SECTION 16500
LIGHTING

PART 1 - GENERAL

1.1 SYSTEMS DESCRIPTION

A. Illumination Levels:

1. Design illumination levels for different activities shall correspond to those listed under "Lighting Level Standards" (below). These levels are based on the Illuminance Standards in the most current edition of the IES Lighting Handbook. The Designer shall confirm the levels given in the edition of the IES Lighting Handbook relevant to the project; any subsequent criteria shall supersede the levels below. For activities not covered by the University standards below, refer to IES recommendations.

<table>
<thead>
<tr>
<th>Type Of Areas</th>
<th>Recommended Footcandle Level at WorkStation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hallways, Corridors</td>
<td>5-10</td>
</tr>
<tr>
<td>Lounges, lobbies, reception areas, stairs, storage rooms, locker rooms, elevators</td>
<td>10-30</td>
</tr>
<tr>
<td>Work circulation areas, surrounding work stations, bathrooms, work areas where critical visual tasks are not performed</td>
<td>20-30</td>
</tr>
<tr>
<td>Conference rooms, library stacks, areas where tasks such as reading, typing and writing are performed</td>
<td>30-50</td>
</tr>
<tr>
<td>Classrooms, study rooms, libraries, offices</td>
<td>40-60</td>
</tr>
<tr>
<td>Laboratories and shop areas</td>
<td>50-75</td>
</tr>
</tbody>
</table>

2. Lighting Levels for Specialized Tasks: Laboratories, shop and work areas where critical or very fine tasks are performed, or areas where poorly printed or reproduced material is used, may require higher light levels. These higher levels shall be directed to the task area only. Ambient light levels shall not be increased to meet the needs of particular tasks.
3. As recommended by the IES, light levels greater than fifty (50) footcandles refer to illuminance on the task. In most cases, the average level of general lighting in an area shall be one-half to one-third the level for the tasks performed in that area.

4. In most cases, illumination levels in excess of sixty (60) footcandles shall be provided by task lighting only.

B. Lighting Power Density:
Adjusted power density for lighting shall comply with in Title 24 compliance procedures.

1.2 DESIGN PROCESS

A. General:

1. Design drawings, data, and calculations at various stages of completion shall be submitted for each phase of the University’s plan review process. The specific submittal requirements for each phase are outlined below.

2. University approval is required at each review phase. Approval of design work that proceeds ahead of the review schedule is contingent on the incorporation of recommended revisions from the most recent review phase.

3. Refer also to Section 01330, Submittal Procedures.

B. Schematic Design: Cost-effective day-lighting strategies, task lighting, lighting controls, and the impact of lighting systems on HVAC systems shall be an integral part of the building’s design. Different day-lighting and artificial lighting design approaches shall be evaluated for their efficiency and cost effectiveness.

C. Design Development: The submittal shall include an economic analysis considering installed costs, energy use, lighting efficiency, maintenance costs, lamp life, footcandle levels, and watts-per-square foot connected load. Manufacturers’ literature and photometric data for each fixture shall be provided. Fixture schedules shall be included along with estimates of fixture quantities and watts per fixture.

D. 50% Construction Documents: Manufacturers’ literature and specifications for all controls shall be provided. An economic and energy analysis of the control scheme shall be provided along with specific details of the entire system.

E. 95% Construction Documents: Complete design with all details on lighting system, economic and energy analysis.

1.3 GENERAL DESIGN CONSIDERATIONS


B. Task/Ambient Lighting: Designers shall investigate a task/ambient lighting layout -- a non uniform lighting pattern, highlighting task locations, while providing a lower level of general illumination for the space. Either the relocation of lighting
equipment when tasks are relocated within a space, or an overall lighting system with adequate switching for flexibility of task arrangements, shall be considered.

C. Daylighting: Designers shall take advantage of natural daylight to replace or supplement artificial lighting. Daylighting aspects shall be considered an integral part of the design and shall be addressed at the conceptual stage of the design process. Control devices such as blinds, diffusers, and light shelves shall be utilized to project light into the space and to control brightness and glare. Where possible, skylights and clerestories shall be considered.

D. Controls:

1. Designers shall consider and design for control schemes to limit the unnecessary operation of artificial lighting. These include:
   a. Abundant, accessible manual switching
   b. Occupancy sensors
   c. Dimming controls
   d. Photo-electric cells for outside lighting
   e. Electronic time clocks
   f. Central programmable microprocessor-based lighting control systems

2. Where natural day-lighting is present, artificial lighting systems shall be controlled to eliminate unnecessary illumination. Controls shall be capable of dimming or turning off lights completely. Where lights are dimmed in response to natural light, a minimum of two (2) steps of reduction shall be utilized:
   a. Fifty percent (50%)
   b. One hundred percent (100%)
   c. Lighting circuits shall be arranged to facilitate localized control. In all areas where effective use may be made of natural light, lighting circuits shall be arranged so that units in areas where natural light is concurrently available are controlled together. Areas where natural light is not available concurrently shall be controlled separately.

3. When a central programmable lighting control system is being used, the following shall be considered:
   a. Control will be circuit-based, per control zones related to switching and daylight dimming zones.
   b. The system shall have native provisions for multiple operating schedules, astronomical timeclock and multiple sensor inputs (daylight and occupancy/vacancy)
   c. The system will have a limited number of local control stations, but primary control-setting and system oversight shall be done centrally in the building, via vendor software resident on a PC.
   d. The system will have capability of expansion to permit reporting status and receiving commands from a campus or building BMS system, even if that feature is not required for the particular project.
E. Surface Reflectivity: Reference Section 09050 - Finishes.

F. Exterior Building Lighting: Reference Section 16520 – Outdoor Lighting System Specifications for requirements for lighting fixtures for roads, parking lots and pathways, Designers shall give priority to the most efficient HID and LED sources for lighting larger areas. Consideration shall be given to existing outdoor illumination, so as to avoid unnecessary lighting.

G. New Energy-Efficient Lighting Products: The University wishes to encourage the use of the most life cycle cost-effective (including replacement costs), energy-efficient lighting products available. All products shall have established reliability, maintenance and performance records.

H. Valence Lighting: Many valence lighting designs are open from above and thus allow combustible materials such as paper and cups to be tossed into the fixtures, creating a fire hazard. Where such conditions exist, lighting ballasts shall be shielded such that combustible materials cannot come in contact with the hot surfaces of the ballasts.

I. No building-attached lighting is permitted unless approved by University Architect / Campus Planning and Design office.

PART 2 -PRODUCTS

2.1 LAMPS

A. General: Priority shall be given to the use of high efficiency light sources.

B. Incandescent lighting shall not be used for general lighting.

C. Fluorescent: must be a high-performance T8 lamp on the Consortium for Energy Efficiency’s (CEE) list of qualifying products (http://library.cee1.org/content/commercial-lighting-qualifying-products-lists) 4-foot linear fluorescent lamps must be 32-watt T8 lamps, color temperature 4100K, minimum color rendering index (CRI) of 85, initial lumens of 3100, 24000 hour lamp life at 3-hr start (based on ANSI C82.11 standard), and TCLP compliant (e.g. low mercury content) from Phillips, Osram/Sylvania, GE, or approved equal, shall be considered the standard fluorescent lamp. For standardization, 4-foot lamps shall be used wherever possible.

D. Screw-in CFL and LED lamps are not acceptable in new construction or when fixtures are being replaced. New fixtures designed for CFL or LED sources are required. If screw-in lamps are used in retrofits, they must be energy star
qualified and on PG&E’s list of Pre-Qualified LED Integral Lamps, available at www.pge.com/led. Linear LED lamp replacements for T8 lamps are not acceptable.

E. High Intensity Discharge (HID): For each category of HID lamp required (metal halide, or high pressure sodium), all lamps within this category shall be of the same manufacturer. HID lamps installed in open-bottom downlight fixtures shall be self-extinguishing types wherein the current to the arc tube is interrupted in the event that the lamp envelope is broken. Interior use of HID sources shall be with consideration given to the problems of start-up and restrike time of these sources. Metal halide fixtures shall use pulse start lamps with electronic ballasts.

2.2 BALLASTS

A. Fluorescent Lamp Ballasts: Ballasts for all fluorescent fixtures shall be solid state electronic consisting of a rectifier, high frequency inverter, with power control and regulation circuitry. These ballasts shall also be UL approved, Class P, with a sound rating of 0.90, a power factor of at least 0.90, and a crest factor less than or equal to 1.7. Light regulation should be no worse than ten percent (10%) with a voltage variation of plus or minus ten percent (+/- 10%). Input current third harmonic shall not exceed ANSI recommendations; twenty percent (20%) total harmonic distortion, and seventeen percent (17%) of the third triplet. Flicker factor shall be less than fifteen percent (15%) for any lamp suitable for the ballast. The ballast shall also be able to withstand transients per IEEE 587, Category A, as well as meet the FCC Rules and Regulations, Part 18. There shall be a three (3) year warranty, including a labor allowance from the ballast manufacturer. Provide CEE-approved high performance ballasts (http://library.cee1.org/content/commercial-lighting-qualifying-products-lists) manufactured by GE AdvanceSylvania Universal All other Manufacturers must meet the requirements of 2.2-A. above, and be approved by the BGM/SEM. For non-dimmable ballasts, program-start ballasts are recommended where lights turn off and on frequently to extend lamp life (see section 3.1.D)

High Intensity Discharge Lamp Ballasts: HID lamp ballasts shall be high power factor regulating type, conforming to applicable NEMA standards, with minimum starting temperature of -20°F. All HID ballasts used inside shall be of the enclosed and potted type with the lowest sound rating available. Specify electronic ballasts that have bi-level capability, utilizing in conjunction with pulse start lamps

2.3 FIXTURES

A. Interior: Designers are encouraged to use fixtures with a coefficient of utilization (CU) greater than 0.80 for a room cavity ratio (RCR) of one (1.0). Fixtures shall be easy to clean and relamp, and shall have a low dirt accumulation rate. Lenses (where used) shall be one-hundred percent (100%) virgin acrylic or lexan. Parabolic, perforated and paracube lensed fixtures are not acceptable.
B. Exterior: All exterior damp and wet location fixtures shall be made of aluminum or a non-corrosive material. Recessed stairway fixtures and fixtures providing decorative lighting only shall be avoided. Refer also to 1.3.F.

C. LED Fixtures: All interior LED fixtures must be on PG&E’s list of Pre-Qualified LED Fixtures (www.pge.com/led) or on the qualified product list (QPL) of the Design Lighting Consortium (DLC) (www.designlights.org). LED fixtures must be compatible with specified lighting controls such as dimmers if applicable.

D. Recessed Cans Applications: LED fixtures shall be considered in recessed can applications. LED fixtures must be on PG&E’s list of approved can fixtures. If a CFL is preferred, the use of one larger CFL instead of two smaller is recommended to increase fixture efficiency.

E. LED light sources shall be 4100K for interior general lighting.

2.4 EMERGENCY LIGHTING

A. Emergency Lighting Systems: For projects where an emergency diesel generator is not available for emergency lighting systems, the following shall be the system of choice. The Project Manager will advise the Consultant whether emergency generator power is available. Battery backup exit signs and emergency egress lights shall meet NFPA 101 that requires an annual functional test for not less than 90 minutes.

1. Remote-powered emergency lighting system for egress path and exit lighting shall be a central inverter system.
2. Remote-powered systems shall be equipped with eighty percent (80%) low voltage cutout protection.
3. Remote-powered egress path lighting system shall be central inverter systems equipped with fluorescent lamps or LEDs.
4. Acceptable Manufacturers:
   a. Chloride
   b. Dual Lite
   c. Sure-Lites
   d. Holophane
5. Battery backup emergency egress lights shall be Dual-Lite with self-diagnostic electronics.

B. Exit Signs: Exit signs shall be self-powered LED type, have 120/277 VAC, 60 Hz field-selectable connections and be provided with 12 V nickel-cadmium batteries and manual test button. The electrical system shall be protected from surges, overvoltage and brownout. The exit signs shall be provided with self-diagnostic capabilities that indicate the condition of the battery, battery charger, transformer, self powered lamps and lamp circuit. The exit signs shall be supplied with universal mounting for top, side and rear mount, interchangeable single or dual
faces with green letter with black trim, and tamper proof LED cover. Words on the sign shall be in block letters six inches in height with a stroke of not less than ¾ inch. Exit signs shall have the option of providing directional arrows. Housing construction shall be white textured reinforced molded polycarbonate materials resistant to scratches and UV radiation.

C. The signs shall have a 25 year warranty on the electronic components, 80 year warranty on the LEDs, and a 10 years warranty on the nickel-cadmium batteries. The signs shall meet UL and UBL standards. Radioactive or self-illuminating exit lights are not allowed.

PART 3 - EXECUTION

3.1 MOTION DETECTORS

A. The objective of this section is to ensure that, through the installation of ultrasonic or infrared occupancy sensing lighting control devices, the lighting is turned off automatically in individual rooms or sections of rooms within a reasonable time delay when the last person leaves the room or area.

B. Occupancy sensor switched lighting controls shall accommodate irregular use of rooms or areas, all individual work habits, and all occupancy habits or conditions of space utilization.

C. The Contractor shall furnish and install a complete and operable ultrasonic/infrared occupancy sensor lighting control system, as described in the specification herein, as an integrated, totally compatible dedicated lighting control system.

D. It shall be the Contractor’s responsibility to provide the quantity of motion detectors required for complete and proper volumetric coverage without gaps within the range of coverage of controlled areas. All areas shall have 100% volumetric coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location. Proper judgment must be exercised in executing the work so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. Program start ballast shall be used where light will turn off and on in high frequency.

E. The Contractor is encouraged to submit the design layout of occupancy sensors to the sensor manufacturer for review. The Contractor shall make any necessary revisions to obtain approval from manufacturer of occupancy sensor design prior to installation.

F. Occupancy sensors may be affected by various conditions in the area. It may be necessary for the Contractor to make adjustments, change the location or type of sensor to obtain proper operation responsibility for proper operation and coverage of the system in changes and adjustments.
G. Sensors shall control lighting in the sensed area only. Occupancy sensors shall be installed as per manufacturer’s recommendations.

H. Occupancy sensors shall be manufactured by Watt Stopper, Sensor Switch, or approved equal. Position and adjust sensors to minimize nuisance shut-offs. Each cubicle, office or work space shall be covered such that the lights will stay on in an area surrounding the worker even if he/she is the only person in the area. Sensors shall be positioned such that the lights in an area turn on immediately upon entering a work area. (No dead spots near doors).

I. The time delay shall be set at fifteen minutes in work areas and conference rooms to eliminate nuisance shut-offs, and at shorter times in Xerox rooms or lunch areas to maximize saving.

3.2 DIFFUSERS

A. Diffusers shall be impact resistant and of a clear acrylic prismatic type construction. Contractor is required in both new installations and retrofit projects to clean and wipe diffuser.

3.3 RETROFIT KITS

A. Retrofit kits as manufactured by Wellmade Fluorescent Lighting or approved equal. Kit shall be UL approved. Reflectors, ballasts, lamps, etc. are required to meet or exceed requirements as specified above.

B. Retrofit kits shall have the same minimum CU or fixture efficiency as the new fixture requirement.

3.4 WARRANTY

A. The Contractor shall provide a one (1) year warranty on labor. The warranty shall be in writing from the Contractor and shall include any necessary repairs or replacement, at no cost to the owner, of all components installed under this contract.

3.5 INVOICING AND PG&E REBATE FORMS

A. Invoices must be itemized and submitted in the format required for PG&E’s rebate program. Contractor shall complete and submit all PG&E rebate forms to Stanford Project Manager and coordinate and attend all required PG&E project inspections.

3.6 PERMITS, FEES, TAXES

A. Contractor shall, on its own, or through its employees, agents or Subcontractors, obtain and pay for all permits, fees, licenses, and inspections required to perform the work. The Contractor shall, in addition, be responsible for all sales, use and other taxes required by law.
B. Before start of work: Submit three (3) copies of the following to the Stanford Project Manager for review.

1. Name and address of PCB ballast disposal firm. Include contact person and telephone number. If name of PCB contaminated material incineration facility is different, provide name and address. Include contact person and telephone number. Provide Proof of Insurance showing general liability and environment impairment coverage.

2. Name and address of fluorescent lamp disposal and/or recycling facility. Include contact person and telephone number. Provide Proof of Insurance showing general liability and environment coverage.

3.7 DISPOSAL OF PCB BALLASTS AND FLUORESCENT LAMPS

A. This section describes the disposal of PCB Ballasts and Fluorescent lamps. This shall include but not be limited to all handling, storage, transportation, disposal and associated documentation.

B. All PCB Ballasts and Fluorescent Lamps shall be handled, stored, transported and disposed of according these specifications and EPA, the Department of Toxic substance Control Guidelines, and Stanford Environmental Health and Safety (EH&S) procedures.

C. Copy of state or locate license for waste hauler.

D. California Waste Manifest Form.

E. Upon completion of project: Submit three (3) copies of all manifests and disposal site receipts to Stanford Project Manager. The Certificate of Destruction for the PCB ballasts must clearly indicate that the PCB contaminated items have been incinerated. A separate lamp disposal certificate is required.

3.8 STORAGE AND TRANSPORTATION

A. All containers shall be properly labeled prior to removal of PCB ballasts and fluorescent lamps. Upon removal PCB ballasts and fluorescent lamps shall be packaged immediately. Do not store containerized materials outside of the work area. Take containers from the work area directly to waste hauler.

B. Contractor is responsible for providing all leak proof waste storage and transportation containers necessary for storage and transportation PCB ballasts and fluorescent lamps. Containers shall be stored and labeled per county, state, federal, EPA and the Department of Toxic Substance Control regulations and guidelines.

C. All waste is to be hauled by a licensed waste hauler. The hauler shall be registered and permitted with all applicable county, state, federal and EPA agencies.
D. If a dumpster is to be located at the site for the project duration, arrange location of dumpster with Stanford Project Manager. Do not place dumpster on site without having Project Manager present.

END OF SECTION