

Part 3 – Execution

Rigid Galvanized Steel Conduit (RGS) shall be half-lap wrapped with Scotch Wrap #50 or approved equal when installed in concrete or in earth.

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Non-Metallic Conduit (PVC) bends of 45 degrees or greater shall be taped RGS.

Rigid Non-Metallic Conduit (PVC) shall be Schedule 40 minimum and may be used subject to all the following conditions: Bends of 45 degrees or more shall be made with RGS elbows.

PVC conduit bends of 45 degrees or more are not acceptable.

PVC may only be used in concrete duct bank or direct buried underground; and PVC shall convert to RGS before stubbing out of earth or concrete with a minimum of 18" of RGS in the slab or earth. RGS shall extend 3' beyond the building when penetrating exterior walls or footings. Conduits penetrating through footings shall be sleeved.

Minimum burial depth shall be 18" for conduits containing wiring 600 volts or less, and 36" for conduits containing cables over 600 volts.

Electrical conduits, telecommunications conduits, water piping, and sanitary sewer piping shall be separated by 12" minimum.

Underground PVC conduit containing cables over 600 volts shall be encased with a minimum of 3" of integral-color red concrete slurry (one 50lb bag of dye per cubic yard of concrete) on all sides of each conduit. Concrete shall be with aggregate small enough to work around conduits. Concrete around duct banks shall be carefully vibrated to prevent voids around and under conduits.

Over 600 volts requires bends of 45 degrees or more with minimum radius of 12.5 ft.

All buried conduit shall be shaded with 6" on all sides with cinder sand or equal.

For two or more conduits, use approved plastic base and intermediate spacers beginning no more than 18" from termination at manhole or building wall, and maximum every 5' thereafter. Stake and tie conduits down securely before concrete pour to prevent float.

3" wide locatable marking tape (with appropriate legend, e.g. ELECTRICAL, TELECOMMUNICATIONS) and a #12 stranded tracer wire shall be placed above all buried conduits and duct banks at 12" below finished grade. If duct bank is more than two conduits wide, use two marking tapes, one at each edge of the trench.

Underground pullboxes shall be installed minimum 6' behind back of curb or sidewalk.



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Part 1 – General

Arc flash labeling is required.

Part 2 – Products

Provide plastic laminate labels (black with white letters for normal power; red with white letters for generator-backed power) switchgear, switchboards, main and feeder breakers in switchboards and switchgear, panelboards, motor controllers, variable frequency drives, disconnect switches, etc. Mount with self-tapping screws; adhesive type is not approved. Panelboard doors shall be labeled with panel designation and voltage. Lettering to be minimum 3/8" high with inscription centered on label. For switchboards and switchgear with spare breakers or spaces the labels shall be left blank for future engraving by others. In addition, CT cabinets shall be marked with the CT ratio.

Part 3 – Execution

Pullboxes and junction boxes shall be identified with permanent marker as to which circuit(s) and panel the box contains, e.g. "Panel E - Cir. 16-18-20."

Branch circuits shall be tagged in panelboards and pullboxes, using as-installed circuit numbers. Tags to be plainly marked with indelible ink, and securely attached to the wires.

Conduit containing cables rated over 600 volts shall be identified minimum every 20'. Transformers, switches, equipment, pullboxes, cabinets, junction boxes and gutters having voltages of more than 600 volts shall be identified as to the voltage of the system within. Letters and numbers shall be a minimum of 2" and are to be highly visible contrasting colors. "DANGER - HIGH VOLTAGE - KEEP OUT" signs shall be permanently attached to the primary section door on transformers and on doors of sectionalizing switches of 600 volts or more. Signs shall be bilingual Spanish/English, and sized according to OSHA codes.

Service entrance main circuit breaker shunt trip panic buttons shall be marked "EMERGENCY-POWER OFF SWITCH" with a red and white laminate label.

Fire alarm system conduit shall be field-painted red, or shall be factory red topcoat colored conduit, or shall be labeled with 2" wide, red, heavy duty, indoor/outdoor rated, pressure-sensitive adhesive-backed flexible high-gloss vinyl tape, similar to Brady #55261 pipebanding tape. For tape-labeled conduit, clean surface to receive label with isopropyl alcohol and completely encircle the conduit in half-lapped turns of tape with the last two turns applied with no tension to prevent possible unwinding. Tape shall be installed maximum of 10' on center and within 3' of all changes of direction.

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Number

Fire alarm system boxes shall be red and shall be labeled “F/A” in 1” indelible black lettering.

All Fire Alarm Signaling Line Circuit/Initiating Device Circuit (SLC/IDC) devices shall have labels physically applied, noting both the Signaling Line Circuit/Loop number and the sequential device number; i.e., “S209” for a Signaling Line Device, sequential number nine (9), located on Signaling Line Circuit/Loop number two (2).

All Fire Alarm Notification Appliance Circuit (NAC) devices shall have labels physically applied, noting whether the Notification Appliance is fed from the fire alarm control panel (FACP) or a Remote Power Supply, the Notification Appliance Circuit/Loop number and the sequential device number; i.e., “N209” for a Notification Appliance Circuit Device sequential number nine (9), located on Notification Appliance Circuit/Loop number two (2), fed from the FACP, or “NP209” for a Notification Appliance Circuit Device sequential number nine (9), located on Notification Appliance Circuit/Loop number two (2), fed from a Notification Remote Power Supply.

Labels for both SLC/IDC and NAC devices shall be ½”, clear flexible vinyl pressure-sensitive adhesive-backed, thermal transfer printed labels with ¼” high, black lettering, similar to Brady #M71C-500-580-CL. Label shall be mounted on flat plane of the metal ceiling tile support grid, directly adjacent to device, or on a non-curved surface of the actual device. Label shall be installed plumb. Installers hands shall be clean, and the surface to receive the label shall be cleaned with isopropyl alcohol prior to installation of label, such that label properly adheres and does not show installer fingerprints.

All fire alarm head-end equipment shall have large red micarta label with two lines of ½” high, white, engraved lettering, physically adhered to the cover, plumb, and attached with minimum of (2) 3/16” diameter rivets and a flat washer. The first line shall indicate the type of head-end equipment, and the second line shall indicate the equipment’s physical location, including building number, floor level, and nearest column intersection; i.e., “FACP B24-1-K/2” for a Fire Alarm Control Panel located in Building 24, level one, near column K/2. Labels shall use the following acronyms:

- FACP – Fire Alarm Control Panel
- FAAP – Fire Alarm Annunciator Panel (Text)
- NP – Fire Alarm Notification Remote Power Supply
- FGAP – Fire Alarm System Graphic Annunciator Panel

Section Title  
Number  
**26 09 00 Instrumentation and Control for Electrical Systems**

26 09 13 Electrical Power Monitoring and Control

Part 1 – General

Provide data connection for metering. Coordinate requirements with NAU IT.

Part 2 – Products

Service entrance switchboards or panelboards shall be provided with an electronic meter with the following functions (per phase as applicable): ammeter, voltmeter, kilowatt demand, kilowatt-hour, harmonic distortion. Meter shall be capable of communication by non-proprietary protocol.

New medium voltage box pad mounted switchgear shall be provided with integral bus voltage and current metering and switch position monitors that shall report to the central metering system at the North Plant via fiber optic pathway.

Determine requirements for submetering of systems necessary to comply with measurement and verification of HVAC and other building systems.

Part 3 – Execution

N/A

26 09 43 Network Lighting Controls

Part 1 – General

Lighting control panels shall be specified to fail all circuits 'ON'.

Part 2 – Products

N/A

Part 3 – Execution

N/A

**\*\*END OF SECTION\*\***

Section Title  
Number

**26 10 00 MEDIUM VOLTAGE ELECTRICAL DISTRIBUTION**

**26 12 00 Medium Voltage Transformers**

Part 1 – General

Building service transformers shall be outdoors, located so as to be accessible for maintenance.

Transformers shall comply with 2010 US Department of Energy requirements.

Part 2 – Products

Building service transformers shall be liquid-filled (less flammable biodegradable oil) padmounted type, with penta-head door bolts. Aluminum or copper windings are acceptable. Primary section shall be dead-front with integral loop-feed switching.

Part 3 – Execution

The concrete pad shall extend 6” beyond transformer footprint on sides and rear, and 36” in front. Top of pad shall be 3” above finished grade.

Penta-head socket to be turned over to NAU Electrical Shop when job is complete.

Provide bollards to protect transformers. The number of bollards will be determined by transformer location.

**26 13 00 Medium Voltage Switchgear**

Part 1 – General

NAU’s primary electrical distribution system campus is a 12.47kV underground system, installed in ductbank or in the tunnel network.

Each new building shall provide the necessary loop-feed box pad mounted switchgear (South Campus) or primary-selective box pad mounted switchgear (North Campus), and transformer(s) for its connected load.

The Design Professional shall use the Arizona Public Service (APS) standard details for installing switchgear, and shall include the appropriate details on the drawings.

Part 2 – Products

Medium voltage switchgear shall be box pad mounted, low profile, deadfront type, as manufactured by S&C, Federal Pacific or approved equal. All fuses shall be S&C SMU-20 with SME-20 fuse holders.

Box pads shall be pre-manufactured fiberglass type.

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New medium voltage box pad mounted switchgear provided on North Campus shall be provided with integral bus voltage metering and switch position monitors which shall report to the central metering system at the North Plant via fiber optic pathway.

### Part 3 – Execution

Transformer pad shall extend 6” beyond footprint on all sides and 36” in front of doors. Top pad shall be 3” above finished grade.

Installation shall be in accordance with the Arizona Public Service (APS) standard details.

Provide bollards to protect switchgear. The number of bollards will be determined by switchgear location.

**\*\*END OF SECTION\*\***

Section Title  
Number

**26 20 00 LOW VOLTAGE ELECTRICAL TRANSMISSION**

**26 22 00 Low Voltage Transformers**

Part 1 – General

Transformers shall fit through doorways without disturbing existing conditions of building for repair/replacement.

Part 2 – Products

Transformer windings shall be copper.

Part 3 – Execution

Dry transformers shall not be suspended or wall-mounted unless specifically approved by the NAU Electrical Shop.

**26 24 00 Switchboards and Panels**

**26 24 13 Switchboards**

Part 1 – General

Panic buttons shall be installed in the electrical service entrance room at the exit(s). These panic buttons shall be wired to a shunt trip main breaker and in parallel with the ground fault trip (where applicable).

Refer to Section 26 09 13, ELECTRICAL POWER MONITORING AND CONTROL, for metering requirements for service entrance switchboards.

Part 2 – Products

Switchboards and switchgear shall be as manufactured by Square D, or approved equal.

All bussing shall be copper.

Panic buttons shall be Allen Bradley #800T-BGA (or approved equal) extended head red push button unit with Allen Bradley #800-N13 (or approved equal) extra long guard ring. Mushroom head push buttons are not acceptable.

Overcurrent devices with adjustable trip characteristics shall be set in the field by the installing contractor, per the settings of the coordination study performed by the Design Professional.

Part 3 – Execution

N/A

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Number

26 24 16 Panelboards

Part 1 – General

If the building is served by a service entrance panelboard, panic buttons shall be installed in the electrical service entrance room at the exit(s). These panic buttons shall be wired to a shunt trip main breaker.

Refer to Section 26 09 13, ELECTRICAL POWER MONITORING AND CONTROL, for metering requirements for service entrance switchboards.

Part 2 – Products

Panelboards shall be as commercial grade, copper bus, circuit breaker type, hinged door, painted gray with manufacturer’s standard finish, keyed alike, without pre-punched knockouts, as manufactured by Square D, General Electric (bolt-on type only), Siemens, Eaton, or approved equal.

Circuit breakers in 120/208 volt and 277/480 volt panelboards shall be bolt-on breakers. Breaker numbers shall be stamped on the deadfront; decal numbering is not allowed.

Load centers are not allowed.

Where applicable, panic buttons shall be Allen Bradley #800T-BGA (or approved equal) extended head red push button unit with Allen Bradley #800-N13 (or approved equal) extra long guard ring. Mushroom head push buttons are not acceptable.

Submit sample directory with material submittals.

Part 3 – Execution

When more than one panelboard is installed at the same location, the tops of the panelboards shall be mounted at the same height.

Furnish and install a neat, plastic-covered printed circuit directory inside of each panelboard door. Directory shall indicate equipment or area(s) of building or equipment supplied by each circuit. Use as-built room numbers affixed on doors or as designated by NAU Project Manager. Minimum size shall be 5" x 8" for panels up to 20 circuits; two for panels above 20 circuits, or 6" x 11".

Overcurrent devices with adjustable trip characteristics shall be set in the field by the installing contractor, per the settings of the coordination study performed by the Design Professional.

Section Title  
Number

**26 25 00 Enclosed Bus Assemblies**

Part 1 – General

N/A

Part 2 – Products

N/A

Part 3 – Execution

Busways shall be installed with wall flanges at all wall penetrations. Floor penetrations shall have a sealed 1" minimum lip above finished floor.

**26 27 00 Low Voltage Distribution Equipment**

26 27 26 Wiring Devices

Part 1 – General

Receptacle outlets in office areas and classrooms, designated for instruction in the use of office or lab equipment, shall be laid out at a maximum of 6' on center.

Lighted toggle switches shall be used in all tunnels and equipment rooms.

Dual technology motion sensing switches shall be specified for all office, restroom, classroom, and storeroom areas, and other areas with more than six two-lamp fixtures.

Toilet rooms shall be equipped with motion sensing switches for both lights and fans.

All exterior receptacles, and interior receptacles within 6' of a water source (such as a sink, eye wash, drinking fountains, emergency showers, hose bibbs, etc.), shall be GFCI type.

Part 2 – Products

Wiring devices shall be 20A, brown or ivory color, specification grade, back or side wired standard NEMA configuration. 15A devices and push-on devices are not acceptable.

Cover plates shall be specification grade, type 302 stainless steel or nylon. Plate color shall match devices. Plates in exposed wiring shall be steel, rounded to box edge. Oversized plates are not acceptable.



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Hubbell part numbers are used as basis of design. Receptacles & GFCI receptacles: heavy-duty specification grade, Hubbell 5362. Surge-suppression isolated-ground receptacles: Hubbell IG5362S. Isolated Ground: Hubbell IB5362BR. Toggle switches: Hubbell 1221. Lighted toggle switches: white or clear only, Hubbell 1221LC. Pilot light toggle switches: Hubbell 1221PLC. Momentary-contact switches: 3-position, single-pole double-throw, Hubbell 1557.

Devices and cover plates on emergency power shall be red. Cover plates shall be engraved "Emergency Power."

### Part 3 – Execution

All device wiring shall be pigtailed.

Horizontal receptacles shall be installed so that the neutral is to the top. Vertical receptacles shall be installed so that the ground is to the top.

All devices shall be grounded to the conduit system, the box ground screw, and the circuit equipment grounding conductor.

Receptacles shall be 18" to center of receptacle, or 48" or 40" where table, work benches and counters occur, or as noted.

Mount wall switches on the latch side of doors. All switches shall be 48" high to the center of the switch, except where located in cabinets.

## **26 29 00 Low Voltage Controllers**

### 26 29 13 Enclosed Controllers

#### Part 1 – General

Provide combination fused-switch magnetic motor starters or variable frequency drives on all motors 1 hp or larger.

Provide loss-of-phase protection on all 3-phase motors.

Provide motor-rated switches with overloads on small single-phase motors.

#### Part 2 – Products

Enclosed controllers shall be as manufactured by Square D, General Electric, Siemens, Eaton, Crouse-Hinds, or approved equal. Controllers shall be heavy-duty (HD), with green and red pilot lights, and operate on 120V control circuits.

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Small single-phase motors shall be protected by an Allen-Bradley Bulletin 600 motor-rated switch at the motor location, or shall be provided with integral overload protection and a fusestat at the motor location, or approved equivalent.

Part 3 – Execution

N/A

26 29 23 Variable Frequency Motor Controllers

Part 1 – General

Do not locate drive inside of air handling units.

Limit length of feeder from VFD to motor as per recommendations of the manufacturer.

On equipment with VFD Drives, provide a separate disconnect and contractor to start and operate equipment when the VFD Drive fails.

Control wiring shall be in separate steel conduit from the motor feeder.

Derate VFDs for installed altitude.

Part 2 – Products

VFDs shall be pulse-width modulated, as manufactured by ABB (ACH series), or approved equivalent. All VFDs shall be the product of the same manufacturer.

Indoor enclosures shall be NEMA 12. Outdoor enclosures shall be NEMA 4.

Match type of drive to actual load driven (i.e. variable torque or constant torque). Coordinate use of VFD rated motors with mechanical trade.

Provide 5% line reactors, EMI/RFI filtering, door-interlocked input circuit breaker or fused switch, and contactor bypass.

Coordinate communications protocol and control signal type with other Divisions of these Technical Standards.

Part 3 – Execution

Complete operation and maintenance manuals shall be provided to NAU prior to conducting the onsite training. The operation and maintenance manual shall contain a complete copy of the submittal documents. Training shall at a minimum consist of four hours of onsite training by a certified factory representative. The training shall be scheduled after the VFDs are in service and fully operational.

DIVISION 26 – ELECTRICAL SYSTEMS

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**\*\*END OF SECTION\*\***

Section Title  
Number

**26 30 00 FACILITY ELECTRICAL POWER GENERATING AND STORING EQUIPMENT**

**26 32 00 Packaged Generator Assemblies**

26 32 13 Engine Generators

Part 1 – General

Generators shall be diesel-fueled. Access for fuel trucks must be provided.

Means shall be provided for shutting down the engine at the entrance to the generator room or enclosure. This shall be labeled "Generator Emergency Stop."

Outdoor generators shall be provided with skid-mounted double-wall steel fuel tank. Indoor generators shall be provided with an outdoor double-wall steel fuel tank.

Derate generators for installed altitude.

Part 2 – Products

Generator Emergency Stop button shall be Allen Bradley #800T-BGA (or approved equal) extended head red push button unit with Allen Bradley #800-N13 (or approved equal) extra long guard ring. Mushroom head push buttons are not acceptable.

Part 3 – Execution

Generators which are installed in structures, or at outside locations, shall have adequate emergency lighting equivalent to normal lighting.

A complete test of the entire emergency electrical system, including load banking of generator and testing of each automatic transfer switch with the generator, shall be performed on or before substantial completion of project.

Overcurrent devices with adjustable trip characteristics shall be set in the field by the installing contractor, per the settings of the coordination study performed by the Design Professional.

**26 36 00 Transfer Switches**

Part 1 – General

Transfer switches shall be 4-pole (switched neutral), except when adding a transfer switch to an existing emergency electrical system which is based on 3-pole topology.

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Section Title  
Number

Part 2 – Products

N/A

Part 3 – Execution

N/A

**\*\*END OF SECTION\*\***

Section Title  
Number

**26 40 00 ELECTRICAL AND CATHODIC PROTECTION**

**26 41 00 Facility Lightning Protection**

26 41 13 Lightning Protection for Structures

Part 1 – General

Lightning Protection Risk Analysis: Prepare and submit calculations as described in Annex L of NFPA 780. Use this analysis to make recommendation to NAU on the provision of a lightning protection system.

Part 2 – Products

N/A

Part 3 – Execution

N/A

**26 43 00 Transient Voltage Suppression**

26 43 13 Transient Voltage Suppression for Low Voltage Electrical Power Circuits

Part 1 – General

Two levels of transient voltage surge suppression (TVSS or SPD) are required to protect electrical distribution equipment serving computer-intensive and/or critical information dependent areas and offices. These levels do not include receptacle-level TVSS.

Part 2 – Products

Surge protection devices shall have lifetime warranty, all modes of protection, and active phase indicator lights.

Part 3 – Execution

N/A

**\*\*END OF SECTION\*\***

Section Title  
Number

**26 50 00 LIGHTING**

**26 51 00 Interior Lighting**

Part 1 – General

Lighting concepts and recommended illuminance levels per the Illuminating Engineering Society of North America (IESNA) Lighting Handbook and Recommended Practices (latest editions) shall govern the lighting design.

The lighting shall be designed for maximum efficiency, incorporating energy saving fixtures and daylighting when possible. Allowed Lighting Power Density (LPD) figures shall follow ASHRE 90.1.

Select fixtures and light sources with long operating lives; which utilize controlling elements (lenses, louvers, reflectors, etc.) designed to provide the best utilization of emitted light at the task location; that are appropriate for the ambient temperature; and that are not prone to dirt accumulation.

Standardize lamp types across fixture types to limit the number of different lamp types and wattages used.

Fluorescent and HID lighting for athletic or machinery spaces shall be circuited to minimize "strobe" effect.

For metal halide fixtures, specify pulse-start ballasts with end-of-lamp-life cutouts, and pulse-start lamps with glass or ceramic arc tubes. Probe-start ballasts and lamps are not acceptable.

Specify cold-start fluorescent lamps and ballasts or LED's for parking garages and under covered outdoor locations.

In high ceiling areas, locate fixtures for maintenance access or provide access for maintenance equipment.

Before specifying any fixtures utilizing HID lamps verify lamp replacement cost. Any fixtures requiring lamps costing more than \$15.00 shall require prior approval by the NAU electric shop.

Task lighting shall be used in order to reduce the general lighting load.

Suitable listed fixtures shall be specified and installed in fire-rated ceilings.

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Incandescent fixtures shall only be allowed when specifically authorized in writing by the NAU Project Manager.

Wall-grazing lighting (fixtures mounted where the wall and ceiling intersect) will highlight irregularities in tile walls, gypboard walls, or wall coverings. Wall grazing lighting should only be used when the wall is highly textured by design. Wall washing lighting (fixtures at least 24” off the wall to the closest edge of fixture) is preferred.

The preferred method of powering egress and exit lighting is (in order of most preferred to least preferred) engine-generator (if present), central inverter with remote maintenance reporting, and integral battery packs.

In renovation projects where existing fixtures are to be re-used, they shall be retrofitted with new ballasts and lamps as specified herein.

The preferred concept for emergency lighting is the use of a centrally-located, listed, emergency lighting inverter. In existing buildings, emergency battery ballasts in unswitched normal power fixtures shall be used. An acceptable alternate is sealed beam emergency lights with individual power packs, circuited to a normal power panel.

Projects requiring emergency power shall have a feasibility study, examining central inverter or generator vs. individual battery packs. Short battery life due to temperature extremes, vandalism, unreliability and high maintenance costs of battery packs should be considered in the study.

The following design parameters are provided as guides only for conceptual calculation for electrical and lighting loads.

<u>AREA</u>	<u>FOOTCANDLES</u>
Computer Labs	20-30
Library Reading Rooms	50
Calculating Rooms	50
Drafting Rooms	75
Accounting Rooms	50
Proofreading Rooms	75
Classrooms	50
Laboratories	75
Seminar Rooms	50
Offices	30-50
Shops	50
Toilet Rooms	10



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Kitchens	30
Locker Rooms	10
Store Rooms	20
Corridors & Stairs (academic and offices)	25
Corridors & Stairs (dormitories)	10
Machine Rooms	20
Building Entrances (interior)	Same as corridors

Supplemental local illumination shall be provided wherever required to give the following local intensities:

Shop work at machines or benches	75
Displays	75
Demonstration Tables or Areas	60

Part 2 – Products

Lamps shall be manufactured by General Electric, Voss, Westinghouse, Sylvania, or equal.

Linear 4 ft fluorescent lamps shall be energy-saving T-8 type, 4100K, 20,000 hr life rated, CRI > 75. Four foot lamps are the standard, and preferred. Compact fluorescent lamps in twin-, tri-, and quad-tube T4 configurations are allowed. 8 ft and U-bend lamps shall be specified only with written approval from the NAU Project Manager.

Exit lights shall be LED type.

All fixtures operating in low temperatures shall be supplied with low temperature ballasts.

Fluorescent ballasts shall be rapid-start electronic type with total harmonic distortion less than 20%, power factor 95% minimum, lamp current crest factor 1.6 or less, sound rating "A," and minimum five year material and labor replacement warrantee. Ballasts shall be as manufactured by Valmont (Ultramizer), Advance, Motorola, EBT, Magnetek (Triad), or approved equal.

Part 3 – Execution

In 277V lighting systems where inside tubes and outside tubes are switched separately, the same phase shall be used for each fixture so that 480V will not be accessible in the fixture.

Wiring for fixtures in accessible ceilings shall be accessible after fixture installation, without requiring removal of the fixture from the ceiling.

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Number

Fixtures mounted in plaster or drywall ceilings shall be rigidly supported with channel supports across plaster framing. Mount all fixtures with a minimum of three 1/4" bolts for 1' x 8' fixtures, two 1/4" bolts for 1' x 4' fixtures, and four 1/4" bolts for 2' x 4' fixtures.

Recessed fixtures shall be supported to the building structure (not the roof deck). All fixtures shall be supported on at least two points (opposite corners each individual fixture) with #12 gauge ceiling wire with a minimum of 3 twists of wire at each point of attachment. Two or more wires shall not be supported by a single anchor. Two or more fixtures shall not be supported by a single wire. Points of attachment and anchoring shall be approved by the Design Professional. Install strut channel as necessary to provide support between building structural points.

**26 56 00 Exterior Lighting**

Part 1 – General

Lighting concepts and recommended illuminance levels per the Illuminating Engineering Society of North America (IESNA) Lighting Handbook and Recommended Practices (latest editions) shall govern the lighting design.

All building entrances shall be illuminated with photocell-controlled luminaires.

Luminaires shall comply with Flagstaff Lighting Code (Development Lighting Regulations, Division 10-08-002 of the Land Development Code).

Exterior lighting shall be coordinated with physical security, CCTV, and landscaping requirements. Exterior decorative lighting shall not be used for general illumination.

Minimize direct light onto windows; direct and reflective (disabling) glare; and spill illumination onto adjacent properties (use house-side shields when adjacent to residential property). Fluorescent lighting is preferred for parking garages.

Include conduits, and mounting provisions in pole bases and on poles, for camera or other security equipment as required. Ensure that all wire installed in poles meets the minimum insulation requirements dictated by the voltage present on the lighting circuit. Provide complete pole base details on plans. Details shall indicate complete structural and electrical elements such as rebar, type of concrete, anchors, conduits, handholes etc. Structural elements shall be designed by a licensed structural engineer to meet all local structural conditions, such as seismic zone, soils, wind loading, etc. Coordinate pole locations with snow removal means, and hardscape and landscape features, including projected tree growth.

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Concrete electrical boxes at all street light and parking lot light poles. Street lights and parking lot lights to be 277 volts. No more than 277 volts to be inside the pole.

Provide outdoor, municipal-street-lighting-type control cabinets with integral main overcurrent device, branch breakers, control components, stainless steel enclosure mounted on legs, and spare 1" conduits out of pad. Mount controller on a concrete pad, in an unobtrusive location out of the way of snow removal equipment or protected with bollards.

Dormitory parking lot lighting shall be fed from the electrical system in the dormitory associated with the lot.

A 20' coil of #4 bare copper wire in contact with earth at the bottom of a pole base excavation is preferred to a driven ground rod.

### Part 2 – Products

N/A

### Part 3 – Execution

N/A

**\*\*END OF SECTION\*\***