LED Retrofit Lamps

Approved for Hazardous Locations

Current

LED Retrofit Lamps – APPROVED FOR HAZARDOUS LOCATIONS

LED technology has fundamentally transformed the lighting industry in the past two decades. It brings unprecedented energy efficiency, significantly reduces operating and maintenance costs while vastly improving the color and quality of light in virtually any setting—commercial, industrial, office, retail and outdoor. Recently, LED retrofit lamps have been developed to replace the High Intensity Discharge (HID) lamps used in hazardous location fixtures, which has accelerated the adoption of LED technology in this unique application. These lamps are purposefully designed and are qualified through vigorous UL testing to be used in the most popular hazardous location fixtures.

The LED hazardous location retrofit lamps offer simple field installation and compelling return on investment (ROI). They provide industrial facility operators in hazardous rated areas an easy upgrade to LED technology that saves 40% or more in energy costs while reducing maintenance and carbon emissions. As these lamps gain popularity in the market, questions may arise about their safety, performance and reliability when used in hazardous locations. This paper will address the concerns regarding the use of these LED hazardous location retrofit lamps.

LED Retrofit Lamps for HID

In its most basic form, an LED retrofit lamp for HID modifies an existing HID lighting fixture into an LED fixture. LED retrofit lamp kits for HID generally consist of a LED lamp, a re-lamp warning label, safety tethers (in some instances), an in-line fuse kit and mounting accessories. LED retrofit lamps for HID gives facility managers the fastest, most cost-effective means to replace outdated HID lamps with the efficiency and performance of LEDs. Why are so many facilities making the change from HID lamps to LED retrofit lamps? The numbers say it all. The key benefits of replacing a HID lamp with a LED retrofit lamp:

1. Save at least **50%** in energy usage.
2. Realize **2 to 3 times longer life**. LED HID retrofit lamp life is typically **50,000 hours**, while HID lamp life for a HPS lamp is typically 24,000 hours, and Metal Halide lamp is typically 10,000 to 20,000 hours[1].
3. Achieve short payback times, generally **less than one year**.

LED HID retrofit lamps are designed to replace HID lamps. However, there are large variations in the luminous flux of different manufacturers' LED retrofit lamps that claim to be the equivalent of a particular HID lamp. These variations generate confusion for customers, and an uneven playing field for manufacturers. To address this issue, NEMA published Standard LL 10-2020: *Replacing HID Lamps with LED Lamps: Light Output Equivalency Claims*[2]. Current uses this Standard for LED lamps replacing HID lamps, meeting or exceeding the minimum LED light output for equivalency claims. End users, specifiers and entities establishing requirements may use this Standard to ensure that enough light output is obtained to adequately cover the demands of their original HID applications.

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Table-1 shows Current lamps that claim equivalency with HID lamps based on NEMA Standard LL 10-2020: *Replacing HID Lamps with LED Lamps: Light Output Equivalency Claims.* This NEMA Standard prescribes the minimum initial light output for LED lamps to replace common HID wattage levels. NEMA took into account lumen maintenance and color rendering differences that allow for lower intial light output from LED lamps when compared to HID lamps. Accordingly, the LED wattage equivalency varies based on the type of HID lamp being replaced - Metal Halide (MH) or High Pressure Sodium (HPS).

Metal Halide Lamp Wattage (W)	Metal Halide Initial Light Output (lm)	Minimum LED Lamp Initial Light Output (lm)	Current LED Ordinary Location Retrofit Lamps Active Cooling	Current LED Selectable Ordinary Location Retrofit Lamps Active Cooling	Current LED Selectable Ordinary Location Retrofit Lamps Passive Cooling	Current LED Hazardous Location Retrofit Lamps Active Cooling
50	3,200	2,000	LED21ED17	LED/LC/ED17	LED/LC/ED17P	LED21ED17/HAZ
70	5,200	3,000	LED21ED17	LED/LC/ED17	LED/LC/ED17P	LED21ED17/HAZ
100	8,100	5,000	LED35ED17; LED45ED17	LED/LC/ED17		LED35ED17/HAZ; LED45ED17/HAZ
150	12,000	7,500	LED50ED23.5	LED/LC/ED23.5	LED/LC/ED23.5P; LED/LC/ED28P	
175	11,000	7,000	LED45ED17; LED50ED23.5	LED/LC/ED17; LED/LC/ED23.5	LED/LC/ED23.5P; LED/LC/ED28P	
250	19,100	12,000	LED80ED23.5	LED/LC/ED23.5	LED/LC/ED28P	LED80ED23.5/HAZ
320	25,600	16,500	LED115ED28	LED/LC/ED28		
350	28,400	18,000	LED115ED28	LED/LC/ED28		
360	29,400	19,000	LED150ED28; LED120ED18	LED/LC/ED28		LED150ED28/HAZ
400	33,100	21,500	LED150ED28; LED180ED18	LED/LC/ED28; LED/LC/ED37		LED150ED28/HAZ
750	72,300	46,500	LED360ED37	LED/LC/ED37		
1,000	100,280	65,000	LED450BT56; LED470BT56	LED/LC/ED37		
1,500	153,000	99,450	LED520BT56			

HPS Lamp Wattage (W)	HPS Initial Light Output (lm)	Minimum LED Lamp Initial Light Output (lm)	Current LED Ordinary Location Retrofit Lamps Active Cooling	Current LED Selectable Ordinary Location Retrofit Lamps Active Cooling	Current LED Selectable Ordinary Location Retrofit Lamps Passive Cooling	Current LED Hazardous Location Retrofit Lamps Active Cooling
50	4,500	2,500	LED21ED17	LED/LC/ED17	LED/LC/ED17P	LED21ED17/HAZ
70	6,300	4,000	LED35ED17	LED/LC/ED17	LED/LC/ED17P	LED35ED17/HAZ
100	9,500	6,000	LED45ED17; LED50ED23.5	LED/LC/ED17; LED/LC/ED23.5	LED/LC/ED23.5P; LED/LC/ED28P	LED45ED17/HAZ
150	13,000	8,500	LED80ED23.5	LED/LC/ED23.5	LED/LC/ED28P	LED80ED23.5/HAZ
200	19,500	12,500		LED/LC/ED23.5		
250	26,000	17,000	LED115ED28; LED120ED18	LED/LC/ED28		
310	33,200	21,500	LED150ED28	LED/LC/ED28		LED150ED28/HAZ
400	44,000	29,000	LED180ED18; LED270BT56	LED/LC/ED37		
600	66,000	42,500	LED360ED37	LED/LC/ED37		
750	82,500	53,500	LED450BT56	LED/LC/ED37		
1,000	110,000	73,000	LED470BT56; LED520BT56			

Table-1: NEMA LL 10-2020 Light output levels required for equivalency and Current's LED retrofit lamp offerings

The ANSI Profile and Why It Is Important for LED Retrofit Lamps

ANSI (American National Standards Institute) has published a series of specification standards for HID lamps[3,4,5]. These standards set forth the physical and electrical characteristics for different shapes and styles of HID lamps to ensure interchangeability and safety. Figure-1 is an example of an ED23.5 Metal Halide Lamp Maximum Outline drawing from ANSI C78.43-20173. The ANSI Maximum Outline Drawing is sometimes also referred to as an ANSI profile.

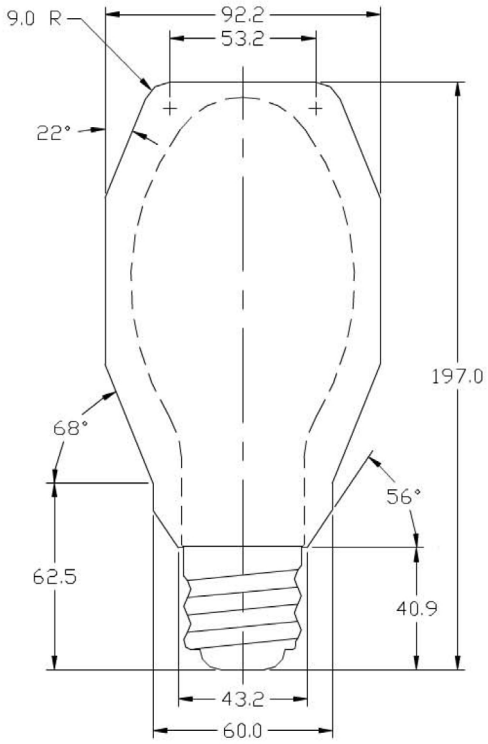

Figure-1: **An example of ED23.5 Metal Halide Lamp Maximum Outline Drawing from ANSI C78.43-2017** [3]

HID lamps, including Metal Halide lamps, High-Pressure Sodium lamps and High-Pressure Mercury lamps, from different lamp manufacturers are expected to conform to these ANSI standards. Luminaire manufacturers also design their fixtures according to these ANSI standards, so lamps that conform to the ANSI profile should not have problems fitting in those fixtures. Traditional HID lamp manufacturers and luminaire manufacturers are quite often different entities, but thanks to these ANSI standards, traditional lamp and fixture compatibility has not been an issue.

The emergence of LED retrofit lamps that do not conform to ANSI profiles breaks this established harmony. There are enormous technical challenges associated with designing LED retrofit lamps for HID that conform to ANSI profiles without sacrificing reliability, light output, efficacy and cost effectiveness. As a result, many companies have launched LED retrofit lamps that are larger than the ANSI profile. Customers who purchase such lamps may face a fit challenge. Even when the fixtures can accommodate these lamps, the light distribution from the fixture will most likely be impacted because of the larger lamp size.

Current's LED retrofit lamps, for both ordinary and hazardous locations, are engineered with our proprietary technologies (U.S. Patents 10788163 and 10508776) to not exceed ANSI lengths and diameters without sacrificing performance. This allows Current to bring reliable and long-lasting LED retrofit lamps into existing HID fixtures without compromising on fit.

What Constitutes a Hazardous Location?

The National Electrical Code (NEC) defines Hazardous locations in terms of **CLASS, DIVISION** and **GROUP**:

- **CLASS I** locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.
- **CLASS II** locations are those that are hazardous because of the presence of combustible dust.
- **CLASS III** locations are those that are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in the air in sufficient quantities to produce ignitable mixtures.

Each **CLASS** is further defined as either **DIVISION 1** or **DIVISION 2**.

- **DIVISION 1** is an environment that is normally hazardous.
- **DIVISION 2** is an environment that is not normally hazardous.

GROUP defines the specific hazardous material in the surrounding atmosphere.

- Common material **GROUP** ratings in **CLASS I** areas:
  GROUP A—Acetylene; **GROUP B**—Hydrogen; **GROUP C**—Ethylene; **GROUP D**—Methane & Propane.
- Common material **GROUP** ratings in **CLASS II** areas:
  GROUP E—Metal Dust; **GROUP F**—Carbon & Charcoal; **GROUP G**—Flour, Starch, Wood & Plastic.

An example description of a specific hazardous location is: **"Class 1, Division 2, Groups A, B, C, D"**

Please be aware that the classification of a given area as to **Class, Division** and **Group** is based on the judgment of **the owner, insurance company and the Authority Having Jurisdiction** taking into consideration many factors.

Hazardous Location Temperature Code and Why It Is Important

Hazardous flammable gases, vapors, combustible dust, ignitable fibers or flyings may auto-ignite if they encounter a surface that has a temperature above their auto-ignition temperature. Table-2 shows the auto-ignition temperatures of some substances that are common in **Class I, Division 2, Groups A, B, C, D** Hazardous locations and the typical dusts covered by **Class II, Groups E, F, G**.

NEC Class	Division	Group	Typical Atmosphere and Auto-ignition Temperatures
1 - Gases, Vapors	2 - Not normally present	A	Acetylene (305°C, 581°F)
		B	Hydrogen (502°C, 986°F) manufactured gases containing more than 30% hydrogen (by volume)
		C	Ethylene (450°C, 842°F) Cylopropane (503°C, 938°F)
		D	Hexane (225°C, 437°F) Butane (288°C, 550°F) Propane (450°C, 842°F) Acetone (465°C, 869°F) Benzene (420°C, 788°F) Gasoline (280°-471°C, 536°-880°F)
2 - Combustible Dusts	1 - Normally present 2 - Not normally present	E	Metal Dusts (Aluminum, Magnesium)
		F	Carbonaceous Dusts (Coal, Carbon black, Charcoal, Coke)
		G	Dusts not in Groups E or F (Flour, Grain, Wood, Plastic)

Table-2: Typical Hazardous Substances and Auto-ignition Temperatures by Group

To mitigate the risk of hazardous substance auto-ignition, UL assigns a hazardous location temperature rating to each certified hazardous location luminaire. The temperature rating is based on the maximum temperature of the luminaire and the lamp within or retrofit lamp kit in a specified ambient temperature range, depending on its hazardous location classification.

- For **Class I, Division 1, All Groups,** and for all **Class II Divisions** and **Groups**, and for all **Class III Divisions**, the maximum temperature is measured on the exterior of the luminaire. The maximum temperature that a given combination of lamp wattage, optical configuration and ballast housing produces while operating in a specific ambient temperature environment **MUST BE LESS** than the temperature Limiting Value specified for that **Class, Division** and **Group**.

- For **Class I, Division 2, Groups A, B, C,** and **D**, the maximum temperature of the luminaire is measured inside the luminaire, if the luminaire contains a traditional HID lamp, usually on the lamp wall surface; for LED fixtures or LED retrofit lamps the maximum temperature is typically measured on the phosphor of the LED. The reason for measuring the maximum temperature inside the luminaire is because the gases in the area could infiltrate the luminaire, contact the lamp or LED surface, and ignite if their auto-ignition temperatures are below that of the lamp or LED surface.

UL844 "Luminaires for Use in Hazardous (Classified) Locations" use the Temperature Code Table in **Table-3** to designate a maximum temperature range identification number for each tested hazardous location lamp or fixture. This code is called the Hazardous Locations Temperature Code, or Tcode. The Tcode matches the identification numbers with the maximum temperature range in degrees Celsius (C) that they represent. The codes are then placed on the hazardous locations luminaire's fixture label.

Identification Number*	T1	T2	T2A	T2B	T2C	T2D	T3	T3A	T3B	T3C	T4	T4A	T5	T6
Max. Temp. Range (°C)	450	300	280	260	230	215	200	180	165	160	135	120	100	85

Table-3: Temperature Code Table (UL844)

**The higher the identification number, the lower the temperature of the fixture.*

Table-4 presents an example of Current's LED hazardous locations retrofit lamps Temperature Code. At the time this paper is written, these lamps are UL844 Listed for **Class I, Division 2, Groups A, B, C, D; Class II, Division 1, Groups E, F, G; Class II, Division 2, Groups F, G** hazardous locations. Per NEC Article 500-503, in **Class I, Division, 2, Groups A, B, C,** and **D** hazardous locations, the maximum luminaire temperature rating is not to exceed the auto-ignition temperature of the gases or vapors involved. Therefore, LED21ED17/YXX/HAZ can be used at a hazardous atmosphere where ambient temperature of the fixture is below 65°C and the auto-ignition temperature of the gases or vapors involved is higher than 120°C (T4A). LED35ED17/YXX/HAZ can be used at a hazardous atmosphere where ambient temperature of the fixture is below 55°C and the auto-ignition temperature of the gases or vapors involved is higher than 135°C (T4). LED45ED17/YXX/HAZ can be used at a hazardous atmosphere where ambient temperature of the fixture is below 45°C and the auto-ignition temperature of the gases or vapors involved is higher than 135°C (T4). Note that **Class I, Division 2, Group A, B, C, D** Hazardous Substances presented above in Table-2 all have their auto-ignition temperature higher than T4 or T4A, therefore each of these lamps can be used in all those applications.

HAZ Model Family	Ambient Temperature Range	Operating Temperature Code
LED21ED17	-20°C to 65°C	T4A
LED35ED17	-20°C to 55°C	T4
LED45ED17	-20°C to 45°C	T4
LED80ED23.5	-20°C to 55°C	T4
LED150ED28	-20°C to 40°C	T4

How to Select the Right LED Retrofit Lamp for a Hazardous Location Luminaire

To satisfy the lighting needs of an area having a hazardous or potentially hazardous environment, **The owner, responsible insurance company and the Authority Having Jurisdiction** must have certain knowledge of the environment to define the needs of the area before specifying a luminaire or lamp in the luminaire. Included in this knowledge should be a full understanding of National Electrical Code® (NEC®), National Fire Protection Association (NFPA), Factory Mutual (FM), Underwriters Laboratories Listings (UL Listing), National Electrical Manufacturers Association (NEMA), and other governing body codes, standards and testing procedures. This knowledge must also include an awareness and understanding of local codes, the physical and chemical properties of the environments, and the testing procedures applicable to the application and product. With this knowledge, a qualified individual can then begin to determine the proper code(s) and code requirements that a luminaire system or a retrofit lamp for a hazardous location must meet.

For hazardous locations, NEC Articles 500-517 and UL844 are particularly relevant to lamp or luminaire selection. The National Electrical Code (NEC) Articles 500-517 define, categorize and provide the basic ground rules of the application and installation of lighting fixtures in hazardous locations. UL844 “Luminaires for Use in Hazardous (Classified) Locations” is the UL standard for hazardous locations lighting (CSA C22.2 No. 137 – “Electric luminaires for use in hazardous locations” is used in Canada).

Here’s a step-by-step guide that the qualified individual should use to select a UL844 certified LED retrofit lamp for an existing hazardous location luminaire.

Step 1. Determine the hazardous location NEC Class, Division and Group.
At the time of this paper’s publishing, Current’s LED hazardous locations retrofit lamps are UL844 certified for **Class I, Division 2, Groups A, B, C,** and **D; Class II, Division 1, Groups E, F, G; Class II, Division 2, Groups F, G**. **Proceed to Step 2 only if the hazardous locations fixture belongs to this category.**

Step 2. Check the to be retrofitted fixture label and record the manufacturer name, model number, UL844 certified **Class, Division** and **Groups**, lamp type and wattage.

Figure-2 shows an example of a GE Filtr-Gard™ fixture label. From the label, we can see this fixture model number is GE Filtr-Gard™ H210M, UL844 certified for **Class I, Division 2, Groups A, B, C, D** for all configurations, and **Class II, Division 2, Group G** and **Class II, Division 1, Group E, F, G** for some configurations. The fixture temperature codes are listed on the label for a 100W M90/E metal halide lamp.

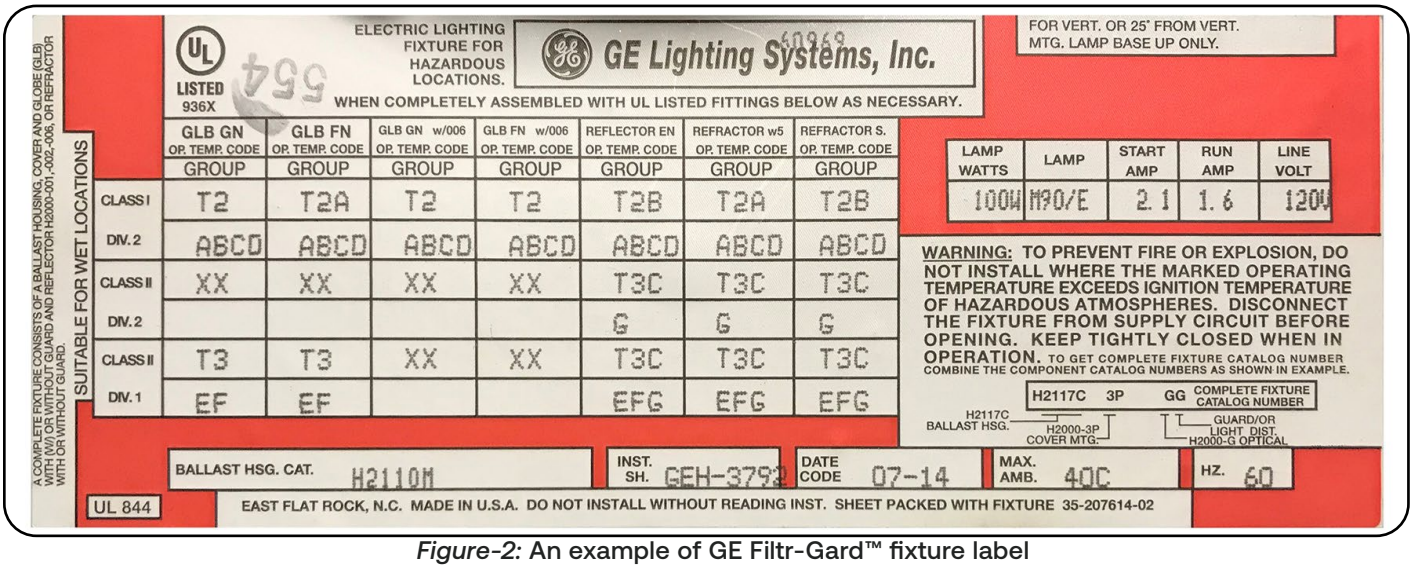

Figure-2: An example of GE Filtr-Gard™ fixture label

As of January 2023, Current's LED hazardous location retrofit lamps are UL844 certified for **Class I, Division 2, Groups A, B, C,** D, and/or **Class II, Division 1, Groups E, F, G, and/or Class II, Division 2, Groups F, G** for use in the following fixtures:

- GE Filtr-Gard™
- Crouse-Hinds Champ® VMV
- Appleton™ Mercmaster™ II Series
- Appleton™ Mercmaster™ III Series
- Hubbell Killark™ VM Series
- Holophane Petrolux™ Series
- Thomas&Betts Hazlux™ Series
- GE Powr-Gard™ Series

(**Note:** This list is subject to change. Current may announce more UL approved fixtures in the future.)

Even though a fixture above may carry other ratings such as **Class I, Division 1,** retrofitting with Current lamps is only fully approved in the area with **Class I, Division 2, Groups A, B, C, D**, and/or **Class II, Division 1, Groups E, F, G, and/or Class II, Division 2, Groups F, G** ratings. Proceed to Step 3 only if the luminaire is one of the approved types and the fixture is UL844 listed for these **Class, Division and Groups ratings**.

Step 3. Determine the LED hazardous location retrofit lamp type and wattage

We recorded the lamp type and wattage in the to be retrofitted fixture in Step 2. In the example above, GE Filtr-Gard™ H2 fixture contains a 100W Metal Halide lamp. Consult Table 1: NEMA Light output levels required for equivalency and Current's product offering, we see that both LED35ED17/HAZ and LED45ED17/HAZ will meet or exceed the minimum light output equivalency. There are six models that we can choose from: two light output levels (5000lm or 6000lm) and three CCTs (3000K, 4000K, 5000K). The customer would choose based on their preference. For example, our customer may prefer a higher light output and the metal halide lamp to be replaced has a CCT of 4000K, in which case the choice would be LED45ED17/740/HAZ.

Step 4. Determine the hazardous atmosphere temperature Limiting Value and maximum ambient temperature in the area to be lighted.

As an example, suppose we will light a storage shed containing propane tanks. This area fits the **NEC Class I, Division 2, Group D** with a maximum ambient temperature of 40°C. Auto-ignition temperature of propane is 450°C. For **Class I, Division 2** hazardous locations, the temperature Limiting Value is equal to the auto-ignition temperature of the hazardous substance. In this case it is 450°C.

Step 5. Verify the LED hazardous locations retrofit lamps' temperature code can meet the hazardous location temperature requirements in **Step 4.**

From Table-4, the LED45ED17/740/HAZ lamp Temperature Code is T4 with a maximum fixture ambient temperature of 45°C. The temperature requirements for a storage shed containing propane tanks have a maximum ambient temperature of 40°C. Therefore, LED45ED17/740/HAZ is a good choice for this application.

Is It Safe to Retrofit a Hazardous Location Fixture with a LED Lamp?

UL has a category (IFUL) to address the safety aspects of hazardous location retrofit kits or retrofit lamps. **For hazardous locations, using a UL844 certified LED hazardous location lamp is the key to ensuring safety.**

The UL requirements and definition for LED hazardous location retrofit kits (or lamps) are best illustrated by citing the UL IFUL guide for LED retrofit luminaire conversion kits for use in hazardous locations. This category covers LED retrofit kits intended for field installation in luminaires. The retrofit kits consist of LED light sources, installation instructions, subassemblies, luminaire marking labels and assembly aids (where appropriate) to facilitate the replacement of the existing light source in complete luminaires. The retrofit installation will require modifications to the luminaire in accordance with the manufacturer's installation instructions. UL certified LED retrofit kits have been investigated and determined that, when installed in accordance with the manufacturer's instructions, they do not affect the operation of the luminaire and maintain the original Safety rating.

To be UL-certified for use in a hazardous location, a retrofit LED lamp must be tested for compliance to UL844, Standard for Luminaires for Use in Hazardous (Classified) Locations, and certified for use with a specific manufacturer and luminaire model. Included in this certification is the established hazardous location temperature codes (Tcode), which are critical to verifying product suitability for a hazardous location environment. These retrofit kits are supplied with new labels. The new label cites the lamp manufacturer and model certified, and the new (lower) Tcode as well as indicating the maximum ambient fixture temperature.

To verify UL certification, examine the LED retrofit lamp cartons for the UL Certified Mark as shown in Figure-3. UL844 certified safety mark indicates the lamp is fully accepted and certified for use in the U.S. and Canada for hazardous locations. UL Safety on the retrofitted luminaire is maintained when the manufacturer's installation instructions enclosed with the lamp are followed.

Figure-3: **UL Certified Safety Mark**

UL also maintains a comprehensive on-line database that allows visitors to search for UL-certified luminaire retrofit kits. The easiest way to verify that a LED retrofit lamp is suitable for hazardous locations is to conduct a search on the UL Online Certification Directory for "IFUL" - the UL Category Control Number (CCN) for Light-emitting-diode Retrofit Luminaire Conversion Kits for Use in Hazardous Locations. Current's lamps may be found this way.

Manufacturers of Light-emitting-diode Retrofit Luminaire Conversion Kits for Use in Hazardous Locations should also be able to provide a UL Certificate of Compliance to UL 844 upon request.

CERTIFICATE OF COMPLIANCE

Certificate Number	E497690
Report Reference	E497690-20201027
Date	2023-January-09

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements

USL, CNL – LED Lamp Retrofit Kits for use in Class I, Division 2, Groups A, B, C and D; Class II, Division 1, Groups E, F and G hazardous locations

LED115ED28/730/HAZ, LED115ED28/740/HAZ, LED115ED28/750/HAZ, LED115ED28/730/277/480/HAZ, LED115ED28/740/277/480/HAZ, LED115ED28/750/277/480/HAZ, LED150ED28/730/HAZ, LED150ED28/740/HAZ, LED150ED28/750/HAZ, LED150ED28/730/277/480/HAZ, LED150ED28/740/277/480/HAZ, LED150ED28/750/277/480/HAZ,LED80ED23.5/750/HAZ, LED80ED23.5/740/HAZ, LED80ED23.5/730/HAZ, LED50ED23.5/750/HAZ, LED50ED23.5/740/HAZ, LED50ED23.5/730/HAZ, LED50ED23.5/730/277/480/HAZ, LED50ED23.5/740/277/480/HAZ, LED50ED23.5/750/277/480/HAZ, LED80ED23.5/730/277/480/HAZ, LED80ED23.5/740/277/480/HAZ, LED80ED23.5/750/277/480/HAZ, LED45ED17/835/HAZ, LED45ED17/750/HAZ, LED45ED17/740/HAZ, LED45ED17/730/HAZ, LED35ED17/750/HAZ, LED35ED17/740/HAZ, LED35ED17/730/HAZ, LED21ED17/750/HAZ, LED21ED17/740/HAZ, LED21ED17/730/HAZ

Figure-4: **An example of a portion of a UL Certificate of Compliance**

When a hazardous location retrofit lamp meets UL844 and is installed per the manufacturer's UL-approved instructions, the system will maintain the UL hazardous location certification of the fixture, with no compromise to safety.

Fixture manufacturers may push back on ideas that might cost them the sale of a new fixture. They may raise concerns and allege safety issues, trying to stop any possibility of using LED retrofit lamps in conventional HID fixtures. It is important to note that the conventional hazardous location fixtures are designed to allow replacement of failed lamps or ballasts periodically and continue to meet UL requirements specific to the application and location. In many regards, it is better to retrofit a hazardous location fixture with a UL844 certified LED hazardous location lamp rather than a traditional HID lamp for the following reasons:

1. Conventional metal halide lamps last about 15,000 hours, while Current's LED hazardous location lamps have a life rating of 50,000 hours. With this longer life, the fixture needs to be opened less frequently to replace the LED lamps than metal halide lamps, so the wear and tear on the fixture gaskets and seals as well as the maintenance costs are reduced.

2. The lower heat profile of the LED lamp may also help mitigate safety risks. Hazardous location fixtures retrofitted with Current's UL844 certified LED lamps typically have a much lower temperature profile than a traditional HID lamp. In many cases, temperature codes are improved from T2 (300°C) to T4 (135°C). This lowered temperature profile helps reduce safety risks and prolong the life of the gaskets and seals.

3. Retrofitting with Current's UL844 certified LED lamps will remove the aging HID lamp ballasts from the circuit. This permanently eliminates another failure point while reducing safety risks and thermal loading on the fixture.

Performance of LED Retrofit Lamps Inside a Hazardous Location Fixture

To ensure a satisfactory retrofit experience, LED hazardous location lamps are carefully engineered so that the luminaire will produce equivalent lumen output, similar light distribution and good illuminance levels in the targeted application areas. In this section, we will discuss performance of LED retrofit lamps in hazardous location fixtures including light output under room temperature and elevated temperature, light distribution and surge protections.

Light output example in a hazardous location fixture under room temperature

A 70W metal halide lamp was seasoned for 100 hours, then installed in an Appleton Mercmaster III 70W fixture. The fixture comes with an old, inefficient magnetic ballast, which is typical in most retrofit situations. The measured fixture total system power was 94W and light output was 4,730 lumens. The fixture was then retrofitted with a Current 35W hazardous location LED lamp, which entails wiring to bypass the ballast. Total system power reduced to 39W and light output was 4643 lumens. By retrofitting a 70W metal halide hazardous location fixture with a 35W hazardous location LED lamp, similar light output was achieved while saving >57% of energy.

Traditional HID lamps have poor lumen maintenance. Per IES RP-36-151 and NEMA LL-102, lumen maintenance of metal halide lamps at 40% rated life (typically 4,000 hours) is 65% of 100-hour lumens, lumen maintenance of HPS lamps at 50% rated life (typically 12,000 hours) is 87%, and lumen maintenance of LED at 50% of rated life is 84% (typical LED L70 life is 50,000 hours). Therefore, retrofitting an old HID fixture with an equivalent LED retrofit lamp would produce increased maintained light levels in most cases.

Light distribution in a hazardous location fixture

The light distribution of the Appleton™ Mercmaster™ III fixture was measured with a 70W metal halide lamp and a 35W Current LED lamp (LED35ED17/HAZ) under photometric laboratory conditions. Figure-5 illustrates the polar plot comparison, where the green line is the polar plot with LED35ED17/HAZ lamp and the red line is the polar plot with 70W metal halide lamp. Table-5 provides the photometric zonal lumen property comparison. The results indicate the hazardous location fixture with the 70W metal halide lamp and the LED 35W hazardous location lamp produces similar zonal lumen distributions, and the polar plots are also similar. Based on the similarity in magnitude and spatial distribution of lumens, we can expect them to produce similar illuminance levels in the targeted application areas.

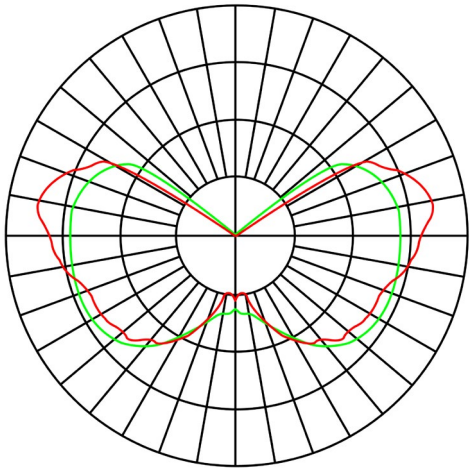

Figure-5: Polar plot LED35W lamp versus 70W metal halide lamp in an Appleton™ Mercmaster™ III fixture

	70W Metal Halide Lamp		LED35ED17/YXX/HAZ	
Zone	**Lumens**	**% Luminarie**	**Lumens**	**% Luminaire**
0-30	263	5.6%	250	5.4%
0-40	529	11.2%	505	10.9%
0-60	1316	27.8%	1315	28.3%
60-90	1651	34.9%	1576	33.9%
90-120	1674	35.4%	1461	31.5%
0-90	2967	62.7%	2892	62.3%
90-180	1763	37.3%	1751	37.7%
0-180	4730	100%	4643	100%
Total Luminaire Watts	94		39	
Luminaire Efficacy Rating (LER)	50		118	

Table-5: Zonal lumens of LED35W lamp and 70W MH lamp in an Appleton™ Mercmaster™ III fixture

Light output in a fixture at elevated temperature

In some hazardous location applications, the fixtures must operate under elevated ambient temperatures. It is well-known that the light output of an LED chip decreases as operating temperature rises. Therefore, all LED hazardous location fixtures, including the ones that are retrofitted with a LED hazardous location lamp, will have reduced light output at elevated temperatures.

LED hazardous location lamps may also be designed with a thermal protection mechanism called "thermal foldback." This will reduce the power supplied to the LED chips when the lamp temperature reaches a pre-determined thermal set-point. This feature provides additional protection for safety and reliability; however, it may reduce fixture light output under elevated temperatures, especially in smaller fixtures. Table-6 shows Current hazardous location lamp in-fixture performance at elevated temperatures. The 21W hazardous location lamp (LED21ED17/HAZ) will operate at full power from 25°C to 65°C. The thermal foldback feature will not be triggered; the light output reduction and the slight lamp power reduction is typical LED chip behavior under elevated temperatures. The 35W and 45W hazardous location lamps (LED35ED17/HAZ and LED45ED17/HAZ) will trigger the thermal foldback feature at 45°C ambient temperature and therefore have reduced light output (9% reduction for 35W lamps and 21% reduction for 45W lamps at 45°C ambient temperature). Any selection of LED hazardous location lamps for elevated ambient locations must keep this light output derating factor in mind.

	LED21ED17/YXX/HAZ		LED35ED17/YXX/HAZ		LED45ED17/YXX/HAZ	
Ambient Temperature (°C)	Light Output (%)	Input Power (W)	Light Output (%)	Input Power (W)	Light Output (%)	Input Power (W)
25	100%	20.9	100%	35	100%	42.5
45	96.2%	20.3	91%	32	79%	33.5
50	95.7%	20.2	83%	29		
55	94.7%	20.0	77%	27		
60	94%	19.9				
65	92.5%	19.7				

Table-6: Current hazardous location lamp performance in an Appleton™ Mercmaster™ III fixture at elevated temperatures

LED retrofit lamp surge protection

Electrical surges and transients are common in industrial environments. Traditional HID luminaires, welding machines, pumps and compressors, and even lightning strikes can induce surges and transients in the AC power lines. This could damage any lighting system, including LEDs, if they are not properly designed with surge protection. The ANSI C136.2-2018 standard[6] defines performance requirements and test procedures for evaluating luminaire and control devices for dielectric withstand and electrical transient immunity. This standard divides luminaires into three risk categories: typical, enhanced and extreme, with requirements of 6kV/3kA, 10kV/5kA, and 20kV/10kA respectively. Current's LED hazardous location lamps include integrated 6KV/3KA surge protection built into the lamp to protect against power surges and transients. This level of surge protection is consistent with typical industrial and many outdoor LED luminaries.

LED Retrofit Lamps - APPROVED FOR HAZARDOUS LOCATIONS

Summary and Takeaways

LED hazardous location lamps offer an opportunity to realize the benefits of an upgrade to LED lighting at an affordable cost. UL844 certified LED retrofit lamps allow existing hazardous location fixtures to be used, while replacing old HID lamps and bypassing the ballasts. Lamps can provide an attractive ROI when entire fixture upgrades may be cost prohibitive, allowing hazardous location facilities to save on energy costs and improve light quality and reliability without compromising safety.

Current's LED lamps approved for hazardous locations provide customers an innovative lighting solution. By offering an ANSI-shaped LED HID retrofit lamp approved for hazardous locations, users will not have fit issues that may occur with other non-ANSI profile compliant lamps in the marketplace. Current's lamps provide omnidirectional light output similar in distribution and magnitude to traditional HID lamps, ranging from 70W to 400W metal halide equivalency. With E26-based hazardous location lamps, Current also includes an E39 socket adapter in the kit for mogul base applications. This eliminates the possibility of ordering a lamp with the wrong base and an installer having to come back at a later date at an additional charge. The heat profile of Current's LED lamps is lower than traditional HID, which equates to a lower overall temperature code. This may provide additional benefits to a facility, beyond the lower energy consumption and increased longevity of the lamps themselves.

References

1. IES RP-36-15 Recommended Practice for Lighting Maintenance, 2015 Edition
2. NEMA Standards Publication LL-10-2020, LED Replacements for HID Lamps: Equivalency Claims
3. ANSI C78.43-2017 American National Standard for Electric Lamps – Single-Ended Metal Halide Lamps
4. ANSI C78.42-2007 American National Standard for Electric Lamps – High Pressure Sodium Lamps
5. ANSI C78.40-2016 American National Standard for Electric Lamps – Specifications for Mercury Lamps
6. ANSI C136.2-2018 American National Standard for Roadway and Area Lighting Equipment—Dielectric Withstand and Electrical Transient Immunity Requirement.

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