

**Western Michigan University  
Facilities Management – Engineering Division**

**Design Guidelines for Construction:**

---

**DESIGN GUIDELINE: DG26-3 INTERIOR LIGHTING**

---


**GUIDELINE CONTENTS:**

1. GENERAL DESIGN REQUIREMENTS .....	2
2. QUALITY OF WORKMANSHIP & MATERIALS.....	2
3. INSPECTIONS.....	2
4. CODES & STANDARDS .....	2
5. BASIC DESIGN, MATERIALS & METHODS .....	3
5.1 Design .....	3
5.2 Products .....	6
5.3 Installation .....	12
6. SUBMITTALS.....	15
6.1 Design Development Submittals .....	15
6.2 Drawing Standards .....	15
6.3 Construction Document Submittals .....	15
6.4 Shop Drawing Standards .....	16
6.5 Operating and Maintenance Manuals .....	16
6.6 As Built Drawings.....	16
7. WARRANTIES (LED) .....	16
8. CLEANING/TURNOVER .....	17

**Western Michigan University Design Guidelines for Interior Lighting**

Western Michigan University in its endeavor to meet quality lighting and energy efficiency standards has developed this Design Guideline for Interior Lighting for new and redevelopment projects on University property.

The Design Guideline will be utilized on all new projects from this date forward by the University and its contracted Professionals.

  
\_\_\_\_\_  
Ms. Jan Van Der Kley  
Vice President Business and Finance  
Western Michigan University

9/19/13  
Effective Date

## **1. GENERAL DESIGN REQUIREMENTS**

These guidelines apply to interior general purpose lighting only.

The information presented in these Design Guidelines is for use by the Professional Service Contractor (Professional) in preparation of documents for the University. These are general design requirements and guidelines that apply to the Electrical Division of the University Guidelines. They represent the standard practices and level of quality required for all University projects. Deviations from these Guidelines require written approval from the University's Facilities Management-Engineering Division.

When the Professional utilizes standard specifications and/or company standard specifications, any differences of materials and practices from these Guidelines shall be identified to the University's Facilities Management-Engineering Division.

## **2. QUALITY OF WORKMANSHIP & 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, energy efficient, long-life usage, while recognizing the budget constraints for the project.

General work practices for electrical construction shall be in accordance with NECA 1, standard practices for good workmanship in electrical construction.

## **3. INSPECTIONS**

The University's electrical engineer will conduct periodic inspections which may require the participation of the contractor(s). The Professional's specifications for the project shall reflect this. During project close-out, the University's Facilities Management-Engineering Division or Engineering Firm will perform an inspection for final acceptance.

## **4. CODES & STANDARDS**

Codes shall be used as minimum requirements, and where these guidelines call for an installation that exceeds and does not violate the code requirements, these guidelines shall be followed.

All designs and work shall conform to the Professional's Agreement, the National Electrical Code, Life Safety Code, IBC, ASHRAE 90.1 and State of Michigan requirements. In addition the design and installation shall comply with all the requirements of MIOSHA and OSHA.

All materials used shall be new and conform to the standards of the Underwriter's laboratories in every case where such standards have been established for the particular type of material and/or application in question. All materials shall be labeled as UL listed.

If applicable, the Professional's specifications shall require the electrical contractor to obtain and pay for all permits identified and required by the State of Michigan. Local codes and restrictions do not apply.

## 5. BASIC DESIGN, MATERIALS & METHODS

### 5.1 Design

- A. Design shall conform to WMU "General Electrical Design Guidelines" DG26-0 as applicable.
- B. Lighting-General: Lighting systems shall be designed to provide uniform lighting throughout the space for adequate visibility, low-glare and safety. Lighting system shall be designed to meet or exceed the requirements of the most current version of the Michigan Energy Code, Life Safety Code and NFPA requirements.
- C. Lighting-LED: Where budget permits, LED Luminaires shall be utilized to maximize energy efficiency of the lighting system. Luminaires and controls shall be selected with the best interest of conserving energy. LED fixtures shall be used exclusively in spaces where lighting will be run 24 hours, 7 days a week. LED fixtures shall be used exclusively in spaces that are difficult to access including but not limited to stairwells, corridors, and atriums.
- D. Dimming: Where multiple lighting levels are desired by the owner, provide a dimming system and utilize daylight harvesting sensors where effective energy savings can be realized.
- E. Lamp Types: Luminaires shall be selected to minimize the number of lamp types utilized and stocked. Non-standard or special application lamps shall not be used without written approval of the University. □
- F. Interior Illumination Levels: The following lighting levels shall be used for design. Lighting levels shall be calculated and measured at 3 feet above finished floor. Foot candle level ratios shall not exceed 2.5:1 maximum to minimum uniformity.

Corridors and Stairwells	10 fc to 15 fc
Waiting Room and Lounge Areas:	10 fc to 15 fc
Toilet Rooms:	20 fc
(general illumination, plus separate fixtures above sink mirrors)	
General office spaces:	30 fc
Separate task lighting	60 fc
Conference and Seminar Rooms:	30-50 fc
Auditoriums:	50 fc
dimnable with switches and dimmers to minimal light levels.	

Cafeterias and Dining Areas:	40 fc
Locker Rooms:	30 fc
Classrooms and Lecture Halls:	30 fc to 50 fc
general illumination up to 50 fc on writing surfaces.	
Laboratories:	
General:	50 fc
Close:	70 fc
Library:	
Reading Rooms and Carrels:	60 fc
Stacks:	30 fc
Mechanical Rooms:	20 fc
(except that supplementary lighting should be provided to provide a light level of 30 fc at control panels, motor control centers and variable frequency drives.)	

**G. Function Specific Requirements:**

Arrange toilet room light fixtures so that failure of a single ballast will not leave room in darkness. If a single two-tube fixture is used in room, provide two ballasts in fixture.

Provide individual lighting fixtures above sink mirrors in all toilet rooms for both single occupancy and multiple occupancy.

In classroom buildings, provide motion sensor switches in toilet rooms.

**H. Decorative Fixtures:**

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. All fixtures should bear the label of the Underwriter's Laboratories. 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 relamping the fixtures. The use of fixtures falling into this category should be approved by the Facilities Management – Engineering Division prior to their incorporation into the project construction documents. When decorative fixtures are used LED lamps should be used.

**I. Lighting Calculations:**

A photometric layout of the room, showing proposed light fixture locations and fixture types shall be submitted for approval. The Layout shall show point by point foot-candle distribution on four foot centers with a summary indicating Average, Minimum, Max/Min and Ave/Min values at floor/work surface. A Light Loss Factor (LLF) of 0.72 shall be used in the calculation.

Emergency Lighting Calculations: Lighting levels with emergency only fixtures shall meet current code required foot-candle levels of 40:1 max to min, 1 foot-candel average and 0.1 foot-candel minimum.

J. Mechanical, Electrical and Telecomm Rooms:

Provide at least one emergency light fixture in each electrical, mechanical or telecomm room. Provide with emergency battery backup.

K. Lighting Controls:

Switching: Provide dual level ballasts where dimming is not utilized.

Provide multiple switching in office areas, classrooms and lecture halls for multiple light levels. Provide daylight harvesting where applicable. Lecture and auditorium classrooms lighting shall be controlled by the Crestron A/V (or the standard A/V controlling system as required in Audio Visual and Technology Standards) and multimedia control system. Provide standalone system that can be directly integrated over IP with the Crestron A/V system with no conversion boxes or separate dry contacts.

Approved manufacturers include: Crestron, LC&D (for lighting and dimming control systems.) Hubbell, Sensor Switch and Watt Stopper (for switches, sensors and standalone devices.

L. Occupancy Sensors:

Occupancy sensors shall be used in all spaces unless otherwise required by code. Ultrasonic technology shall not be used, dual technology or infrared sensors shall be used. Provide auxiliary contacts for HVAC where applicable.

Approved manufacturers include: Hubbell, Sensor Switch and Watt Stopper.

## 5.2 Products

### A. Luminaires

1. Provide lighting fixtures, complete with, but not limited to, housings, lenses, ballasts, lamps, and wiring. Ship fixtures factory-assembled, with those components required for a complete installation. Fixtures shall have concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen ballast generating noise.
2. List approved manufacturers in specifications.
3. Consideration of life cycle costs shall be required when selecting the lighting system.

### B. Excluded Lamp and Luminaire Types The following lamp types are not permitted under normal circumstances to be used in new Luminaires.

1. High Intensity Discharge (HID) Luminaires lamps shall not be used due to lamp color and lumen output shift.
2. Incandescent luminaires - Incandescent lamps are not to be used unless they are the last resort to accomplish a lighting task.
3. 8' or longer linear light fixtures and lamps – Fluorescent lamps and fixtures run in linear runs shall be multiple 4' sections. 8' light fixtures or lamps are not permitted.
4. Parabolic – Unless matching existing construction, parabolic lensed troffers shall not be used. The use of high efficiency volumetric or indirect lighting shall be used instead.
5. Compact Fluorescent (CFL) – Utilize LED recessed down-lights where incandescent and CFL were once used.

### C. LED Luminaires

1. General
  - a. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. A complete Luminaire shall consist of a housing, LED array, and electronic driver (power supply).
  - b. Luminaires shall be of uniform quality and appearance.
  - c. Luminaires shall have published independent testing results in accordance with LM79, LM80 & TM21.

- d. Luminaires shall be IC rated when in contact with insulation.
  - e. LED drivers shall feature standard dimming option with compatible 0-10V or incandescent dimmer.
  - f. All LED fixtures shall be 4100K color temperature, utilize same manufacturer within project where possible to maintain color consistency.
  - g. Luminaires shall comply with the following:
    - a) IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
    - b) IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources.
    - c) IESNA TM-21-11, Projecting Long Term Lumen Maintenance of LED Light Sources.
    - d) UL1598, Standard for Safety of Luminaires.
    - e) NEMA SSL 3-2010, High-Power White LED Binning for General Illumination
    - f) ANSI/ G.NEMA SSL 3-2010. Binning of LEDs
    - g) DLC Qualified and/or DOE Lighting Facts Listed.
    - h) UL Listed.
    - i) Photometric testing shall be in accordance with IESNA LM-80, certified by an independent laboratory. All ies data shall be available on-line.
  - h. Voltage – Luminaires shall be suitable for use on 277 Volt distribution wherever possible. Wire fixtures so that branch circuits supplying fixtures are same phase and so that no 480V differential is accessible. Specify multiple voltage option when available.
2. Recessed "Troffer" style luminaires shall comply with the following:
- a. Fixtures shall have a published minimum efficacy value of 95 Lumens per Watt tested in compliance with LM79 standards.
  - b. Color Rendering Index (CRI) shall be a value of 80 or higher.
  - c. Warranty: 10 years on fixture, LED's drivers and all components.
  - d. Manufacturers - Luminaires shall be one of the following:
    - a) Finelite: HPR-LED Series
    - b) Focal Point: FEQL Series
    - c) Corelite: ClassR2-LED Series

3. Recessed "Downlight" style luminaires shall comply with the following:
  - a. Downlights shall be of the lensed type to maintain a low glare appearance.
  - b. Fixtures shall have a published minimum efficacy value of 80 Lumens per Watt tested in compliance with LM79 standards.
  - c. Color Rendering Index (CRI) shall be a value of 85 or higher.
  - d. Warranty: 10 years on fixture, LED's drivers and all components.
  - e. Manufactures - Luminaires shall be one of the following:
    - a) Gotham: Series
    - b) Cree / Beta LED: LR Series
4. Decorative Luminaires shall comply with the following:
  - a. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. A complete Luminaire shall consist of a housing, LED array, and electronic driver (power supply).
  - b. Luminaires shall be of uniform quality and appearance.
  - c. LED drivers shall feature standard dimming option with compatible 0-10V or incandescent dimmer.
  - d. Provide Luminaires with color temperature required by the interior design group. When no color is chosen, utilize 4100K to match building lighting systems.
  - e. Photometric testing shall be in accordance with IESNA LM-80, certified by an independent laboratory. All ies data shall be available on-line.
5. Track and pendant Lighting shall comply with the following:
  - a. Provide LED track heads with appropriate beam angle and lens media to spot or wash the desired evenly.
    - a. 60 Lumens per watt or higher.
    - b. Color Rendering Index (CRI) shall be a value of 80 or higher.
    - c. 25,000 hour minimum rated fixture life.
    - d. 5-year warranty.
6. Other Decorative Fixtures with MR16 lamps:



- a. When MR16 fixtures are the only available source for a decorative fixture required, utilize Phillips MR16 LED lamps or equivalent with prior approval from Engineering Division.

#### D. Fluorescent Luminaires

1. Fluorescent luminaires should be T-8 technology, with locking T8 sockets, tandem wiring for ballasts if possible, and 95% efficient reflectors to minimize number of lamps and reduce wattage. High efficiency indirect or volumetric lighting are preferred to reduce glare and provide even illumination.
2. Ballasts
  - a. All Ballasts are to be electronic. Magnetic ballasts shall not be utilized, unless there is sufficient evidence that electronic ballasts will cause interference to other electronic equipment. Ballasts shall be Programmed Rapid Start, parallel wired (lamps) and for use with T8 lamps. Electronic ballasts shall have less than 10% total harmonic distortion, Type 1; Class P; sound rated A and 0.99 minimum power factor.
  - b. Fluorescent ballasts shall be manufactured by Phillip's Advance.
  - c. Dimming fluorescent ballasts may be used with appropriate and compatible dimming system such as the Lutron Grafik Eye.
  - d. Lighting at the University shall be powered from 277 volt circuits where possible. In 277 volt fluorescent lighting systems, where inside tubes and outside tubes are switched separately, use same phase for both sets of tubes so that 480 volts is not accessible in fixture. Require the use of barriers in any boxes where 480 volts would be accessible.
  - e. Fluorescent troffers shall be specification grade 3-3/4 inch minimum depth steel housing with die formed stiffeners, painted after assembly with baked white enamel finish with minimum reflectance of 90%, positive light seal not relying on foam gaskets, reinforced flat white steel door with mitered corners, cam latches, 0.125 inch thick low brightness acrylic prismatic lens, minimum fixture efficiency shall be 70% for a 2'x4' and 65% for a 1'x4'.
  - f. Industrial Fluorescent fixtures shall be heavy duty die formed steel channel and reflector, metal clad lamp holders with twist lock sockets, baked white enamel finish with minimum reflectance of 90%, 25% up-light, minimum fixture efficiency shall be 90%.

### 3. Lamps

- a. Lamps: Lamps are to be energy efficient, low mercury, long life, T8, 32W, 17W or 24W fluorescent. T5-HO fixtures may only be used under careful consideration to energy efficiency in the space and cost payback analysis with LED.
- b. Lamp color is to be 4100K, 800 series.
- c. No U-tube lamps are to be used. Single tube (F17T8) or PL lamps are to be used in place of U-Tubes.
- d. Lamps used should be same wattage and type as already in use on campus.
- e. New style lamps should not be introduced unless expressly approved by appropriate Facilities Management – Engineering Division.

### E. Emergency Lighting

1. Emergency lighting to be provided in buildings that have code compliant emergency generator systems shall have emergency lighting on an emergency lighting distribution system. The emergency lighting distribution system shall be provided with a code required dedicated ATS (automatic transfer switch) per NEC requirements.
2. Emergency lighting provided in buildings without emergency generators shall utilize battery backup ballasts integrated into the fixture.
3. The emergency system shall comply with UL 924 requirements and the fixtures shall be UL listed.
4. Emergency Power Transfer Device
  - a. Emergency power transfer devices shall be 20A rated with automatic diagnostic function and power indication LED.
  - b. Connect to UL listed automatic transfer switch powered emergency panel, constant power sensing hot feed and switched feed per manufacturer's wiring diagram.
  - c. When dimming fixtures are required to function as emergency fixtures, provide dimmer compatible power transfer device.
  - d. Subject to compliance with the requirements, provide products by the following:

a) LVS Controls (EPC and EPC-D for dimming)

5. Battery Units

- a. Emergency battery units shall be sealed, maintenance free nickel-cadmium type with a 10 year nominal life factory mounted inside lighting fixtures.
- b. Battery chargers shall be fully automatic, solid-state with sealed UL924 rated transfer relay.
- c. Battery units shall provide minimum 1100 lumen output for 90 minutes.
- d. When emergency battery pack is remotely located, an engraved label shall be provided to indicate battery pack location.
- e. Arrange the unit with the test switch and LED indicator light visible to the space served without removing any access panels or ceiling tiles.
- f. Subject to compliance with the requirements, provide products by the following:
  - a) Bodine

F. Exit Signs

1. Exit signs shall be LED type with aluminum housing and vandal resistant construction.
2. Exit signs shall be white with green lettering.
3. Battery powered exit signs shall be UL listed for 90 minute operation and provided with test switch and indicator light visible to space served.

G. Controls

1. On-Off Control – The lights shall be controlled from a local occupancy sensor controlling the lights in the same room per current ASHRAE 90.1 standard.
2. Dimming – Provide dimming system compatible with ballast/driver of the light fixtures served.
3. Daylight Harvesting – Provide daylight harvesting where dimming, LED or step dimming fixtures are used.

4. Mechanical, Electrical and Telecom rooms shall be switched only with no automatic lighting control.
5. When a lighting control system is utilized for time of day switching and lighting automation, the system shall be controlled by the Building Management System and shall not require standalone or proprietary software to manage. A single point of programming and/or monitoring shall be used to maintain system simplicity and operability.
6. Classroom white screens shall have front row near whiteboard with separate switching or when budget allows, dimming.
7. In lecture and auditorium classrooms, provide standalone system that can be directly integrated over IP with the Crestron A/V system with no conversion boxes or separate dry contacts.

### 5.3 Installation

1. Install interior lighting fixtures in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to insure that lighting fixtures fulfill requirements.
2. Do not install lighting fixtures over stairs, planters, or in other non-accessible locations.
3. Do not install lighting fixtures where subject to abuse and/or damage.
4. Light fixtures shall not be installed in direct contact with building insulation unless rated for such use. Coordinate installation with insulation installer to satisfy requirements of NEC Article 410-66.
5. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.
6. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
7. Fasten fixtures securely to structural supports. Ensure that pendant fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum one inch adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than the number of fixtures in the row.

8. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the NEC.
9. Support surface mounted fixtures greater than 2 feet in length at a point in addition to the outlet box fixture stud.
10. Do not support lighting fixtures from roof deck.
11. Provide all additional means to support lighting fixtures that would put excessive stress on the ceiling system. Lighting fixtures weighing more than 20 pounds but less than 56 pounds shall have two (2) No. 12 gage hangers connected from the fixture housing to the ceiling system hangers or structure above. Fixtures weighing 56 pounds or more shall be supported directly from the structure above by hangers.
12. Light fixtures in suspended ceiling systems shall be positively attached to the ceiling system using manufacturer supplied clips.
13. Clean interior lighting fixtures of dirt and construction debris upon completion of installation.
14. Protect lighting fixtures from damage during remainder of construction period.

H. Grounding:

1. Provide equipment grounding connections for interior lighting fixtures. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

I. Lamp Replacement:

1. Furnish replacement stock lamps amounting to 10%, but not less than 4 lamps in each case, of each type and size lamp used in each type fixture. Deliver replacement stock as directed by Project Manager.
2. Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion.

J. Demonstration:

1. Upon completion of installation of interior lighting fixtures, and after energizing the supply circuit, apply electrical power to lighting fixtures to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to

demonstrate compliance. Otherwise, remove and replace with new units, and proceed with retesting.

2. Upon completion of installation of emergency lighting fixtures apply normal power supply to demonstrate proper operation under normal conditions. Interrupt normal power supply to demonstrate proper transfer and operation under battery power. Operate under battery power for five minutes and then restore normal power supply to demonstrate proper retransfer and operation under normal power.
3. MC-Cable is only allowed for final 3' to light fixture connection to recessed troffers. Flex is acceptable for tandem wiring of ballasts.
4. Emergency lights shall be provided and installed in accordance with all applicable NEC and NFPA life safety codes.
5. Provide at least one light fixture connected to the emergency lighting system in each mechanical room, electrical room, auditorium, theater, large lecture hall and dining room.
6. Night lights shall be on the emergency power system and utilized as part of the emergency lighting system.
7. Lighting units shall be mounted for easy removal and service. Wall shelves or brackets shall be designed to securely fasten the emergency unit.
8. Set lighting units plumb, square and level. Align with the ceilings and walls and secure in accordance with manufacturer's written instructions and shop drawings.
9. Recessed and semi-recessed fixtures may be supported from suspended ceiling support system if the system support rods or wires are not more than 6 inches from the fixture corners. For fixtures smaller than the acoustical panel ceiling grid, install a minimum of four rods or wires per fixture. Do not support fixtures by ceiling tiles. Fixtures shall be centered in the acoustical panel. Install support clips securely fastened to the grid members near each corner for recessed fixtures. Support fixtures independently with at least two ¾-inch metal channels spanning and secured to the ceiling panels.
10. Provide and install lamps for units in accordance with manufacturer's instructions. Make external wiring connections required for proper functioning.
11. Coordinate non-current-carrying parts of equipment. Where the copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

12. Tighten grounding connections to comply with tightening torques specified in UL 486A.
13. Clean emergency lighting fixtures of dirt and construction debris upon completion of installation.
14. Protect installed fixtures from damage during remainder of construction period.

**K. Field Quality Control**

- 
- 
- 1. Inspect each installed fixtures for damage. Replace damaged or malfunctioning units.
  2. All fixtures to be clean and free of dust and debris.
  3. After installing conductors and cables and before electrical circuitry has been energized, test for continuity and grounds.
  4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

**6. SUBMITTALS**

**6.1 Design Development Submittals**

- A. Refer to WMU "General Electrical Design Guidelines" DG26-0 for Basic Requirements.□□
- B. In addition provide a layout drawing of the proposed lighting that includes the following:
  1. Fixture Basis of design with Distribution Type and Wattage
  2. Photometric Layout showing point by point calculations in accordance with paragraph 5.1 H above.
  3. Proposed circuit routing and control equipment location.

**6.2 Drawing Standards**

- A. Refer to WMU "General Electrical Design Guidelines" DG26-0 for Basic Requirements.

**6.3 Construction Document Submittals**

- A. Refer to WMU "General Electrical Design Guidelines" DG26-0 for Basic Requirements.

#### 6.4 Shop Drawing Standards

- A. Refer to WMU "General Electrical Design Guidelines" DG26-0 for Basic Requirements.
- B. Furnish Manufacturers Specification Sheet for the following:
  - 1. Each Luminaire Type furnished, indicating full catalog number with included accessories, and options.
  - 2. Each control device and occupancy sensor.
  - 3. Submit fixture shop drawings in booklet form with separate sheets for each fixture assembled in luminaire "type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.

#### 6.5 Operating and Maintenance Manuals

- A. Refer to WMU "General Electrical Design Guidelines" DG26-0 for Basic Requirements.
- B. O&M manuals shall include procedures for the following:
  - 1. Replacement of fuses, LED light bars, drivers, and any other replaceable device.
  - 2. Occupancy Sensor adjustment when detector is furnished.
  - 3. Recommended maintenance schedules.
  - 4. Spare parts list.

#### 6.6 As Built Drawings

- A. Refer to WMU "General Electrical Design Guidelines" DG26-0 for Basic Requirements.

### 7. WARRANTIES (LED)

- A. Refer to WMU "General Electrical Design Guidelines" DG26-0 for Basic Requirements.
- B. Luminaires shall be provided with a warranty covering:  
  
LEDs, drivers, paint and all components.
- C. Each Luminaire shall be rated for a minimum operational life of 100,000 hours of operation with at least 90% initial light output. LED Downlights shall be rated for a minimum operational life of 50,000 hours of operation with at least 90% of initial light output.



- D. Installation shall be warranted for a period of one (1) year from date of Owner acceptance.
- E. Warranty's shall be submitted in writing at substantial completion of the project. Each warranty shall clearly state the warranty period with start and end dates.

## **8. CLEANING/TURNOVER**

- A. Clean luminaire units after installation. Use methods and materials recommended by manufacturer.
- B. Vacuum out and wipe down all panels disturbed as part of the construction work.

