LED REFRIGERATED DISPLAY CASE LIGHTING

PART 1 – GENERAL

1.1 SUMMARY

This specification for high-performance LED luminaires and controls is intended to provide adequate illumination of refrigerated display cases while reducing both connected load (kW) and ongoing energy consumption (kWh). This document has been adopted by the U.S. Department of Energy's Retailer Energy Alliances (REA) and is subject to future revisions without notice.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. Commission Internationale de l´Eclairage (CIE)

1. CIE 013.3-1995, "Method of measuring and specifying colour rendering properties of light sources"

C. European Commission (EC)

1. RoHS Directive 2002/95/EC, "On the restriction of the use of certain hazardous substances in electrical and electronic equipment"
2. WEEE Directive 2002/96/EC, "On waste electrical and electronic equipment"

D. Federal Communications Commission (FCC)

1. CFR Title 47, "Telecommunication"
   a. Part 15, "Radio frequency devices"
   b. Part 18, "Industrial, scientific, and medical equipment"

E. Illuminating Engineering Society of North America (IES or IESNA)

1. IES LM-79-08, "Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products"
2. IES LM-80-08, "Approved Method for Measuring Lumen Maintenance of LED Light Sources"
3. ANSI/IESNA RP-16-05, "Nomenclature and Definitions for Illuminating Engineering" (including Addendum a)

F. Institute of Electrical and Electronics Engineers (IEEE)

1. ANSI/IEEE C62.41.1-2002, "IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits"
2. ANSI/IEEE C62.41.2-2002, "IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits"

G. International Electrotechnical Commission (IEC)

1. IEC 60529, “Degrees of protection provided by enclosures (IP Code)”

H. Joint Electron Device Engineering Council (JEDEC)

1. JEDEC J-STD-020D.01, “Joint IPC/JEDEC standard for moisture/reflow sensitivity classification for nonhermetic solid state surface-mount devices”
2. JEDEC JESD22-A104D, “Temperature cycling”
3. JEDEC JESD22-A107B, “Salt atmosphere”
4. JEDEC JESD22-A108C, “Temperature, bias, and operating life”
5. JEDEC JESD22-A114F, “Electrostatic discharge (ESD) sensitivity testing human body model (HBM):”
6. JEDEC JESD22-B104C, “Mechanical shock”

I. Japan Electronics and Information Technology Industries Association (JEITA)

1. JEITA EIAJ ED-4701/100, “Environmental and endurance test methods for semiconductor devices (Life test I)”
2. JEITA EIAJ ED-4701/200, “Environmental and endurance test methods for semiconductor devices (Life test II)”
3. JEITA EIAJ ED-4701/300, “Environmental and endurance test methods for semiconductor devices (Stress test I)”
4. JEITA EIAJ ED-4701/400, “Environmental and endurance test methods for semiconductor devices (Stress test II)”

J. National Electrical Manufacturers Association (NEMA)

1. ANSI/NEMA/ANSLG C78.377-2008, “American National Standard for the Chromaticity of Solid State Lighting Products”
2. WD 7-2000, “Occupancy Motion Sensors”

K. National Fire Protection Association (NFPA)

1. NFPA 70, “National Electrical Code” (NEC)

L. National Institute of Standards and Technology (NIST)

1. National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products (NVLAP)

M. NSF International

1. NSF/ANSI Standard 7, “Commercial Refrigerators and Storage Freezers”

N. Underwriters Laboratories (UL)

1. UL 1310, “Class 2 Power Units”

2. UL 1598, “Luminaires”
3. UL 2108, “Low Voltage Lighting Systems”
4. UL 8750, “Light Emitting Diode (LED) Light Sources for use in Lighting Products”

O. U.S. Department of Energy (DOE)

1. ENERGY STAR® Program Requirements for Solid State Lighting Luminaires Eligibility Criteria – Version 1.1
2. ENERGY STAR® Manufacturer’s Guide for Qualifying Solid State Lighting Luminaires – Version 2.1

1.3 SECTION INCLUDES

Luminaires, including light sources, drivers, wiring, and controls for lighting in the following refrigerated display case applications:

A. Enclosed reach-in and “walk-in” cases with luminaires installed such that the long axis is oriented vertically

B. Open cases with luminaires mounted to underside of canopy, i.e. installed such that the long axis is oriented horizontally, and luminaires are installed end-to-end (continuous)

1. This type of case may include a second line of luminaires located inside the lower ledge or “nose,” directed upward to improve uniformity.

C. Open cases with luminaires mounted above each shelf, i.e. installed such that the long axis is oriented horizontally, and luminaires are installed end-to-end (continuous)

1.4 QUALITY ASSURANCE

A. Luminaire Testing

1. Testing shall be conducted per the applicable IESNA and ANSI approved methods for products using Solid-State Lighting (SSL) sources. LM-79 and LM-80 laboratory test results must be produced using the specific LED package(s)/module(s)/array(s) and driver combination that will be used in production. Provide a test report from a laboratory that is either:
   a. Accredited by NVLAP or one of its Mutual Recognition Arrangement (MRA) signatories. If the laboratory used for this test is accredited by NVLAP or one of its MRA signatories it must also have a scope of accreditation that includes the method of measurement reference standard for this performance characteristic.
   b. Or approved by the DOE CALiPER program: http://www1.eere.energy.gov/buildings/ssl/test_labs.html.
2. LM-79 and LM-80 reports are required for every luminaire type to demonstrate adequate initial performance and projected maintenance.

a. A report for one luminaire can be used for another (equivalent) if the following criteria are satisfied:
   i. Same physical luminaire cross-section, including optics and thermal management.
   ii. Same diodes, diode spacing and drive current.
   iii. For drivers integral to luminaire housing, efficiency of driver tested is less than or equal to efficiency of driver to be provided.
   iv. For drivers external to luminaire housing, efficiency of tested driver is included in the report.

b. Catalog numbers indicated in laboratory report(s) shall be complete and identifiable in their entirety on submitted manufacturer cut-sheet(s).

   i. For example, it would be unacceptable for a product to be identified as "ABC-123" if either "ABC" or "123" could not be found on the cut-sheet(s).

   ii. It would also be unacceptable if "ABC-123" did not specify a unique product (incomplete), e.g. did not specify the CCT.

3. Additional LM-79 testing may be required for some luminaires and drivers near end of warranty period as per Warranty section 1.7.

1.5 LIGHTING SYSTEM PERFORMANCE

A. Luminaire Performance

1. The owner may, at a date before the end of the warranty period (but allowing time for testing), select representative combinations of luminaires and drivers for testing at the expense of the manufacturer.

   a. For each luminaire type, the lowest-efficiency driver configuration listed in the completed Appendix D External Driver Submittal Forms shall be tested.

   b. Cleaning shall be as per manufacturer recommendations, with procedure documented by the test lab.

   c. Luminaires shall be tested for both output and chromaticity.

   d. Configurations of two or more light fixtures sharing a single driver shall be tested such that the driver feeds all luminaires simultaneously.

      - Luminous output of luminaires is measured one-at-a-time. Meter will be shielded to eliminate contribution from other luminaire(s).
      - Driver efficiency is calculated as total power output to the luminaire(s) divided by power input to driver.
      - Luminaire input power is measured at each luminaire, downstream of the driver.
      - Adjusted input power is calculated by dividing luminaire input power by driver efficiency (to include the proportionate share of driver losses).

- Efficacy is calculated for each luminaire as luminous output divided by adjusted input power.

e. Luminaires shall meet the requirements for maintained performance. See Warranty section 1.7.

f. Owner shall furnish luminaires and drivers for temporary replacement of luminaires and drivers being tested.

1.6 SUBMITTALS

A. Product Samples & Mock-ups

1. Owner reserves the right to reject products on the (subjective) basis of visual inspection of uniformity, color rendering, chromaticity, glare, flicker, and fit/finish of housing. Owner approval may be obtained by one of the following methods, using luminaires of identical lm/ft, spectral content, distribution, and construction:

   a. Mock-up(s) of each representative configuration of case and luminaire(s) geometry.

   b. Site visit(s), with representative configurations of cases and luminaires.

B. Complete and provide Submittal Forms as per Appendix D.

C. Schematic Floor Plan (optional)

1. Shall indicate diagrammatic layout of refrigerated cases, sensors, drivers and associated luminaires, labeled as per the completed Submittal Forms.

D. Luminaire and Driver Data

1. Manufacturers product cut-sheets for each luminaire and driver type.

   a. Shall include product ordering code showing options that correspond with complete catalog numbers used for ordering and shown in Submittal Forms (see Appendix D) and in LM-79 reports (see below) for both luminaire and driver.

   b. Options and standard features shall be clearly described.

2. Manufacturers installation instructions.

   a. Shall be appropriate for the refrigerated cases associated with this project.

3. Independent LM-79 luminaire photometric report(s) for each luminaire type, including thermal testing as per Appendix A.

   a. For the purpose of quantifying errant light, spatial (goniometer) reports shall summarize total luminous flux for four separate quarter-spheres, defined by the plane of the mounting surface and an orthogonal plane that contains the long axis of the luminaire. For example, a vertically-oriented luminaire intended for use at one end of an enclosed case would

have total flux reported for the following regions: Forward-left, forward-right, backward-left, and backward-right.

4. LM-80 lumen maintenance report(s) for each luminaire type as per Appendix A.
5. Diagrams for each driver showing driver efficiency (output power divided by input power) as a function of output power.
6. Safety certification and file number as required for the luminaire family which shall be listed, labeled, or identified per the National Electric Code (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL):

   http://www.osha.gov/dts/otpca/nrtl/
7. Documentation indicating percent composition of materials by weight and their recyclability.

E. Occupancy Sensor Data

1. Manufacturers product cut-sheets for each type.
   a. Product ordering code submitted shall be complete and identifiable in its entirety on cut-sheets.
   b. Include cut-sheets and complete catalog numbers for any low-voltage power packs.

1.7 WARRANTY

A. Luminaires and Drivers

1. Manufacturer shall provide a written replacement warranty. On-site replacement includes materials, shipping, disposal, and labor for removal and installation. Causes for replacement include inadequate initial performance, inadequate maintained performance, and significant deterioration to product housing or components. Warranty durations shall be as indicated in Appendix D.
2. Maintained Performance
   a. Manufacturer shall replace all luminaires of a given type (at no cost to owner) if the selected luminaires of that type do not satisfy the following during future testing described in Lighting System Performance section 1.5.A:
      - Luminaire output and efficacy shall diminish to no less than 70% of initial requirements.
      - Luminaires shall satisfy the source color and color rendering requirements indicated on the completed Submittal Forms.
   b. Owner shall be reimbursed by manufacturer for any additional independent testing that demonstrates inadequate performance. Such failed products shall be replaced by manufacturer at no cost to owner.
3. Luminaire Housing and Components
   a. The chassis shall exhibit no warping, cracking, or oxidization.

b. The finish shall not exhibit noticeable blistering, cracking, peeling, or chalking.

c. Lenses shall not exhibit noticeable discoloration, clouding, warping, or cracking.

4. Driver

a. Maintained performance shall be as per specifications.

b. Housing and internal components shall not exhibit noticeable signs of deterioration.

c. Shall be furnished and warrantied by the luminaire manufacturer as part of a complete luminaire-driver system.

B. Occupancy Sensors

1. Manufacturer shall provide a written replacement warranty for malfunctioning sensors free of physical damage to product housing. Warranty duration shall be as per Appendix D. On-site replacement includes materials, shipping, disposal, and labor for removal and installation.

2. Maintained performance shall be as per specifications.

3. Lens shall not exhibit noticeable discoloration, clouding, or brittleness.

PART 2 – PRODUCTS

2.1 GENERAL

A. Luminaire shall be the type indicated in the Submittal Forms. Luminaires, drivers, and sensors of same type shall be by a single manufacturer.

2.2 LUMINAIRE REQUIREMENTS

A. General Requirements

1. Any secondary optical cavity (shared by more than one LED) shall be sealed to the Ingress Protection (IP) ratings indicated in Appendix D.

2. Luminaire housing shall be designed to protect electrical connections from exposure to the high-humidity environments found in refrigerated display cases.

3. Luminaires shall be fully assembled and electrically tested before shipment from factory.

4. Luminaires shall have country-appropriate governing mark and safety certification.

5. OVER-SHELF and NOSE luminaires shall have remote Class 2 power supply (or driver).

6. Housing material, finish, and hardware shall be suitable for the application and of adequate durability for the required warranty period. All visible non-optical components shall be matte/flat black in color unless otherwise indicated in Appendix D.

7. Lens material shall be suitable for the application and of adequate durability for the required warranty period.
8. The luminaire shall meet NSF requirements for breakable glass components.
9. Installed luminaire shall protrude from mounting surface no more than the distance indicated in Appendix D.
10. The percentage of the luminaire material indicated in Appendix D (by weight) shall be recyclable at end of life. Luminaire shall be designed for end-of-life disassembly.

B. Operating Temperature

1. Luminaire shall be designed for long-term (normal) ambient operating temperature of -37°C to 5°C.
2. Luminaire shall be designed for operation at 25°C ambient temperature (during periodic independent testing) for duration of 200 hours without compromise to luminous output, chromaticity, or rated life.
3. Installing contractor shall certify that luminaires installed in enclosed cases are not operated until cases are refrigerated, e.g. during installation of new cases. This ensures luminaires aren't operated at excessively high ambient temperatures.

C. Correlated Color Temperature (CCT)

1. Each luminaire type shall be of a single nominal CCT divisible by 100K, as specified in Appendix D.
2. For a given nominal CCT, a luminaires deviation from the target CCT shall not exceed NEMA tolerances. Refer to electronic Submittal Form spreadsheets for specific values.
3. For a given nominal CCT, a luminaires deviation from the target Duv shall not exceed NEMA tolerances. Refer to electronic Submittal Form spreadsheets for specific values.
4. Color variation along the length of the luminaire shall be subject to visual approval by owner.
5. Color shift during dimmed operation shall be subject to visual approval by owner.

D. Color Rendition

1. Luminaires shall have a CIE general Color Rendering Index (CRI or R_a) as specified in Appendix D.
2. Luminaires shall have CIE special indices R_9 through R_{12} (red, yellow, green, and blue) as specified in Appendix D for acceptable rendition of strong/saturated colors.

E. Luminous Output

1. Luminaires shall distribute light uniformly over the targets described in Appendix C, subject to visual approval by owner.
2. Luminous flux shall be directed into the appropriate hemisphere or quarter-sphere as indicated in Appendix D.
3. Luminaires shall produce luminous flux per foot as indicated in Appendix D.
4. For CANOPY, NOSE, and OVER-SHELF luminaires, nominal length shall be the length of the continuous horizontal target surface, or the on-center spacing between equivalent fluorescent luminaires for even illumination of the target.

F. Luminous Efficacy

1. Luminous efficacy is defined here as lumens produced by a luminaire, divided by the driver watts output to the luminaire, and divided again by the efficiency of the driver (which may be shared by two or more luminaires if external) as loaded.
2. Initial luminous efficacy shall be as indicated in Appendix D at full power.

G. Lumen Maintenance shall be as indicated in Appendices A and D.

H. Color Maintenance shall be as indicated in Appendices A and D.

I. Reliability

1. The device (LED chip or package) manufacturer shall subject all products to the tests listed in Appendix B.
    a. The manufacturer is responsible for determining and reporting appropriate stress conditions.
2. The luminaire manufacturer shall follow all handling and integration recommendations of the device manufacturer.

2.3 DRIVER REQUIREMENTS

A. The IES RP-16 definition for the term “driver” is modified here for the purposes of this specification to simply indicate the component *or system of components* that provide any and all conditioning of line voltage power for use by an LED device/module/array. This includes power supplies and may include dimming control hardware. Occupancy sensors (and associated dedicated power packs) are excluded. Possible configurations include:

1. Driver integral to luminaire, suited to the conditioned environment, and satisfying all power conditioning needs.
2. Driver external to luminaire (remote), suited to the unconditioned environment, and consisting of either:
    a. One component (within one housing) satisfying all power conditioning needs.
    b. Or two or more components (within separate housings) that work as a system to meet all power conditioning needs. In this case, housing requirements shall be satisfied for each component, and input/output requirements shall be applied to the system as a whole.

B. Installing contractor shall coordinate installation requirements and locations with owner and with luminaire and refrigerated case manufacturers.

1. Installing contractor shall coordinate space, ambient temperature and relative humidity requirements with case manufacturer.

C. Wattage loading (output) of drivers shall not be above or below the range recommended by the driver manufacturer.

D. Installing contractor shall coordinate with refrigerated case manufacturer to ensure driver manufacturers maximum recommended case temperature or TMP is not exceeded when measured during in-situ operation.

1. This performance characteristic is separate and distinct from thermal requirements established by UL which governs safety rather than longevity of the driver.
2. Installing contractor shall provide written certification that TMP is not exceeded.

E. Installing contractor shall coordinate with sensor manufacturer for required dimming control input(s).

F. Power supplies (or drivers) for OVER-SHELF and NOSE luminaires shall be external and Class 2 (low-voltage output) and physically protected such that neither driver nor line-voltage feeds may be exposed to water from routine hose-down cleaning of the case and shelves.

G. LED drivers shall:

1. Be housed in plastic/metal can or all metal can construction to meet all plenum requirements.
2. Not contain any Polychlorinated Biphenyl (PCB).
3. Be RoHS and WEEE compliant.
4. Be provided with poke-in wire trap connectors or integral leads.
5. Operate from 60 Hz input source with sustained variations of ± 10% (voltage and frequency) with no damage to the driver.
6. Comply with ANSI/IEEE C62.41 Category A for transient protection. The line transient shall consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.
7. Have a nominal input voltage as indicated in Appendix D (±10%) single phase or as required. Installing contractor shall coordinate with case manufacturer.
8. Tolerate sustained open circuit and short circuit output conditions without damage and without need for external fuses or trip devices.
9. Regulate output to ± 5% across published load range.
10. Have a power factor (PF) as indicated in Appendix D for full output and dimmed operation.

11. Produce Total Harmonic Distortion (THD) as indicated in Appendix D for full output and dimmed operation.
12. Have country-appropriate governing mark and safety certification for the application.
    a. Installing contractor shall coordinate with case manufacturer for appropriate dry/damp/wet rating.
    b. Any separate components, such as dimming controllers, shall have country-appropriate governing mark and safety certification for the application.
13. Meet FCC restrictions on conducted and radiated interference for non-consumer use.
14. Produce output frequency as indicated in Appendix D for full output and dimmed operation to mitigate visible flicker.
15. Have a Class A sound rating.
16. Feature the following dimming characteristics:
    a. Gradual fade and ramp-up rates as indicated in Appendix D, independently adjustable.
    b. Shall be capable of reducing driver input power as per Appendix D.

2.4 CONTROL REQUIREMENTS

A. Occupancy Sensor Controls

1. Install and aim sensors in locations to achieve coverage of areas indicated. Coverage patterns shall be derated as recommended by manufacturer based on mounting height of sensor. Sensor layout shall be based on coverage pattern dimensions with overlap as indicated in Appendix D (or as recommended by sensor manufacturer), not on simple coverage area.
2. The last inward-facing case at each end of an aisle shall not be controlled by occupancy sensors, and the coverage pattern of occupancy sensors shall not extend beyond the last case (to avoid false-ons by traffic between aisles).
3. Occupancy/vacancy sensors shall comply with NEMA Standard WD 7.
4. Occupancy sensors shall be of the infrared type.
5. Installing contractor shall provide low-voltage power packs as required and coordinate location and installation.
6. Installing contractor shall provide installation hardware as required for clean and permanent installation to top of refrigerated case. Coordinate with case manufacturer to ensure maintained integrity of refrigerated case housing and warranty.
7. Sensors shall be located or shielded or controlled by software to adjust sensitivity based on ambient temperature or air temperature variations.

8. Installing contractor shall coordinate with input signal and wiring requirements of dimming driver.
9. Installing contractor shall coordinate physical wiring method with case manufacturer.
10. Sensor shall have the adjustable time delay features indicated in Appendix D.

2.5 PRODUCT MANUFACTURERS

A. Luminaire Manufacturers List: The following manufacturers offer products complying with the required performance and operation criteria. This is NOT a list of approved products.

1. TBD

B. Driver Manufacturers List: The following manufacturers offer products complying with the required performance and operation criteria. This is NOT a list of approved products.

1. TBD

C. Controls Manufacturers List: The following manufacturers offer products complying with the required performance and operation criteria. This is NOT a list of approved products.

1. TBD

D. Substitution Limitations: Any manufacturer who offers products that comply with the required product performance and operation criteria may be submitted for prior approval.

E. Product Options:

1. The above product description, performance and operation requirements must be followed.

2. Other mutually exclusive product options offered by qualified manufacturers such as housing color or source CCT shall be approved by owner prior to ordering and installation of the product.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Follow manufacturers' recommended installation procedures.

1. Case warranty and safety certification shall not be compromised by installation of luminaires, drivers, or occupancy sensors.

B. All electrical work shall be performed in accordance with applicable local and national building and electrical codes.

3.2 TESTING & COMMISSIONING

A. Adjust sensor sensitivity to eliminate false-ons.

B. Adjust sensor time delay per owner requirements.

C. Adjust dimming setpoints per owner requirements.

3.3 MANUFACTURER SERVICES

Manufacturers must provide installation and troubleshooting support via telephone.

END OF SECTION

Appendix A – Lumen and Color Maintenance (Adopted from ENERGY STAR with modifications)

Luminaires shall demonstrate compliance with either Option 1 (Component Performance) or Option 2 (Luminaire Performance). Ambient temperature shall be 25°C.

OPTION 1: Component Performance

The Component Performance option allows the applicant to demonstrate compliance with the lumen and color maintenance requirements by demonstrating an LM-80 tested LED light source (package/module/array) operates at or below specified temperatures when operated in situ (within a luminaire). To be eligible for the component performance option, ALL three of the conditions below must be met. If ANY of the conditions are not met, the component performance option may not be used and the applicant must use the luminaire performance option for compliance.

- The LEDs used in the luminaire have been tested according to LM-80 and demonstrated lumen maintenance and color maintenance as indicated in Appendix D after 6,000 hours of operation.

- The LED manufacturer prescribes/indicates a temperature measurement point (TMPLED) on the LED package/module/array.

- The TMPLED is accessible to allow temporary attachment of a thermocouple for measurement of in situ temperature. Access via a temporary hole in the housing, tightly resealed during testing with putty or other flexible sealant is allowable.

The luminaire PASSES the lumen and color maintenance requirements if:

- The temperature measured in situ at the TMPLED is less than or equal to the temperature(s) specified in the LM-80 test report for the corresponding drive current or higher, within the manufacturer's specified operating current range.

- The drive current measured in the luminaire is less than or equal to the drive current specified in the LM-80 test report at the corresponding temperature or higher.

OPTION 2: Luminaire Performance

The Luminaire Performance option allows the applicant to demonstrate compliance with the lumen and color maintenance requirements by submitting two LM-79 test reports: One for initial output and the other for output after 6,000 hours of operation at full output (maintained). The test report must demonstrate lumen maintenance and color maintenance as indicated in Appendix D.

- The luminaire must be operated continuously in the appropriate UL 1598/153 environment except when it is removed to perform the LM-79 light output tests. Long-term operation shall be by an approved independent testing laboratory.

Appendix B – LED Reliability

Test	Reference Standard
Room Temp Operating Life Test (RTOL)	JEDEC JESD22-A108-C or JEITA EIJA ED-4701/101
High Temp Operating Life Test (HTOL)	JEDEC JESD22-A108-C or JEITA EIJA ED-4701/101
Low Temp Operating Life Test (LTOL)	JEDEC JESD22-A108-C or JEITA EIJA ED-4701/101
Wet/Humid Operating Life Test (WHTOL)	JEDEC JESD22-A108-C or JEITA EIJA ED-4701/102
Low Temp Storage	JEDEC JESD22-A108-C or JEITA EIJA ED-4701/201
High Temp Storage	JEDEC JESD22-A108-C or JEITA EIJA ED-4701/202
Humid & High Temp Storage	JEDEC JESD22-A108-C or JEITA EIJA ED-4701/103
Thermal Shock (Cycling)	JEDEC JESD22-A104-D or JEITA EIJA ED-4701/105
Mechanical Shock	JEDEC JESD22-B104-C or JEITA EIJA ED-4701/403
Electrostatic Discharge (ESD)	JEDEC JESD22-A114-F or JEITA EIJA ED-4701/304
Corrosion (Salt Spray)	JEDEC JESD22-A107-B or JEITA EIJA ED-4701/204
Moisture & Reflow Temp Test	JEDEC J-STD-020D.01, or JEITA EIJA ED-4701/104 *and* JEITA EIJA ED-4701/301

Appendix C – Typical Geometries

For the purposes of this specification, it is assumed that in enclosed display cases, **products shall not be located any closer than four inches from face of mullion** (to which luminaires are mounted). If products are located any closer, a dark band of low-level illumination may appear down the center of the door. This is of particular importance for roll-in cases, where spacers may be required to ensure adequate clearance.

The dimensions and geometries provided below are diagrammatic. Verify actual case dimensions.

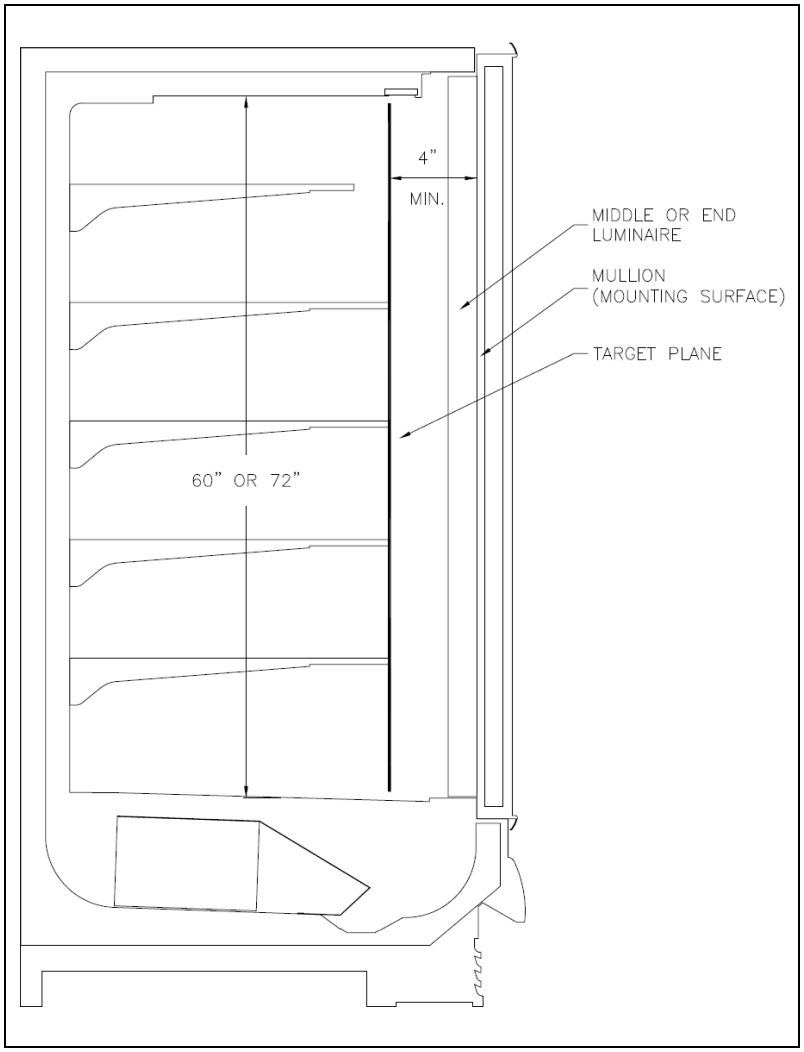

Figure C1. Side view of an enclosed case with MIDDLE and END luminaires for illumination of a target of continuous horizontal extent between ends of case, and having a nominal height of 5' or 6'.

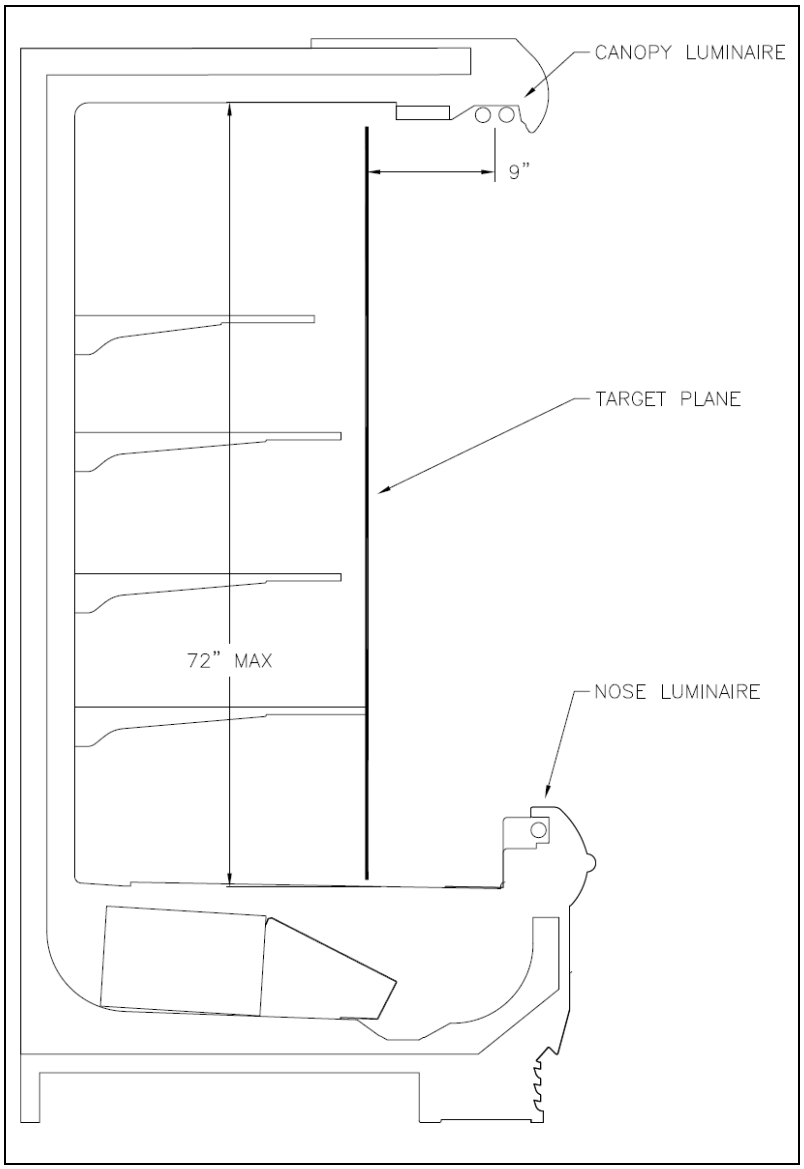

Figure C2. Side view of open case with CANOPY and NOSE (optional) luminaires for illumination of a target of continuous horizontal extent.

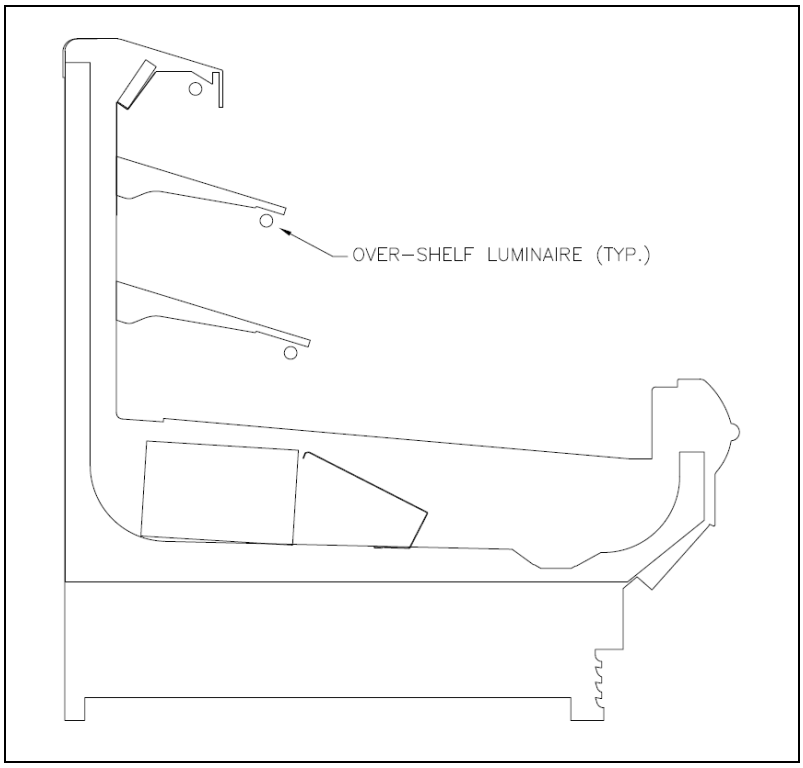

Figure C3. Side view of open case with concealed OVER-SHELF luminaires for illumination of targets of continuous horizontal extent.

Contractor to verify luminaire-target geometry.

Appendix D – Submittal Forms

The following appended forms will be provided in electronic spreadsheet format. Submittal forms shall be completed and submitted by the installing contractor for all luminaires, external drivers, and occupancy/motion sensors having unique catalog numbers.

Submittal forms for external drivers are two pages long, with driver-luminaire(s) configurations indicated in tables on the second page. Submittal forms for luminaires and sensors are one page long.

Completed forms shall precede submittals for each type. Submittals shall be provided in appropriately sized D-ring binder(s), with each type separated by labeled tabs.

LUMINAIRE SUBMITTAL FORM

Note: See project specifications for additional requirements.

Type: **M5E**
Category: MIDDLE (located on mullion between doors)
Length: 5 nominal feet
Driver: ☐ Integral to luminaire housing
☒ External to luminaire housing
Meat Display: ☐
Notes:

Attached:
☐ Cut-sheet(s)
☐ Installation instructions
☐ LM-79 report(s)
☐ LM-80 report
☐ Device reliability data
☐ Recyclability data
☐ Contractor certifies the product is marked for this application as per the NEC
☐ Contractor certifies product compatibility with the installation environment
☐ Contractor certifies product is not operated prior to case refrigeration

Catalog #

☐ NSF compliant
☐ RoHS compliant

Spec Item	Description	Submitted	Required	Complies
Light Output	Initial lumens		≥ 1900	☐
	Lumens per nominal foot (lm/ft)	0	≥ 380	☐
Power Consumption	Without Driver Losses (W)			
	Worst-case Driver Configuration (W)	0.0	≤ 48.5	☐
	Watts per nominal foot (W/ft)	0.0	≤ 9.7	☐
Efficacy	lm/W	0	≥ 39	☐
Stray Light	% of lumens in hemisphere		≥ 95%	☐
Source Color	Nominal/catalogued CCT (K)		≥ 3900 ≤ 4300	☐
	LM-79 measured CCT (K)		= ±	☐
	Duv		= ±	☐
Color Rendition	CRI or Ra		≥ 70	☐
	R9		≥ 0	☐
	Lowest value among R10, R11 & R12		≥ 0	☐
	Average R(9-12)		≥ 50	☐
Lumen Maint.	Compliance Option		= 1 or 2	☐
	Drive current (mA)		≥	☐
	TMPLED at 25°C ambient (°C)		≤	☐
	% of initial output after 6,000 hours		≥ 95%	☐
Color Maint.	Δu'v' after 6,000 hours		≤ 0.007	☐
Warranty	Parts and labor warranty (years)		≥ 5	☐
Size	Max projection (inches)		≤ 2.5	☐
Recyclability	% recyclable by weight		≥ 80%	☐
Cleaning	Ingress protection (IP) rating		≥ 54	☐

LUMINAIRE SUBMITTAL FORM

Note: See project specifications for additional requirements.

Type: **E5E**
Category: END (located at end of enclosed case)
Length: 5 nominal feet
Driver: ☐ Integral to luminaire housing
☒ External to luminaire housing
Meat Display: ☐
Notes: Left or right side of door (see bill of materials).

SAMPLE

Attached:
☐ Cut-sheet(s)
☐ Installation instructions
☐ LM-79 report(s)
☐ LM-80 report
☐ Device reliability data
☐ Recyclability data

Catalog #

☐ NSF compliant
☐ RoHS compliant

☐ Contractor certifies the product is marked for this application as per the NEC
☐ Contractor certifies product compatibility with the installation environment
☐ Contractor certifies product is not operated prior to case refrigeration

Spec Item	Description	Submitted	Required	Complies
Light Output	Initial lumens		≥ 950	☐
	Lumens per nominal foot (lm/ft)	0	≥ 190	☐
Power Consumption	Without Driver Losses (W)			
	Worst-case Driver Configuration (W)	0.0	≤ 24.5	☐
	Watts per nominal foot (W/ft)	0.0	≤ 4.9	☐
Efficacy	lm/W	0	≥ 39	☐
Stray Light	% of lumens in quarter-sphere		≥ 90%	☐
Source Color	Nominal/catalogued CCT (K)		≥ 3900 ≤ 4300	☐
	LM-79 measured CCT (K)		= ±	☐
	Duv		= ±	☐
Color Rendition	CRI or Ra		≥ 70	☐
	R9		≥ 0	☐
	Lowest value among R10, R11 & R12		≥ 0	☐
	Average R(9-12)		≥ 50	☐
Lumen Maint.	Compliance Option		= 1 or 2	☐
	Drive current (mA)		≥	☐
	TMPLED at 25°C ambient (°C)		≤	☐
	% of initial output after 6,000 hours		≥ 95%	☐
Color Maint.	Δu'v' after 6,000 hours		≤ 0.007	☐
Warranty	Parts and labor warranty (years)		≥ 5	☐
Size	Max projection (inches)		≤ 2.5	☐
Recyclability	% recyclable by weight		≥ 80%	☐
Cleaning	Ingress protection (IP) rating		≥ 54	☐

OCCUPANCY/MOTION SENSOR SUBMITTAL FORM

Note: See project specifications for additional requirements.

Type: **S1**

Low-voltage: ☒ Power pack required

Notes:

Attached:
- ☐ Cut-sheet(s) for sensor — Catalog #
- ☐ Cut-sheet(s) for power pack
- ☐ Installation instructions
- ☐ Device reliability data — ☐ NSF compliant
- ☐ Recyclability data — ☐ RoHS compliant
- ☐ Contractor certifies the product is marked for this application as per the NEC
- ☐ Contractor certifies product compatibility with the installation environment

Spec Item	Description	Submitted	Required		Complies
	Coverage patterns overlap		≥	20%	☐
	Minimum time delay (seconds)		≤	30	☐
	Maximum time delay (minutes)		≤	30	☐
	Time delay increment (minutes)		≤	2	☐
	Line voltage (V)		=	120	☐
	Parts and labor warranty (years)		≥	5	☐
	Minimum fade duration (seconds)		≤	1	☐
	Maximum fade duration (seconds)		≥	5	☐

EXTERNAL DRIVER SUBMITTAL FORM (1 of 2)

Note: See project specifications for additional requirements.

Type: **D1**

Driver: ☒ External to luminaire housing (remote)

Capacity: 0 W

Dimming: ☒

Notes:

SAMPLE

Attached:
- ☐ Cut-sheet(s) Catalog #
- ☐ Installation instructions
- ☐ Diagram of driver efficiency as a function of output power
- ☐ Device reliability data
- ☐ Recyclability data
- ☐ Contractor certifies the product is marked for this application as per the NEC
- ☐ Contractor certifies product compatibility with the installation environment

Certifications:
- ☐ NSF compliant
- ☐ RoHS compliant

Description	Submitted	Required		Complies
Maximum output (W)	0	≤		☐
Minimum output (W)	0	≥		☐
Line voltage (V)		=	120	☐
Driver output frequency (Hz)		≥	120	☐
Power Factor at full output		≥	0.90	☐
THD at full output		≤	10%	☐
Wattage reduction when dimmed (%)		≥	40%	☐
Power Factor when dimmed		≥	0.80	☐
THD when dimmed		≤	20%	☐
Parts and labor warranty (years)		≥	5	☐

EXTERNAL DRIVER SUBMITTAL FORM (2 of 2)

Note: See project specifications for additional requirements.

Type: **D1**		Configuration						
		A	B	C	D	E	F	G
Luminaire	w/o losses	# Luminaires Sharing Driver						
M5E	0							
E5E	0							
		0	0	0	0	0	0	0
		0	0	0	0	0	0	0
Output Power		0	0	0	0	0	0	0
Efficiency								
Total Input Power		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capacity Not Exceeded		☒	☒	☒	☒	☒	☒	☒

Luminaire	Max W	Driver Input Power by Luminaire Type						
M5E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E5E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Configuration						
	A	B	C	D	E	F	G
Instances							