Design Directive

To: Distribution

From: Erik Stoothoff
Chief Engineer

Date: October 1, 2015

RE: Design Lighting Levels and Fixtures

Design submissions for all new construction and renovation projects for stations and facilities must design lighting levels and fixtures in accordance with the following table and text.

Project Managers are required to verify that this requirement is included in the designer's contract, and that applicable code and reference standards are listed on the code sheet in the drawing set. They will also schedule joint working sessions with both the Environmental Department and the Engineering and Maintenance Department at 30%, 60%, and 90% to ensure design direction from the beginning, and to accommodate evolving technology as design develops.

When a designer advises that any aspect of these requirements is not applicable to a project, an evaluation of the requirements must be made, and the Project Manager shall prepare the attached waiver request for signature by the Assistant General Manager or Chief Engineer. The waiver request must be made in advance of any submittal to which it would apply.

Lighting System Criteria

The lighting system(s) shall be designed in accordance with all current applicable standards, ASHTO standards for highway signs and luminaires, NFPA standards, IESNA Lighting Handbook (latest edition) and the Massachusetts State Building and Electrical Codes. Other standards included by reference also are applicable, and the most stringent criteria shall govern where differing requirements exist.

Illumination Levels

Minimum maintained illumination levels for various areas shall be provided as shown in table. The normal method for calculating these levels shall be in accordance with the IESNA Lighting Handbook (latest edition) with modifications or other requirements stated in this section. The "Point-By-Point" method of computing illumination shall be used to verify or confirm illumination and uniformity levels.

(In the event that conflicts occur between the average maintained IESNA recommended practices 'Lighting for Transport' and the MBTA minimum maintained requirements, the higher and more stringent of the two criteria shall be designed to.)

Location Type	MBTA Minimum Maintained* Illumination Level (Foot-candles at Finished Floor or Unfinished Grade)
Parking Lot - Revenue Collection Area	20
Parking Lot – Parking Area	6
Garage Ramps**	10
Outdoor Plazas	10
Bus Loading Zone	15
Exterior Pedestrian Walkways	10
Outdoor Entrance to Escalator and Stairway	35
Passageways	40
Stairways and Escalators	40
Entrance Lobbies	55
Fare Vending Machines	65
Fare Collection Array	65
CSA Booth Work Surface	50
Platform Tactile Edge	55 (may drop to 35 away from edge)
Customer Assistance Area	65
Waiting Area-Interior	45
Waiting Area – Exterior (Covered)	30
Waiting Area – Exterior (Uncovered)	30
Starter's Room	40
Concession Area	40
Mechanical and Electrical spaces	40
Toilets	40

Storage Rooms	25
Bus Parking	6
Task lighting – task dependent	50-100
Maintenance Track Pits	40
Tunnel	10

* after approximately 25% burn-off at 70 degrees F

** for other locations within parking garages, use standards in this table for those areas

Lighting Systems

The lighting system shall be designed to minimize initial capital cost, as well as frequency and expense of maintenance. All lighting systems shall adhere to the following general requirements and all requested information shall be incorporated in the system lighting design.

- Product Data: For each type of lighting fixture, arranged in order of fixture designation, include data on features, accessories, finishes, and the following:
  a. Physical description of lighting fixture including dimensions.
  b. Ballast data, including ballast factor (BF).
  c. Energy-usage data (wattage).
  d. Lamping information. (LM-79 for LED)
  e. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps (LM-80 and TM-21 for LED).
  f. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated in the specification.
  g. Warranty information to be provided with each fixture specified (see warranty requirements below).
  h. Listing information, showing that all fixtures being utilized have a minimum ingress protection rating of 44 (IP44) or have been listed to UL Wet Location standards.

- Life Cycle and Energy
  a. Evaluate all lighting solutions to balance initial capital costs with energy consumption, with the goal of minimizing each without compromising MBTA lighting standards for illumination levels.
  b. Document and provide return on investment (ROI) analysis for all proposed lighting solutions, should they deviate from the standard MBTA specifications.
  c. Document all materials utilized within each fixture and verify the proposed materials ability to withstand corrosive and unconditioned environments.

- Controls
  a. Provide point-of-use controls and, in areas where applicable, use daylight responsive controls, central lighting control systems, time clocks, photoelectric controls, lighting contactors, emergency shunt relays, and occupancy sensors.
  b. Occupancy sensors are not permitted in public spaces; appropriate innovative technology (such as astronomical timers) shall be used for control of luminaires in public areas, including sidewalk and parking lot areas, surface level transit stops, and any other outdoor areas.
  c. Lighting controls shall provide the means to automatically turn off 30% of station interior lighting between the hours of 1:00 AM and 5:00 AM.
  d. For any lighting control, the system shall have "Fail On" functionality; in the event the control system malfunctions, illumination will still occur.
  e. Provide the following for design review:
     1. Cut sheets of all equipment specified.
     2. Interconnection diagrams showing field-installed wiring.
     3. Diagrams for power, signal, and control wiring.
     4. Load and Panel Schedules to include the following:
        a. Actual connected load per circuit
        b. Total connected load
        c. Load type
        d. Voltage per circuit
        e. Circuits and their respective control zones
        f. Circuits that are on emergency
        g. System and panel capacity
        h. Phase and corresponding circuit numbers.
     5. Schematic of system.
     6. Warranty information
  f. Require the following as Contractor Submittals:
     1. Cut sheets of all equipment.
     2. Interconnection diagrams showing field-installed wiring.
     3. Diagrams for power, signal, and control wiring.
     4. Load and Panel Schedules to include the following:
        a) Actual connected load per circuit
        b) Total connected load
        c) Load type
        d) Voltage per circuit
        e) Circuits and their respective control zones
        f) Circuits that are on emergency
        g) System and panel capacity
        h) Phase and corresponding circuit numbers.
     5. Schematic of system.
     6. Warranty information.
     7. Start-up guides and user manuals.
     8. Verification of training time (time allotted).

- Emergency Lighting
  a. Emergency lighting shall be provided to permit passenger egress from the station during loss of normal power. Emergency lighting shall be provided throughout the platform, stairs, ramps, pedestrian overpass, elevator areas, and entranceways in accordance with NFPA 101 minimum required illumination.
  b. Power for exit and emergency lights shall be supplied from a UPS system.
  c. Emergency power for lighting shall be capable of carrying their connected loads for a minimum of 5-days.

- Safety and Security
  a. Any required illumination shall be arranged and wired so that the failure of any single lighting unit or circuit shall not leave the area in total darkness.
  b. Satisfy both security requirements and the need to provide a pleasant environment.

- Good Neighbor. Lighting shall be designed to avoid light "spill" and glare.
  a. All site photometrics to include adjacent properties, with the lighting calculation grid continuing a minimum of 30' past the property line to demonstrate compliance.
  b. Sectional and elevation studies showing no direct exitance of lighting from the proposed structure onto adjacent, non-MBTA properties, must be provided.
  c. All lighting fixtures and pole placements, along with pole elevations, must account for light trespass. Unless specifically designated by the MBTA at the onset of the project, the environmental zone classification shall be considered to be environmental zone "E2," such that a 0.3 lm/ft^2 pre-curfew limitation and a 0.1 lm/ft^2 post-curfew limitation are accounted for (as defined in IESNA-TM-11-00).
  d. Any 'house-side' shielding being utilized needs to be called out in the fixture specification.
  e. Site lighting with "full cut-off" classification for lateral and vertical light distribution/control shall be utilized.

- Calculations
  a. Design illumination calculations shall be prepared for each area, space, or room (broken out per the "Minimum Maintained Illumination Level" chart above), utilizing the following design criteria, or actual conditions, whichever is more restrictive:
     1. Floor Cavity Reflectance – 20 maximum
     2. Wall Cavity Reflectance – 30 maximum
     3. Ceiling Cavity Reflectance – 50 maximum
     4. Light Meter – Horizontal Meter and Grid Setting
     5. Total Light Loss Factor (LLF) – .72 maximum allowable

        The LLF for this project shall be computed based on the following formula:
        LLF = (LLD) x (LLD) x (EF) x (VF) x (LT)
        LLD = Lamp lumen depreciation factor
        LDD = Luminaire dirt depreciation factor: Utilize 0.80 based on Category V (very dirty atmosphere, no annual cleaning)
        EF = Equipment factor
        VF = Voltage to luminaire factor
        LT = Luminaire ambient temperature factor

b. Design summary for each area to include the following information (per area, space, or room):
    1. Luminaire Schedule:
        i. Luminaire Label (to match layout label)
        j. Quantity
        k. Total Lamp Lumens
        l. Total Lamp Wattage
        m. Light Loss Factor
        n. Illuminating Engineering Society (IES) Classification
        o. Backlight, uplight and glare (BUG) Rating
    2. Calculation Summary:
        a) Average Illumination
        b) Maximum Illumination
        c) Minimum Illumination
        d) Average/Minimum Ratio
        e) Maximum/Minimum Ratio
c. Contrast ratio: 3:1 (average/minimum)

- Warranty Requirements
    a. Designs shall require manufacturers of LED fixtures to provide a 10 year warranty, minimum, for parts and labor (non-depreciating)
    b. Designs shall require manufacturers of all other lighting fixtures to provide a 2 year warranty, minimum, for parts and labor.
    c. Designs shall require manufacturers of all dimming and control equipment to provide a 10 year warranty, minimum, for all parts and labor.

- Fixtures
    a. All LED fixtures shall be protected via a filter (in-line or integral to the fixture) to account for the presence of DC power in the electrical system and for unaccounted electrical surges.
    b. Luminaires shall have porcelain enamel, stainless steel, or other durable finish.
    c. When applicable, lamp sockets shall be porcelain enclosed, heavy duty, and anti-vibration type, with mogul bases only.
    d. All fixtures shall include fusing and quick disconnect for ballast tray removal without the use of tools.
    e. Linear luminaires shall include solid frame, gasketed vandal-proof diffusers hinged on one side (i.e., not removable) to mitigate water and dust intake.
    f. Reflector-dependent luminaires shall utilize reflectors with a minimum 90% reflectance.
    g. All fluorescent luminaires shall be provided with low temperature ballasts.
    h. All ballasts shall be high power factor and regulate the lamp wattage to plus or minus 2 percent at plus or minus 5 percent line voltage variation.
    i. All luminaires located over stairwells shall have two power feeds and shall go to full output during "emergency" situations or in the event of a power failure.
    j. Lamp types shall be minimized to the greatest extent possible.

k. Only LED luminaires with replaceable LED modules shall be utilized. Manufacturers contact information and replacement module order code(s) shall be located on all modules.
l. All lamping and LED modules to be provided with a consistent Correlated Color Temperature (CCT) of 4,000 to 4,100 Kelvin.
m. All lamping and LED modules to be provided with a minimum Color Rendering Index (CCT) of 85, with the exception of back-of house lighting, which must have a minimum CCT rating of 75.
n. Incandescent, halogen, induction, high pressure sodium, low pressure sodium, and mercury vapor lamps shall not be utilized.

- Mounting
  a. Interior fixtures are to be mounted no more than 20 feet above finished floor, or above stairs and escalators.
  b. Exterior areas may utilize lighting above 20 feet, if readily accessible with a bucket truck. Max allowable mounting height of 40'.
  c. The integration of lighting into handrails shall not be allowed without prior authorization.
  d. The integration of lighting into escalators shall not be allowed without prior authorization..
  e. In-ground/In-grade lighting shall not be utilized without prior authorization..
  f. All lighting designs shall take into account bird roosting, and take measures to avoid bird roosting and nesting.

- Samples.
  During construction, samples of all proposed fixtures types must be submitted for approval.

Lighting Levels and Fixtures Design Waiver

Contract #: Click here to enter text.

Description: Click here to enter text.

Project Manager: Click here to enter text.

Date: Click here to enter text.

Design submissions for all new construction and renovation projects for stations and facilities must design lighting levels and fixtures in accordance with the design directive table and text. The project is requesting a waiver for the above item. The reason for the waiver request, as well as specified controls that will ensure proper design, and a description of related/affected elements, is described below:

Click here to enter text.

Signature: _____ Date: _____
Assistant General Manager of Engineering
Of Engineering and Maintenance

Signature: _____ Date: _____
Chief Engineer of Design and Construction

Approved ☐ Denied ☐