The following narrative pertains to UNL city and east campus buildings only. The design of Electrical Systems for UNL Housing, UNO, UNK and UNL owned outstate buildings shall be coordinated with NU engineering on a project-by-project basis.

Compliance: The design and construction of all building electrical systems shall be in complete compliance with all current adopted codes as outlined in the code section of this narrative. Referenced codes are to be viewed as the "final authority" for establishing the minimum requirements of electrical devices, equipment and systems. The requirements in these documents often exceed the minimum requirements of the code, when this occurs the more stringent requirement shall be complied with.

Quality of Workmanship and Materials: The selection, design, and specification of the materials and workmanship to be incorporated into the electrical systems of the project should respond to the demanding environment of a major educational institution providing reliable, durable, low-maintenance, long-life usage, while recognizing the budget constraints for the project.

General Narratives: Refer to General Narratives within these Guidelines for additional information on Application Guidelines; Codes Standards and Regulations; Commissioning, Design Deliverables; Project Design Calculations and Sustainability.

Electrical Design Deliverable: Refer to Design Deliverable Checklist within these Guidelines.

Service Entrance: Refer to the Utility Electrical Service and Utility Electrical Distribution Section for additional information. Note: Unless specifically authorized by utilities Management, all medium voltage feeders serving campus building transformers and utility distribution equipment shall be provided within concrete encased ductbanks. Each building shall be served by a single pad mounted transformer located as close as possible to the main electrical room. There should be a single disconnect, allowing the complete elimination of all electric service to the facility located at the main switchgear. Electrical design shall take power system harmonics into consideration. Calculated fault currents and short circuit calculations shall be applied in determining connected equipment fault current ratings. Where electrical service is provided by the local utility company, ascertain all their requirements are met and provide metering accordingly. An electronic meter with KYZ and Modbus communications shall be provided in the main switchgear regardless of main utility metering requirements.

Field markings indicating the actual short circuit current available per NEC 2017 Article 110.24 (for all electrical services) shall be provided along with enhanced markings and documentation for arc-flash information for 1200 amp and larger services per NEC 110.16. See Overcurrent Protection/Coordination Section below for further information.

Utilities: Refer to Utilities Narrative within these Guidelines for additional electrical requirements.

Service Switchgear and Metering: Consider replacement of the existing main disconnect, switchgear and distribution system on a case by case basis with the project manager or UNL representative. Evaluation shall include the age of existing equipment and extent of renovation. Switchgear and distribution system equipment shall be sized and located within facility and in accordance with the following:

- Meet actual building system loads
- Minimize distribution system losses
- Ensure safety of patrons
- Function within the architectural environment of the facility
- Be cost effective

Refer to the Utility Metering Section for additional information. Provide Switchgear with solid state metering. KYZ and Modbus output shall be specified on solid state metering.

Surge Protection Device: SPDs are required generally at all service entrances at a minimum and at distribution panels throughout a building. See specification 26 24 13 & 26 24 16 for technical requirements.

- SPDs integral to the panel are generally preferable over standalone units.
- SPDs at service entrance and distribution panels shall have a dedicated overcurrent protection device for servicing with no power outage. SPDs at branch panels do not require overcurrent protection unless manufacturer requires it.
- Where not integral to the panel, switchgear or switchboard bus, position the SPD as close to the panel as possible and provide as short & straight of a circuit as possible. Serve external SPD with specialty low impedance cabling.
- It is recommended to provide at least one SPD device at each voltage level within a system.
- Sensitive loads may require additional SPD protection at the panel serving these loads.
- SPDs should be cascaded such that higher surge current rated units are provided at the service entrance and distribution SPDs while lower surge current rated units are provided at the branch panel level.
- SPD sizes & ratings should be coordinated so that upstream units have larger max continuous operating voltages (MCOV) and voltage protection ratings (VPR) versus downstream units. The effect is to 'chop' the transient down as it passes through the system.
- SPD clamping voltages should be coordinated with voltage limitations of equipment protected downstream. The VPR rating should not exceed the equipment voltage tolerance.
- All panel, switchboard, and switchgear SPDs shall include surge counter & aux contacts.
- Units shall be the UL Type (I-III) & IEEE Category (A-C) appropriate for the location.
- All SPDs provided shall have a AIC or SCCR rating that meet calculated short circuit current levels present within the system at the SPD installation locations.
- LED light fixtures pose additional requirements for SPDs. See the interior and exterior lighting sections below for more information.

Overcurrent Protection/Coordination: For new construction projects or projects that significantly impact the electrical distribution system for an existing building, a short circuit and overcurrent protection coordination study and arc flash study shall be provided. All distribution equipment shall be marked with appropriate arc flash rating per NFPA requirements and switchgear labeled with CT ratios. Project overcurrent protection/coordination studies shall include the following:

- Electronic copies of study report, system one-line diagram(s), and copy of the analysis software file in either SKM or Easypower format. UNL will be provided full access and ownership of the analysis file.
- Arc flash label graphics that meet current UNL standards for aesthetics as well as specific information required on the label itself. Coordinate with UNL Project Manager for details. Label printing and application in the field to be paid for by the project.
- Discussion and recommendations of study findings as they pertain to enhancing system overcurrent protection coordination, minimizing arc flash incident energy levels, and other points of interest related to improving the system performance, safety, and reliability.

Coordination studies shall be submitted for review during the submittal review process of the project. The study shall be reviewed and approved prior to ordering of any electrical panels, switchboards, switchgear, equipment disconnects, or any other devices whose short circuit current ratings (AIC or SCCR ratings) may need to be modified in light of the study's findings. Projects will be responsible to implement the necessary overcurrent protection device settings or setting adjustments required of the system by the study.

Service Grounding: A central grounding system will be provided for the electrical service, all switchboards, and step-down transformers. A low impedance connection to earth will be obtained using ground rods, a concrete encased electrode and bonding to the building steel and main water piping. All grounded busses from switchboards, transformers, panelboards will be connected at a central ground bus in the electrical room. The telecommunications room grounds will also use the main building ground bus as the reference point.

Building grounding electrode system shall achieve low impedance per IEEE 132 recommendations. The inclusion of ground test wells is anticipated typically to allow for testing of ground system after installation. See Specification 26 05 26 for additional requirements.

Service for Mechanical Systems: Project A/E consultants shall structure contract documents to reflect the assignment of responsibilities for procuring materials and equipment and installing/setting/placing of such procured materials and equipment. A responsibility table shall be provided for electrical/mechanical work indicating both providing and installation responsibilities included as follows but not limited to:

- Safety switches
- Starters
- VFD's
- Control wiring
- Main Overcurrent Protection
- Connections for simultaneous run

Building Automation/Energy Management and Control Systems: Coordinate construction documents with Energy Management and Control Systems documents prepared by UNL BSM. Show location of electrical work for control devices on electrical drawings. Low voltage control wiring in mechanical rooms or other occupied spaces should be run in EMT, (coordinate size with UNL BSM) except the final connection from junction box to actuators should be run in 3/8" flexible aluminum conduit. The length of the flexible conduit should not exceed 24" or the length of the actuator's power/data cable.

Project specifications should require electrical installer to provide temporary lighting for UNL BSM personnel at ATC panels to facilitate the installation of energy management and control systems wiring and devices. Specifications should direct the completion of the power circuits required for the control system components to enable the Control Systems Group to test and calibrate components of the control system installation. This should occur well in advance of the date at which the control system is to be made operational. Each piece of equipment or system shall be served by a dedicated control circuit that is wired so as to be disabled when the power circuit is disabled. Standard control circuits shall be 120 Volt. Automated/Energy management controls shall be provided as part of the standby power circuit where a generator is installed. Low voltage wiring in mechanical spaces or other occupied spaces should be run in EMT, (coordinate size with UNL BSM) unless concealed or routed in cable tray.

HVAC Control and Building Automation: Refer to HVAC Control and Building Automation Narrative within these Guidelines for additional electrical requirements.

Energy Conservation: Refer to Energy Conservation Narrative within these Guidelines. Projects are encouraged to consider reduced watts/square foot calculations based on current code requirements and industry practices. For example, see NEC 2017 Section 220.12 lighting load by occupancy exceptions.

Motor Starters: Each three-phase motor shall be served by a magnetic starter with a hand-off-auto switch, as opposed to a manual starter or a VFD. As a general rule, provide a VFD for all motor loads of 5 HP or larger. Motor loads shall be evaluated and provided with 3-phase loss/phase unbalance protection when deemed necessary per specific installations. Coordinate the use of starters and fused safety switches with Mechanical Engineer and equipment being

provided. Provide a responsibility table for coordination of providing and installing equipment necessary for electrical power and control of mechanical equipment. Motor starting equipment furnished as part of the mechanical equipment package shall have a minimum short circuit current rating matching the available fault current in the circuit. VFD cable meeting UNL requirements shall be provided. Cable from VFD to motors shall be symmetrical, shielded, with heavy ground conductors, Belden Classic 300% Braid Design 2kV VFD Cable, no equal. VFD cable ground to be fully rated to match phase conductors. Ground from VFD back to source panel to be fully rated to match phase conductors. Dedicated bonding conductor shall be provided from motor wiring termination box to the motor frame itself.

Generator: A standby power generator system with automatic transfer switch(es) should be provided wherever possible to provide power for life safety loads, standby power loads, and optional standby power loads. Generator manufacturers shall have a local service department with 1 hour of project location and should be manufactured by Caterpillar, Generac, Kohler, or approved equal. The preferred location is the exterior of the building with full weatherproof enclosure; exact location will be approved by the UNL Project Manager and/or Architect. As a general rule, fuel source shall be natural gas for generators rated 150KVA or smaller and diesel fuel with a sub-base fuel tank for units larger than 150KVA. All generators shall be provided with remote annunciators, self-contained battery charging systems and cold weather kits as necessary. Provide generator with dedicated overcurrent protection and protected cam locks for portable load bank connectivity combining load bank connection with portable genset provisions is encouraged. Generator engine manuals shall be provided with project submittals.

All new generator systems serving like safety loads shall come with permanent switching means to connect a portable or temporary source of power. See NEC 700.3 for details.

Life Safety, Standby Power, and Optional Standby Power Distribution: Generally, the life safety panel(s), standby power panel(s), and optional standby power panel(s) shall be located in the main electrical room. Life safety power systems, standby power systems, and optional standby power systems shall be separated electrically as required by code.

Life Safety Power: Life safety power shall only serve systems legally required and classified as life safety by code and AHJ. This system is intended to automatically supply illumination and power to designated areas and equipment in the event of normal power failure and which is essential for safety to human life. Exit and egress path lighting, fire detection and alarms, public safety communications, etc. are a few systems that require life safety power systems as deemed appropriate and necessary.

Standby Power: Standby power shall only serve systems legally required per code and AHJ that enhance the act of egress and improve firefighter operations. This category includes smoke evacuation and elevator systems.

Optional Standby Power: Optional standby power shall serve power to systems and operations that the University has designated as important but that aren't necessarily code or AHJ required. The designation occurs on a project-by-project basis. Typical loads include: building automation controls, communication systems, ventilation (fume hoods), and select heating elements.

Life Safety and Standby Power Systems Distribution: Where new buildings or building renovation projects are provided with a life safety, standby and optional standby power generator, the standby and optional standby power shall be provided and connected to separate power branch circuits through separate transfer switches from the life safety transfer switch. All three power types will have dedicated transfer switches and electrical distribution infrastructure.
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Coordinate with the University project manager, representative, BSM and occupant interviews for optional standby power required per individual facility needs. The following are typical optional standby power requirements that shall be evaluated and provided as necessary but not limited to:

- Perimeter heating systems
- Building automated controls (including T-stats)
- Energy management systems
- Card Access
- Fire Systems
- Telecomm & data processing
- Refrigerated systems
- Sump pumps
- Programmatic space needs
- Programmatic equipment
- Chemical fume hoods

Automatic Transfer Switch: Provide a separate transfer switch and electrical distribution system for life safety power systems, standby power systems, and optional standby power system loads as required. Provide the automatic transfer switch for the optional standby power connection in a closed transition configuration with solid neutral connection and protective relays. Life safety and standby branch power does not require the use of closed transition transfer devices. Where open to public view, provide keyed or code protection at switch controllers. Evaluate and coordinate with the UNL Project Manager and UNL Facilities Planning and Construction Engineering department the use of closed transition type transfer switch for optional standby power systems to help deter manual resetting of building controls during monthly generator tests.

Panelboards and Distribution: Each distribution panel located within the building shall be served by a dedicated circuit breaker within the distribution section of the unit substation. Distribution and branch panels may be located in electrical closets that are directly accessible from a public corridor. These closets shall be labeled “Electrical”. They may also be located in public corridor walls and, if so, shall be flush-mounted. Each panel shall only serve electrical devices that are located on the same floor as the panel. The only exception to this is an emergency panel, which may serve multiple floors. Branch panels shall be located such that branch circuits will not exceed 100 ft. in total developed length. Each flush-mounted panel shall be fitted with four spare 1” conduits that extend above accessible ceiling space or to a point near the structural ceiling. Each new distribution or branch panel shall have a minimum of 42 spaces and a minimum of 20% spare circuit breakers when the entire installation is complete.

Electrical Identification labels: Every electrical unit substation, switchboard, transfer switch, motor controls, safety and starter switches, distribution panels, branch panelboards, etc. shall be identified with a permanent nameplate label. The label shall include verbiage as required per NEC Art. 408. The label shall consist of three sets of alphanumeric abbreviations that are combined to form a single identification label. For example: 1L1-0H1/032B

> ‘1L1-’: The first abbreviation is a combination of alphanumeric digits, the first digit shall indicate what floor the panel is located on. The middle digit(s) indicate the panel voltage and power type: ‘H’-High 277/480V, ‘L’-Low 120/208V and backup power abbreviation digits, ‘LS’-Life Safety, or ‘OS’-Optional Standby. A normal power abbreviation digit ‘N’-Normal IS NOT necessary as it’s presumed to be normal power when emergency abbreviation digits are not present. The last digit within the first abbreviation shall indicate the sequential number of panel quantities for multiple panels per floor.
>
> ‘0H1/’: The second set of abbreviations is the alphanumeric identification label ‘0H1’-Basement High Voltage Panel 1 which is the source panel, equipment, transformer, switchgear or distribution panel that feeds the corresponding panel being labeled.

'032B': The last set of abbreviations is the alphanumeric room identification '032B' which is the room number of the source panel, equipment, transformer, switchgear or distribution panel that feeds the corresponding panel being labeled.

Understandably this panel label designation is not realistic to use on floorplans within the electrical design documents. A shortened form of the three set alphanumeric abbreviation is allowable in the floorplan view using only the first set of abbreviated nomenclature for the panel name: 1L1; 1H2; 0HLS1, 2LOS1; 0HEQ2; etc. is acceptable to use on the plans for homerun circuits.

Panelboard/Equipment elevation/details, schedules and one-line diagrams shall be labeled with the full nomenclature nameplate designation. A note or matrix shall be provided on the plans explaining the full three set alphanumeric abbreviation labeling requirements to be provided by the contractor on each panelboard/equipment as the permanent posted nameplate. All nameplate labels must be formally printed out on an acceptable form of media and not hand written.

Flexibility of Electrical Systems: The usage of space within University buildings, especially laboratory spaces, changes frequently. Remodeling, renovations and program space changes are a common occurrence. Therefore, the building electrical systems shall be designed with sufficient flexibility and spare capacity to accommodate substantial future changes. Generally, a spare capacity of 25% minimum, when feasible, shall be provided throughout each electrical system, from the reserve transformer capacity to individual lighting and power circuits to the spare amperage capacity in each branch panel. Of course the initial cost effectiveness and feasibility shall be evaluated and coordinated with the University Project Manager or representative.

Circuiting: General use receptacles shall be served by 20 Amp circuits with a maximum of six duplex receptacles per circuit. Lighting shall be served by 20 Amp circuits using 277 Volt when available. Generally, a spare amperage capacity of 25% minimum, when feasible, shall be provided on each circuit. Shared neutrals should be limited on campus. This is to eliminate common trip breakers on multi-wire branch circuits.

Receptacles located in corridors shall be served by corridor circuits only and shall not be connected with receptacles located in other spaces such as offices, laboratories or other spaces where computers and/or equipment may be in operation. Corridor receptacles are used by custodial staff to power large cleaning equipment, resulting in the occasional tripping of circuit breakers.

Each substantial piece of hard-wired single-phase electrical equipment shall be served by a dedicated circuit. Every piece of hard-wired three-phase electrical equipment shall be served by a dedicated circuit. Equipment that incorporates duplex units for the sake of redundancy such as air compressor units, sump pump units and condensate pump units shall be served by two separate power and control circuits such that one unit can continue to operate when the other has failed. Each piece of equipment or system shall be served by a dedicated control circuit that is wired so as to be disabled when the power circuit is disabled. Standard control circuits shall be 120 Volt.

Separation of Electrical Systems: It is required that each different electrical system be separated and routed in separate conduits and as individual systems, complete with individual conduits, wireways, boxes, and other raceway components. Sharing of raceways and raceway components shall not be allowed, including but not limited to the following:

- 120/208 Volt Power Systems
- 277/480 Volt Power Systems
- Emergency System Power
- Optional Standby Power
- Power Circuits

- Lighting Circuits
- Telecommunication Systems
- CCTV/CATV Systems
- Building Automation Controls
- Security and Access Control

Low voltage wiring in mechanical spaces or other occupied spaces should be run in EMT, (coordinate size with UNL BSM) unless concealed or routed in cable tray. Color coded raceways are encouraged, though generally not a requirement, and shall meet UNL requirements.

Receptacle Layout: The density of portable electrical devices used within University buildings is often high and the usage of space changes frequently. Therefore an appropriate, per-space quantity of recessed, wall mounted, permanent 20 Amp duplex receptacles shall be provided in new and remodeled spaces.

Small offices shall have a minimum of two 20 Amp duplex receptacles whereas mid-sized and large offices, Classrooms, Lecture Halls and Labs shall be evaluated on a case by case basis and provided with sufficient 20 Amp receptacles as required by programing space needs. Provide receptacles for all pieces of office equipment (printers, monitors, computers, TV's, Projectors, phones, A/V head-end equipment, etc.) within close proximity to the location of such equipment so as to prevent the additional use of power strips and extension cords. A minimum of one receptacle per wall shall be provided and a minimum of one, four-plex receptacle is to be located adjacent to all new office workstations, office desks and A/V head-end equipment locations. The designer is to use sound judgment and occupant interviews in determining if any additional electrical receptacles are required and accommodate as necessary.

Provide 20 Amp duplex receptacles every 50 ft. (maximum) in corridors and public areas for use by custodial staff. Mechanical equipment rooms, electrical equipment rooms, elevator machine rooms, janitor closets and other service and support areas shall be provided with adequate 20 Amp receptacles as required by space needs. Provide dedicated receptacles for all pieces of equipment located within said space. Convenience receptacles shall be located with sound judgment and user interview input.

The location of outlets shall be coordinated with the layout of modular furniture/partitions with integral raceway. Surface mounted "tombstone" type floor outlets are not allowed. However, recessed, flush mounted floor boxes with hinged/removable covers that contain power and/or voice/data receptacles may be installed to serve equipment that is located remotely from the nearest wall.

An exterior 20 Amp, weatherproof, ground fault circuit interrupted receptacle shall be provided adjacent to each piece, or grouping of mechanical equipment at ground level and on rooftops within 25 feet of equipment to facilitate service and maintenance needs. The receptacle shall not be installed on mechanical equipment or on the mechanical equipment circuit.

Refer to the telecommunications section of this document for more receptacle requirements.

All final receptacle layouts shall be coordinated and approved by the University Classroom Support Group.

Building Elements: Refer to General Building Spaces, Rooms, Areas and other Building Element Narratives within these Guidelines for additional receptacle requirements.

Lighting Selection and Layout: Provide high quality equipment to meet the requirements of the design that provides low cost illumination with a minimum of installation and maintenance expense. For this reason, fixture selection will include, though not limited to, evaluation of:

- Minimum life cycle cost

- Ease of obtaining and replacing lamps, lenses, lamp sockets, and ballasts
- Structural integrity and fixture finish durability, including ease of cleaning
- Installation labor including aligning fixtures when mounted on stems.

The energy performance of Installed lighting power density shall conform to ASHRAE 90.1, and the A/E shall endeavor to exceed this standard by the widest margin possible. Photometric calculation sheets shall be provided to the owner as part of the design review submittals.

The quality and quantity of all illumination, in all areas shall be in compliance with the requirements of the Illumination Engineering Society of North America (IESNA) Handbook.

Recessed fixtures in solid ceilings should not be connected with fixture whips. Associated junction boxes should be accessible without removing fixture from ceiling.

In areas with fixed seating and/or tiered or sloping floors, locate light fixtures to facilitate their re-lamping/replacing by maintenance personnel.

Where fixtures are recessed into fire-rated ceilings and fire-rated enclosures are required, the fixtures scheduled for use in such areas should be approved and suitable for use in such areas.

General illumination for typical interior spaces such as offices, classrooms, laboratories, lecture halls, stairwells, corridors, and other public areas, equipment rooms, service areas, storage rooms, etc. shall be provided by 2'x4' or 2'x2' troffer fixtures.

Illumination of restrooms shall be provided so that failure of a single ballast or driver will not leave room in darkness. If a single two-tube fixture is used, provide two ballasts or drivers in fixture. Provide individual lighting fixtures above sink mirrors in all toilet rooms, both single occupancy and multiple occupancy.

Illumination for larger interior areas such as atriums, auditoriums, gymnasiums, warehouses, etc. shall be provided by fixtures and lamps that represent the lowest life-cycle-cost installation. Fixtures shall provide direct illumination.

Specialty lighting used to illuminate blackboards, presentation areas, etc. and associated controls shall be provided as directed by the Program Statement.

Specialty Lighting, if used, display case, decorative, accent and other special needs lighting shall be kept to a minimum and used only in high profile areas, such as main entry lobbies, theaters, etc. or where appropriate for historical preservation. Fixtures shall provide direct illumination.

All final lighting layouts shall be coordinated & approved by University Classroom Support Group.

Building Elements: Refer to General Building Spaces, Rooms, Areas and other Building Element Narratives within these Guidelines for additional lighting requirements.

Interior Lighting: General interior illumination shall use the most efficient method available that is compatible with the ambiance of the building areas, space use parameters, and building aesthetics. The quality and quantity of illumination shall be in compliance with the requirements of all local building codes and the specific requirements listed below. See Specification 265100 for additional requirements. For space types not specifically addressed by the UNL Design Guidelines, refer to criteria listed in the Illuminating Engineering Society (IES) Lighting Handbook or appropriate IES Standards.

Generally, LED based lighting technology is accepted for all interior lighting systems. Fluorescent based lighting is acceptable where required or for renovation projects to match existing, but metal halide and incandescent based systems are not permitted without written permission of the UNL

project manager. Interior lighting projects shall utilize energy efficient LED lighting with 3500K color temperature to reduce future maintenance and energy costs. Color rendering index (CRI) shall be 80 or higher. Warmer color temperatures may be used for building, artwork, or special feature lighting on a case by case basis if approved by the project manager.

Appropriate fixture layouts and light distributions shall be selected by project designer based on specific areas being illuminated (i.e. highbay spaces, corridors, classrooms). Appropriate wattage and drive currents shall be selected by the project designer based on the illumination criteria for each space. Generally, UNL expects fixtures from the list of standard product offerings to be provided for project common areas, corridors, office spaces, and vestibules where specialized or accent lighting is not required. Standard products can be found in Specification 265100 and are concerned only with lensed and center basket 2'x4' and 2'x2' troffer style fixtures. Downlights, track lighting, pendants, highbay fixtures, and other types are not restricted to any specific standard product list.

For all projects with exterior lighting, submit point-by-point photometric calculations (horizontal illuminance) overlaid on project floor plan. Plan shall also include summary table indicating compliance with horizontal and vertical illuminance criteria listed in illumination tables below.

Select interior LED fixtures with drivers that have integral surge protection. Consider the use of additional surge protection at the fixture for specialty lighting, sports lighting, and high wattage LED fixtures. Additional surge protection should be considered for either parallel or serial circuit connection as required by the project (i.e. serial circuit would disconnect the fixture upon SPD failure). Additional SPDs shall have an appropriate MCOV and VPR that limits the output voltage to within the tolerance of the protected LED fixture. See Specification 265100 'Interior Lighting' for more specific information and requirements.

If project work requires outages of any interior lighting adequate temporary lighting shall be provided for the entire duration of the outage as part of the project. Location, placement, and number of temporary lights shall be coordinated to the satisfaction of the project manager before existing lighting is disrupted. Staff, student, and public safety shall be given utmost importance.

The use of ornamental or decorative fixtures, particularly those of foreign origin, should be strictly limited to locations of special architectural emphasis and then only where it has been established that domestic-made fixtures providing the same effect are not available. Considerations which should enter into the selection of decorative fixtures should include the long-term availability of replacement parts, including lenses and other glass components and the costs associated with cleaning and re-lamping of the fixtures. The use of fixtures falling into this category should be approved by the University project manager or representative prior to their incorporation into the project construction documents.

In ground fixtures are discouraged for use at the University.

Lighted bollards are discouraged for use at the University.

Avoid manufacturers whose replacements ballasts, drivers, or parts are not in line typical costs.

All fixtures should bear the label of the Underwriter's Laboratories.

Exit and Egress Lighting: Provide emergency egress lighting and exit signage in accordance with all applicable codes and standards, including NFPA 101 and NEC 700. Egress lighting systems shall be designed with the minimum possible maintenance requirements.

All exit lighting shall be LED light source. No self-powered or tritium powered emergency devices are allowed. Do not use units containing radioactive material.

Where head of emergency lighting fixture is located remotely from battery pack, a printed label should be provided, indicating the location of the battery pack.

Where budget permits, provide emergency lighting system wired back to a single point and only one backup system, i.e. generator or inverter.

- All emergency lighting fixtures, whether powered by a central generator or by battery back-up, shall be equipped with identifying markers and provide illumination for at least 90 minutes.
- Battery backup fixtures are allowed if no other emergency source is available.
- Provide Generator Transfer Devices on individual fixtures that are locally controlled for user visual circumstances by manual or automatic switching. i.e. A relay device that switches the lighting load to a generator fed emergency circuit in response to loss of power on the normal circuit regardless of local switching control position or mode.

Lighting Levels: General design illumination levels should not exceed the criteria listed below and should not exceed the average raw foot candle values that are recommended in the IESNA Handbook, latest edition. Maximum to minimum ratios and average to minimum ratios should comply with IESNA guidelines for each application. Illumination levels and quality for areas and tasks in campus buildings shall be within 10 percent of that recommended by the IESNA Handbook for each type of space. It is not the intention of the standard to sacrifice safety, comfort or performance for the sake of energy conservation.

Sample foot-candle calculations for each typical space within the project shall be provided to the owner as part of the design review submittals. Calculations shall also be submitted for review indicating illumination levels and energy consumption are in compliance with program requirements, IESNA recommendations and ASHRAE 90.1.

Refer to the telecommunications section herein this document for additional related lighting level requirements.

Lighting Controls: Digital and networked lighting controls are expected on projects. Integration with University Building System Maintenance HVAC controls is expected. Controls shall be provided that adhere to IECC and ASHRAE energy codes as applicable. Lighting projects shall include ComCheck controls and energy verifications documentation as part of the design submittals. See Specification 26 09 23 for additional requirements.

~~***Lighting Controls:*** Where reduced lighting levels are necessary to allow note-taking during video presentations; incremental multilevel switching of stepped dimmed ballast shall be considered. Areas such as conference rooms, lecture halls as well as some classrooms, instructional labs and offices shall be designed with incremental multilevel switching.~~

~~If stepped dimmed ballast or drivers are not available for intended applications then multilevel switching of (2) dual ballasts which control inboard and outboard lamps shall be considered pending the cost effectiveness.~~

~~If the desired level/distribution of lighting cannot be achieved in this manner, dimmable LED lighting shall be provided. Dimmable fluorescent lighting shall only be used as a last resort and as budget allows.~~

~~Dual technology occupancy sensors with integral dual level lighting control switches or integral dimming switches shall be used wherever practical. When occupancy sensors are used the lighting that serves an area shall also be controlled by local dual manual override switches.~~

~~All manual override lighting control switches shall be installed as close as possible to the entrances that serve the area. Locate lighting control switches at the ends of hallways rather than the middle.~~

~~Controls for Specialty lighting used to illuminate blackboards, presentation areas, etc. shall be provided as directed by the Program Statement.~~

~~Where multiple circuit switching is necessary, multi-pole contactors or lighting control systems shall be used.~~

~~If a building-wide, networked lighting control system is used, it is encouraged to be integrated with the building automation system (BAS) for mechanical systems controls.~~

~~Coordinate all lighting control with University Building Systems Maintenance who provide occupancy sensing and control in all new buildings.~~

Exterior Lighting: General exterior illumination shall use the most efficient method available that is compatible with the ambiance of the surrounding area. Plan lighting to provide maximum visibility along walkways and near building entrances. Make provision for the natural view of gathering areas such as benches, tables, bike racks, and trash collection / pick-up locations. See Specification 265600 for additional requirements.

The quality and quantity of illumination shall be in compliance with the requirements of all local building codes and the specific requirements listed below. For space types not specifically addressed in this document, refer to criteria listed in the Illuminating Engineering Society (IES) Lighting Handbook or appropriate IES Standards. Particular attention shall be paid to enhancing vertical illumination for safety, while minimizing glare and light pollution.

All exterior lighting projects shall utilize energy efficient LED lighting with 4000K color temperature to reduce future maintenance and energy costs. Color rendering index (CRI) shall be 70 or higher. Warmer color temperatures may be used for building, artwork, or special feature lighting on a case by case basis if approved by the project manager, campus architect, and campus landscape architect. Examples include 3000K façade lighting of warm-toned materials or lighting near residence windows.

Appropriate optical light distributions shall be selected by project designer based on specific areas being illuminated. For example, type 5 distributions to illuminate intersections versus type 2 or 3 distributions to illuminate straight walkways. Appropriate wattage and drive currents shall be selected by the project designer based on the illumination criteria table for each area.

For all projects with exterior lighting, submit point-by-point photometric calculations (horizontal illuminance) overlaid on project site plan for review by project manager. Plan shall also include summary table indicating compliance with horizontal and vertical illuminance criteria listed in illumination tables below.

Select exterior LED fixtures with drivers that have integral surge protection. Consider the use of additional surge protection at the fixture for specialty lighting, sports lighting, and high wattage LED fixture. Additional surge protection should be considered for either parallel or serial circuit connection as required by the project (i.e. serial circuit would disable the fixture upon SPD failure). Additional SPDs shall have an appropriate MCOV and VPR that limits the output voltage to within the tolerance of the protected LED fixture. See Specification 265600 ‘Exterior Lighting’ for more specific information and requirements.

If project work requires outages of any exterior lighting (including building, sidewalk, or street lighting), adequate temporary lighting shall be provided for the entire duration of the outage as part of the project. Location, placement, and number of temporary lights shall be coordinated to the satisfaction of the project manager before existing lighting is disrupted. Pedestrian and vehicle safety shall be given utmost importance.

Exterior lighting shall adequate illuminate exterior exits, sidewalks, driveways, parking lots, courtyards, etc. as required to meet minimum requirements for path of egress illumination. Light levels from building to the designated public right of way shall meet minimum requirements per life safety code. Review of illumination requirements for egress shall be reviewed with UNL Code Official and project manager on a project-by-project basis to ensure compliance based on site specifics.

Parking Lot Lighting: Lighting for parking lots shall be simple and efficient via full cutoff luminaires. Lithonia DSX0 series shall be utilized for pole heights less than 25'-0". Lithonia DSX1 series shall be utilized for pole heights 25'-0" to maximum 30'-0". Poles shall be ~~6" nominal diameter~~ round tapered steel, black finish, with factory installed vibration dampeners, base cover, and raised concrete base foundation. Utilize optical light distributions appropriate for the size and layout of parking lot. Provide each luminaire with 0-10V dimming driver(s) and a seven-wire receptacle with photocell for control. Coordinate with UNL project manager and facilities engineering and controls group for consideration of a central lighting control system. When adding lighting to supplement in existing parking lots, closely match existing pole finish, shape, size and height while ensuring the University illuminance criteria are met. See Drawing 26 56 00-01 – Parking Light and Street Light Pole Detail – and table below for light level design criteria.

Table 1 – Parking Lot Illuminance Criteria

Parking Lot Illuminance Criteria					
	Average (fc)	**Max (fc)**	**Min (fc)**	**Average/Min**	**Max/Min**
Horizontal Illuminance	1.0	3.0	0.5	3.0	6.0
Vertical Illuminance	--	--	0.5	4.0	--

Notes:

1. *Values derived from IESNA G-1-03 and IES RP-20-14.*
2. *Maintained values calculated with a light loss factor of 0.8 and ground reflectance of 40%.*
3. *Horizontal calculation points taken at ground level and vertical points at 5'-0" above ground.*
4. *Horizontal calculation grid point spacing at 1/3 pole height with points maximum of 1/2 grid spacing at the perimeter boundary.*
5. *Vertical calculation grid points at the same horizontal grid point spacing in the two primary directions of vehicular travel.*

Street and Roadway Lighting: Lighting for roadways shall be simple and efficient via full cutoff luminaires. Lithonia DSX0 series shall be utilized for pole heights less than 25'-0". Lithonia DSX1 series shall be utilized for pole heights 25'-0" to 30'-0". Decorative luminaires may be considered for special applications as directed by the project manager, campus architect, or campus landscape architect for a specific project and location. Decorative luminaires shall be limited to Pedestrian Pole options 'B' and 'C described in the Pedestrian Lighting section. Standard poles shall be round tapered steel, black finish, with factory installed vibration dampeners, and raised concrete base foundation.

Design roadway lighting to illuminate adjacent sidewalks – two separate rows of poles for street and sidewalk is not acceptable. Particular attention should be paid to lighting levels at crosswalks, bike paths, and intersections. Roadway lighting levels, quality, and uniformity shall be in compliance with the IES Lighting Handbook and IES RP-8.

Provide each luminaire with 0-10V dimming driver(s) and a seven-wire receptacle with photocell for control. Coordinate with UNL project manager and facilities engineering and controls group for consideration of a central lighting control system. See Drawing 26 56 00-01 – Parking Lot and Street Light Pole Detail – and table below for light level criteria:

Table 2 – Street and Roadway Illuminance Criteria

Street and Roadway Illuminance Criteria					
	Average (fc)	**Max (fc)**	**Min (fc)**	**Average/Min**	**Max/Min**
Horizontal Illuminance	0.8	--	--	6.0	--
Vertical Illuminance	--	--	--	--	--

Notes:

1. *Values derived from IESNA RP-8-00. Assumes high pedestrian conflict area, Local Road, and both R1 and R4 surfaces. Designer shall adjust values accordingly based on project conditions.*
2. *Maintained values calculated with a light loss factor of 0.8 and ground reflectance of 40%.*
3. *Horizontal calculation points taken at ground level.*
4. *Horizontal calculation grid point spacing at 1/3 pole height with points maximum of 1/2 grid spacing at the perimeter boundary.*
5. *Intersections to be illuminated 50% higher than the roadway average value with similar uniformity.*

Pedestrian Lighting: Lighting for pedestrian walkways shall be via full cutoff post-top luminaires by Lithonia (Omero MRP LED series). Poles shall be Lumenpulse LumenTech 5" diameter, round smooth aluminum, black finish, with SPL011781 adapter for Lithonia Omero and four self-contained tracks for mounting accessory equipment such as banner arms, security cameras, speakers, etc. A decorative clam-shell base cover (Lumenpulse LumenArea ~~'QB8'~~ QB6' series) and flush concrete base foundation shall be provided with a concrete collar for ease of maintenance. Poles shall be installed adjacent to walkway with one side of concrete collar abutting the walkway and poles oriented such that mounting tracks are parallel and perpendicular to walkway. Provide each luminaire with 0-10V dimming driver(s) and a seven-wire receptacle with photocell for control. Coordinate with UNL project manager and facilities engineering and controls group for consideration of a central lighting control system.

Pedestrian areas can be categorized as campus malls, courtyards, plazas, quadrangles, or secondary pathways. Refer to the "Plan Big Campus Architectural and Landscape Guidelines Document" within the UNL Conformance to Campus Mater Plan for identification, location and definition of these spaces on campus. Three standard pole configurations shall be used for pedestrian lighting based on space type. The determination of the use of Pole A, B, or C should be reviewed and coordinated with the UNL project manager, campus architect, and campus landscape architect. Pedestrian Pole 'A' – Drawing 26 56 00-02 – is intended to be used for secondary pathways away from main throughways and courtyards, small standalone locations for security where appropriate. ~~and courtyards, where appropriate.~~ Pedestrian Pole 'B' – Drawing 26 56 00-03 – In general is the most desirable and intended to be most widely used throughout campus. ~~Is~~ It's intended to be used for campus malls, plazas, and quadrangles. Pedestrian Pole 'C' – Drawing 26 56 00-04 – is intended to be used for quadrangles and decorative street lighting applications. ~~In general, Pole 'B' – Drawing 26 56 00-03 is the most desirable and intended to be most widely used throughout campus.~~

Coordinate luminaire locations with landscaping and site furnishings. Along campus malls, luminaires should be directional and formally ordered, with a clear and intentional relationship to path paving module and geometry. Light levels shall meet the criteria listed in Table 4. In large open spaces such as quadrangles or plazas, lighting should be kept to the edges of the space to minimize visual clutter and maximize a flexible, unimpeded interior space. Light levels for courtyards, plazas, and quadrangles shall meet the criteria listed in Table 3 for secondary pathways, but discretion should be used for determining the specific areas requiring illumination. For example, it may be determined that these criteria only apply to the perimeter walkways of a large, unimpeded quadrangle.

Pole layouts and photometric calculations should be reviewed and coordinated with project manager, campus architect, and campus landscape architect. Utilize optical light distributions appropriate for the size and layout of walkways. See tables below for light level design criteria:

Table 3 – Courtyards, Plazas, Quads, Secondary Pathways Illuminance Criteria

Courtyards, Plazas, Quads, Secondary Pathways					
	Average (fc)	**Max (fc)**	**Min (fc)**	**Average/Min**	**Max/Min**
Horizontal Illuminance	1.0	3.0	0.2	4.0	8.0
Vertical Illuminance	--	--	0.2	--	--

Table 4 – Campus Malls, Main Pathways Illuminance Criteria

Campus Malls, Main Pathways					
	Average (fc)	**Max (fc)**	**Min (fc)**	**Average/Min**	**Max/Min**
Horizontal Illuminance	2.0	6.0	0.5	3.0	6.0
Vertical Illuminance	--	--	0.5	--	--

Notes:

1. *Values derived from IESNA G-1-03 and IES RP-8-00.*
2. *Maintained values calculated with a light loss factor of 0.8 and ground reflectance of 40%.*
3. *Horizontal calculation points taken at ground level and vertical points at 5'-0" above ground.*
4. *Horizontal calculation grid point spacing at 1/3 pole height with points maximum of 1/2 grid spacing at the perimeter boundary.*
5. *Vertical calculation grid points at 5'-0" from center of pole to between poles at same horizontal grid point spacing. Vertical calculation grid points face perpendicular to walkway (parallel to direction of travel).*

Exterior Lighting Controls: Exterior lighting shall be equipped with 0-10V dimming driver(s) and a seven-wire receptacle with photocell for control. Photocell shall be low profile and black in color. Coordinate with UNL project manager and facilities engineering and controls group for consideration of a central lighting control system and/or manual override via contactors at light pole source panel. Building mounted lights shall be controlled by the local lighting control system in that building, programmed to operate based on astronomical time clock or outdoor photocell input.

Project Outages: If project work requires outages of any exterior lighting (including building, sidewalk or street lighting) adequate temporary lighting shall be provided for the entire duration of the outage as part of the project. Location, placement and number of temporary lights shall be coordinated to the satisfaction of the owner's representative before existing lighting is disrupted. Pedestrian and vehicle safety shall be given utmost importance.

Telecommunications Entrance Conduit: Do not install more than two 90 degree bends between pulling points when installing underground conduit. Require that bends be long sweep type, with a radius of not less than six times the internal diameter of conduit for 2" or smaller conduit and ten times the internal diameter for conduit larger than 2".

Keep area around entrance conduit free of any construction, storage, mechanical apparatus, pipes or other items which might interfere with installing or maintaining cables.

Seal the inside-building end of conduit to prevent entrance of water or gases. Reseal conduits after cable is placed.

Provide pull string in all entrance conduits.
Terminate telecomm entrance conduit with metallic insulated-throat threaded bushing at terminal board or at cable tray. Secure conduit to cable tray with Gedney* CTC or comparable clamp.

Provide conduit from exterior of building into telephone entrance area in telecommunications wiring closet, sized in accordance with the following:

Entrance Pairs	Conduit Size
1-99 pairs	(1) 2” conduit
100-300 pairs	(1) 3” conduit
301-1000 pairs	(1) 4” conduit
1001-2000 pairs	(2) 4” conduits
2001-3000 pairs	(3) 4” conduits

Telecommunication Protection: Require conformance with Article 250-Grounding and Article 800-Communications of the National Electrical Code (NEC) for grounding, bonding, and protecting electrical and communications circuits. Provide appropriate grounding system in telecommunications equipment and server rooms. Provide appropriate bonding of cable tray and all other raceway devices as required.

Telecommunication Distribution: Cable trays shall be the primary low voltage raceway source for all facilities. Located cable trays in a clear accessible location above ceiling where other infrastructure does not interfere and so that there is ample expansion for future renovations, additions and adaptation to technology cable needs.
Provide fire stops for any cable tray system or riser system as required by the NEC.

Provide adequate raceways, for the distribution of telephone/data wiring, “home runs” the cabling from the telecommunications wiring closet to the work area outlet, without “daisy-chaining” boxes together. The raceways should be sized according to the number of telephone/data outlets to be served. Raceways may be horizontal and vertical conduit, cable trays, cable ladders, or any combination of the foregoing. Install all work area conduits to within three feet of the cable tray and provided with bushings.

Telecomm Cabling Conduit Size:

No. of Wires of Cables	Conduit Size
1	½”
5	¾”
8	1”
14	1-1/4”
18	1-1/2”
26	2”
40	2-1/2”
60	3”

Telecommunications Closet: Provide 100 amp 120/208 Volt 3-phase panel in each closet, connected to the emergency generator via standby power system when available. Receptacles in each room should include a minimum of one each L6-30R, one each L 6-20R, one each L14-30R, 2 each 120 volt 20 amp quad plex receptacles. A ground plate connected to the building main electrical ground system shall be mounted in the room with wiring sized as necessary by the engineer. The door to the room should be on the building card access system.

Telecommunications Layout: Confirm number of phone/data jack locations with UNL Facilities Management and UNL Telecommunications offices. For initial planning purposes, on combination telephone/data outlet should be allowed for each 50 to 60 sq. ft. of net office or laboratory area.

Office, Lab, Classroom Lecture Hall, Conference Room electrical and telecomm is to be evaluated and designed such that sufficient recessed, wall mounted, permanent, electrical and telecomm outlets are provided for all pieces of office equipment (printers, monitors, computers, TV's, projectors, phones, A/V head-end equipment, etc.) within close proximity to the location of such equipment so as to prevent the additional use of power strips, extension cords and patch cables. The designer is to use sound judgment and occupant interviews in determining if any additional electrical and telecomm outlets are required.

All final telecomm layouts shall be coordinated and approved by the University Classroom Support Group.

Low voltage wiring in mechanical spaces or other occupied spaces should be run in EMT, (coordinate size with UNL BSM) unless concealed or routed in cable tray.

Telecomm. Room Lighting: Provide a lighting level of 50 foot candles at worktop level in Telecommunication Rooms.

Communication Systems: Refer to Communication Systems Narrative within these Guidelines for additional electrical requirements.

Fiber Optics: Where fiber optic entrance is required, provide one 4-inch conduit, with three inner ducts (two 1-1/2" and one 1"). Refer to Telecommunications Systems Narrative herein for additional electrical requirements.

CCTV/CATV Coaxial Cable: Provide separate conduit for coaxial cable entrance; do not combine with other telecommunications entrances.

Provide TV trunk raceways 1" minimum conduit to each wing or floor of the building, terminating in a secure, accessible area, such as an electrical closet. Provide branch paths 3/4" minimum conduit from trunk termination to each television receiver location, terminating in a standard 3" x 5" box.

Provide one 110 Volt duplex receptacle at each television receiver location, located adjacent to television cable outlet.
Refer to Telecommunications Systems Narrative herein for additional electrical requirements.

Door Access Control: Refer to Door Access Control Narrative within these Guidelines for additional electrical requirements.

Fire Alarm: Refer to Fire Alarm Systems Narrative within these Guidelines for additional electrical requirements.

Elevators: Elevator receptacles and telecomm outlets shall be installed in metal boxes and grounded in accordance with code requirements.

Emergency lights shall be installed in all elevators.

Firefighter switches on elevators should be keyed alike and in accordance with University and Lincoln Fire Department standards.

Low voltage wiring in mechanical spaces or other occupied spaces should be run in EMT, (coordinate size with UNL BSM) unless concealed or routed in cable tray.

Where battery lowering is used, the overcurrent protection device (OCPD) protecting the elevator feeder circuit shall be provided with a set of auxiliary contacts. The auxiliary contacts shall be tied in parallel with the auxiliary contacts integral to the elevator disconnect switch. The auxiliary contacts shall de-energize the elevator and all sources of elevator power, including battery power. For retrofit applications, the auxiliary contact connection required at the elevator feeder OCPD can be made via an enclosed circuit breaker connected in series between the elevator feeder OCPD and the elevator disconnect. This requirement shall be met for all passenger and freight elevators.

Elevator Systems: Refer to Elevator Systems Narrative within these Guidelines for additional electrical requirements.

Specification Compliance:
Testing: Define requirements for testing of electrical systems.

Service Interruptions: Provide instructions for arranging for service interruptions.

Existing Exterior Area Lighting: Provide instructions in contract documents for keeping exterior area lighting in the vicinity of the project in service during the construction of the project. Where it is necessary to interrupt service to existing area lights, provide temporary service connections to such lights or provide temporary lighting arrangements with equivalent illumination and area coverage as provided by interrupted permanent fixtures. Control temporary area lighting with photo cells or time clocks.

Temporary Facilities: Insure that requirements for temporary electrical service and temporary lighting are properly defined and coordinated. It is UNL preference that temporary power services to construction projects be obtained directly from the available utility transformer, as opposed to being derived from an existing adjacent building's electrical service.

Access: Define responsibilities for placing sleeves, cutting and patching, and placing roof penetrations.

Removal of Abandoned Conduit: On remodel projects, require that existing electrical conduit which is not concealed in wall or floor slab construction and which is not being reused to be removed. Wires should be removed and embedded or non-accessible conduits abandoned in place should be cut off flush where it enters floor or wall construction.

Clean Up: Define responsibilities of electrical systems installer for clean up during and at conclusion of construction period.