LED Lighting in Tunnels

In addition to providing a clearer, whiter light than traditional high pressure sodium luminaires, LED lighting also offers maintenance benefits, providing 20+ years or longer of operation to reduce costs and nearly eliminate lane closures.

Tunnel shutdown time is drastically reduced as there is no need to perform routine maintenance to replace failed high intensity discharge lamps and ballasts.

A Tough Environment

Tunnels are challenging environments due to pollution from round-the-clock traffic and the corrosiveness associated with high levels of humidity, exhaust fumes and fluctuating temperatures. Luminaires in tunnels are also subjected to wind and reverberation of heavy vehicles passing by which causes vibration.

Lighting systems intended for this environment must include a robust mechanical design and materials capable of withstanding the challenges of a harsh environment over time. The luminaires are versatile enough to be ceiling or wall mounted, depending on the tunnel's geometry and height. Periodic maintenance procedures commonly deployed include high pressure washing, which is yet another aspect of the tough environment for tunnel luminaires.

Safely Transitioning Driver

The goal of any tunnel lighting system is to provide sufficient quality illumination to keep drivers who often travel at high rates of speed safe. Tunnels, however, present many unique challenges because lighting is required for both daytime and nighttime conditions.

To safely drive through a tunnel at posted highway speed during the day, a driver must be able to see into the tunnel. This is not possible if the tunnel is not properly lighted. Without daytime lighting, a tunnel entrance will appear as a black hole. Properly lighting a tunnel allows the driver's eye the time to adapt to the lower light levels inside the tunnel.

During daytime hours ambient light levels may exceed 10,000 foot-candles. The driver's vision will be adapted to this high level of light. Traveling at 65 miles per hour a vehicle is moving at 95 feet per second. In the time needed for visual adaption to occur a significant distance will be traversed, thus the need for a high level of light at the tunnel entrance. This permits time for visual adaption while maintaining visibility into the tunnel.

Once inside the tunnel, the lighting level may be gradually decreased and visibility will be maintained. At night, the situation is reversed. Inside the tunnel the driver's vision is adapted to a level higher than outside the tunnel. Upon exiting the tunnel, the driver's vision must have time to adapt to a lower level of light. The road beyond the exit portal should be lighted to at least one third the tunnel's lighting level.
Tunnel Lighting Requirements and Criteria

Daytime Tunnel Lighting Criteria Includes Three Lighting Zones to Help Driver’s Vision Adapt.

Threshold zone – This is the area beginning at the tunnel portal with a length equal to one Safe Sight Stopping Distance (SSSD) less the Adaptation Distance. Vehicles traveling at higher rates of speed will require longer threshold zones. A tunnel in which posted traffic speed is 70 miles per hour, for example, will require a longer threshold zone than a tunnel where the posted speed is 50 miles per hour.

Transition zone – This is the next area that allows a driver’s vision to adapt to lower levels of light in incremental steps. The transition zone length and number of steps will depend upon the threshold luminance, daytime interior luminance and posted speed.

Interior zone – This is the area within the tunnel after the end of the transition zone where the driver’s eye adaption is complete. Nighttime tunnel lighting is recommended to be 2.5 cd/sq. m if the tunnel is divided. If the tunnel is undivided, the lighting level should be the same as the daytime interior level. Nighttime lighting is provided for the entire length of the tunnel. The road before and after the tunnel portal should be illuminated to at least 1/3 the nighttime level for a distance of 1 SSSD.

Common Requirements for Daytime and Nighttime Lighting Systems

Both the daytime and nighttime lighting systems have common criteria regarding wall luminance and uniformity of light. The lower 6.6-ft portion of the walls above the roadway shoulder should have a maximum ratio of 2.5 between the average roadway luminance and the average wall luminance. Wall luminance is diffuse luminance as opposed to the roadway luminance which is calculated in accordance with the roadway luminance calculation procedure described in IES RP-8. Uniformity for tunnel lighting for the calculation areas within each zone should not exceed 2.0 average to minimum and 3.5 maximum to minimum ratios.

Emergency lighting is prescribed in the National Fire Protection Association (NFPA) publication 502. Emergency lighting is an aid to the egress of people and vehicles from the tunnel in the case of a power interruption. Requirements for emergency lighting are given in units of illuminance rather than luminance. Average levels are to be 1.0-fc with a minimum of 0.1 fc on walkway and roadway surfaces. The maximum to minimum ratio should be less than or equal to 40 to 1.

Tunnel’s Three Lighting Systems

Lighting systems for tunnels need to satisfy criteria for daytime, nighttime, and emergency situations. The current recommended practice for daytime and nighttime tunnel lighting is RP-8-18, Chapter 14, published by the Illuminating Engineering Society (IES). Tunnel lighting requirements are described in terms of luminance for road and wall surfaces. Requirements are determined based upon several factors: Multiple lighting distributions to include ceiling counterbeam, long and narrow, and wall mount crossbeam:

- Approach scene, road grade of approach, and materials around approach
- Average annual daily traffic volume
- Posted speed limit
- Compass orientation of the tunnel’s approach
- Direction of travel: one direction only (divided tunnel) or in two directions (undivided tunnel)

Holophane: Your Tunnel Lighting Expert

Holophane has been the leader in lighting solutions for more than a century and has supplied reliable, durable luminaires for tunnel applications for more than 25 years.

Three Holophane professionals helped form the Illuminating Engineering Society in 1906, and company engineers helped shape industry standards for tunnel lighting as members of the IES Tunnel Lighting Committee years later.
Application Design and Assistance

Holophane experts offer complete application assistance in tunnel and underpass lighting design with full support to see your project through from beginning to completion. We are committed to help you meet your tunnel lighting goals, providing innovative solutions designed for performance and versatility—with minimal operating costs and long life.
With energy savings up to 60% over HPS and expected service life over 20 years, the TunnelPass LED Large (TNLED2) and TunnelPass LED Medium (TNLEDMED) luminaires excel at meeting the challenges associated with tunnel lighting. By combining robust mechanical design features with Holophane’s optical expertise and permanence of prismatic glass, the TunnelPass LED enhances driver safety while providing reliability and flexibility in application design.

Now with a new “gen 2” light engine and enhanced integrated controls, the TunnelPass LED is the industry’s most advanced luminaire available for tunnel and underpass applications.

**Quick Facts**

- Replaces 100-1,000W HPS luminaires
- Lumen packages from 6,800 to 58,000 lumens
- 20kV/10kA “Extreme” surge protection
- 3000K, 4000K and 5000K CCT and 70 CRI
- L70 LED and driver life greater than 100,000 hours
- Configurations available with ambient ratings up to 50°C

**Quick Facts**

- **Borosilicate prismatic glass** refractor lens for durability, permanence, and visual comfort
- **Multiple lighting distributions** to include ceiling counterbeam, long and narrow, and wall mount crossbeam and underpass
- **Wall or ceiling mount design** with optional adjustable 45 degree mounting bracket (preconfigured at the factory to your specified tilt angle)
- **Control options** - available with integral Nyx Hemera control modules or field-adjustable lumen output
- **DALI drivers** available, consult with your Holophane sales rep to define details.
- **AS, AH and IAH** voltage options (IAH voltage –internal transformer protects 277v input derived from 480V-WYE)
- **Removable hinged door** to simplify and expedite installation, maintenance or future upgrades
- **Through-wire raceway** option for installations requiring continuous straight wiring installation
- **Robust 3G design** with IP66 rating, UL1598A-marine certification, and diecast aluminum housing
- **Polyester powder-coat** finish yields a finish that achieves a scribe creepage rating of 9 with 9,000 hours in a salt fog chamber (Luminaire mounting brackets are 316 grade stainless steel)
TunnelPass LED™ Large

TNLED2 Series

- Durable cast aluminum housing and powder coat paint finish
- Optional Nyx Hemera control system or adjustable lumen output device
- 20kV/10kA extreme surge protection with indicator light
- Three-stage terminal block
- Adjustable 45°-tilt mounting bracket preset at factory
- Durable Borosilicate glass refractor
- Hinged, removable driver door with stainless steel latches
- High-performance segmented reflector system
- Tool-less entry via stainless steel latches

### 250-1,000W HID Replacement

<table>
<thead>
<tr>
<th>Package</th>
<th>Lumens</th>
<th>Watts</th>
<th>LPW</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK1</td>
<td>25,077</td>
<td>212</td>
<td>119</td>
</tr>
<tr>
<td>PK2</td>
<td>30,484</td>
<td>262</td>
<td>116</td>
</tr>
<tr>
<td>PK3</td>
<td>36,849</td>
<td>321</td>
<td>115</td>
</tr>
<tr>
<td>PK4</td>
<td>40,562</td>
<td>345</td>
<td>118</td>
</tr>
<tr>
<td>PK5</td>
<td>50,087</td>
<td>435</td>
<td>115</td>
</tr>
<tr>
<td>PK6</td>
<td>55,922</td>
<td>495</td>
<td>113</td>
</tr>
</tbody>
</table>

Lumen package available for up to 50°C ambient (See specification sheets for restrictions)

**TNLED2**

Max weight:  
AS/AH Volt: 58lbs (26.3kg)  
IAH Volt: 65lbs. (29.5 kg)  
Max EPA: 3.5 ft² (0.325 m²)
**TunnelPass LED™ Medium**

**TNLEDMED Series**

- Through-wire raceway option for continuous wire installation
- Durable cast aluminum housing and powder coat paint finish
- Adjustable 25°-tilt mounting bracket preset at factory
- Hinged removable driver door with stainless steel latches
- Optional Nyx Hemera control system or adjustable lumen output device
- High-performance segmented reflector system
- 20kV/10kA extreme surge protection with indicator light
- Three-stage terminal block
- Durable borosilicate glass refractor

### 100-400W HID Replacement

<table>
<thead>
<tr>
<th>Package</th>
<th>Lumens</th>
<th>Watts</th>
<th>LPW</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK1</td>
<td>6,782</td>
<td>57</td>
<td>119</td>
</tr>
<tr>
<td>PK2</td>
<td>9,168</td>
<td>70</td>
<td>131</td>
</tr>
<tr>
<td>PK3</td>
<td>12,592</td>
<td>102</td>
<td>123</td>
</tr>
<tr>
<td>PK4</td>
<td>14,897</td>
<td>125</td>
<td>119</td>
</tr>
<tr>
<td>PK5</td>
<td>17,601</td>
<td>151</td>
<td>117</td>
</tr>
<tr>
<td>PK6</td>
<td>19,551</td>
<td>182</td>
<td>107</td>
</tr>
<tr>
<td>PK7</td>
<td>25,497</td>
<td>203</td>
<td>126</td>
</tr>
<tr>
<td>PK8</td>
<td>29,801</td>
<td>246</td>
<td>121</td>
</tr>
<tr>
<td>PK9</td>
<td>34,026</td>
<td>323</td>
<td>105</td>
</tr>
</tbody>
</table>

Lumen packages available for up to 40°C ambient (See specification sheets for restrictions)

---

**TNLEDMED**

- **Max weight:** 43 lbs (19.5 kg)
- **Max EPA:** 3.2 ft² (0.3 m²)
Engineered With Your Needs in Mind

With over 120 years in the lighting industry, Holophane has become an expert in something else... listening to the customer. Our engineers and product development teams ensure that your needs are taken into consideration with every new product. The TunnelPass family is no exception, with a variety of user-requested features that save you money and hassles.

Modular high density LED module for high lumens per watt and low energy costs

Optional adjustable lumen output module for energy reduction (TNLED2 series only)

The TNLED2 series offers an IAH voltage option protecting 277v input derived from 480V-WYE

High-performance segmented reflector system with counterbeam, long and narrow and crossbeam distributions

System is protected by a 20kV/10kA extreme surge protection device with indicator light

Borosilicate prismatic glass refractor for durability, permanence and visual comfort

Available angle wall brackets added for tilt up to 45 degrees (factory pre-configured)

Optional tool-less entry via durable stainless steel hinges

Save Operational Costs with Controls

An optional, integrated Nyx Hemera system is available for advanced control strategies. This system has a wide range of capabilities that can facilitate a reduction in both energy and maintenance costs.

- Adaptive Dimming
- Reporting of the electrical parameters (voltage, power factor, current, power consumption and lamp status)
- Integrated filter to overcome noise
- Acts as dynamic repeater
- Universal supply 120-480 VAC
- Controls: Relay / 0-10 VDC / DALI
Continuous Row vs Through Wiring Raceway

Design and installation of a tunnel lighting system can sometimes be quite complex. There are a number of options to consider when planning the wiring of your installation. Typically they fall into these two categories – Continuous Row (standard) or Through Wire Raceway wiring.

Continuous Row (Standard)

The TunnelPass LED comes standard for continuous row mounting. By definition, this occurs when individual luminaires connected together by a recognized wiring method, shall be permitted to contain the conductors of a 2 wire branch circuit or one multi-wire branch, thereby supplying the connected luminaires. One additional 2-wire branch circuit separately supplying one or more of the connected luminaires shall also be permitted.

Through Wiring Raceway (TW-Option)

The TW is for the use of luminaires as raceways. By definition, luminaires intended to serve as a raceway for conductors of a circuit other than the conductors of the branch circuit supplying the luminaire. The TW is a fixture option and allows max 10-#10 conductors, suitable for 90°C permitted in box. (Ambient rating is decreased slightly with TW-option, see specification sheets for details)

TunnelPassLED Large (TNLED2) offers Through Wiring Raceway natively within the main housing via a set of brass 1/4-14 NPT plugs

TunnelPassLED Medium (TNLEDMED) offers Through Wiring Raceway through an optional external case, via a set of brass 1/4-14 NPT plugs
Application Efficacy

Applications of new LED technology in TunnelPass LED luminaires make them suitable for retrofit replacement of 400 watt HPS fixtures while satisfying requirements of IES RP-8-18 Chapter 14. These requirements will be met for longer periods of time with less maintenance and energy consumption than the HPS system it replaces. To illustrate the benefits over time TunnelPass LED will be compared with a HPS lighting system which meets RP-8-18 Chapter 14 recommendations. The road luminance and energy use of the HPS system will then be compared with the TunnelPass Large (TNLED2). The example tunnel is a 1,000-ft long tunnel with posted speed of 60 mph. There are two 12-ft wide asphalt traffic lanes between 8-ft shoulders. Tunnel is a culvert type with rectangular shape entrance and 18.75 ft. high ceiling. Approach scene is open road with 0% grade. Reflectance of walls and ceiling is 30%. The minimum recommended average roadway luminance is 160 candelas per sq meter. Uniformity ratios are recommended to not exceed 2.0 average to minimum and 3.5 maximum to minimum. The diffuse wall luminance is recommended to be at least 40% of the road luminance.

Comparision of Average Luminance Over Time

Over time, the light level decreases from the initial condition due to lumen depreciation, lamp burn outs, and dirt accumulating on the optics of the fixture. Accumulation of dirt on the fixture will be the same for either the HPS or the TunnelPass LED. In this example it is given that the installation will be cleaned annually when the lumen output due to dirt is 70% of its original value (LLD).

The mortality factor due to lamp burnouts differs between HPS and LED sources (LBO). This information is published by lamp manufacturers. LED lamp mortality is highly dependent upon the heat transfer characteristics of the luminaire. The TunnelPass LED has a L70 rating greater than 100,000 hours.

Lumen depreciation is also very different between the two sources. Similar to mortality factors, lamp manufacturers publish lumen depreciation curves for HPS lamps at 10% intervals of rated lamp life. In this case the life rating of the HPS lamp is 30,000 hours. The lumen depreciation for LED is estimated according to TM-21 data. The rate of lumen depreciation of the TunnelPass LED luminaire is much slower than the HPS. For example, when the HPS is at the end of its rated life the lumen depreciation (LLD) is 72% of the initial value. At this point in time the LED’s lumen depreciation is 95% of its initial value.
The LLD, LBO and LDD are the major factors in determining the road luminance at any point in time. Multiplying the factors together results in a product that is referred to as the Light Loss Factor (LLF). The product of the initial road luminance and the LLF is the predicted road average luminance at that point in time. The IES recommended average luminance is 160 cd per sq m. The HPS source reaches this value at 16,800 hours of operation, or at 3.83 years. At this time the installation needs relamped. Maintenance will require the cost of lane closures, labor and cost to replace failed lamps and ballasts to restore the system back to designed levels.

After more than 23 years of operation, the TunnelPass LED has a maintained average luminance greater than the required 160 cd per sq m., which equates to 23 years of maintenance free operation. At this time, the HPS system will have been relamped five times and would be nearing a sixth lamp change.

Public safety is improved with the TunnelPass LED luminaire while reducing operational costs. A more reliable lighting system will provide the required luminance to allow driver’s vision to adapt to light levels inside the tunnel. This will help keep the traffic moving in a safe manner. Longer intervals between maintenance procedures will also produce operational cost savings resulting from the lighting system needing less maintenance to keep IES recommended average road luminance levels. The largest savings will come as a result of the reduction in lane closures. Vehicular traffic through a high volume tunnel can exceed 150,000 vehicles per day. The process to implement the lane closure is costly, requires political intervention to execute, and the result is a negative impact on both the state and local commerce.

Minimize Lane Closure
20+ Year Service Life
50% Energy Savings
CCB, ceiling mount counterbeam – Recommended for divided tunnels with the majority of lumens directed against oncoming drivers to maximize roadway luminance while controlling disability glare. The distribution is similar to IES type III asymmetric distribution but is oriented toward the oncoming driver rather than perpendicular to the direction of travel.

CLN, ceiling mount long and narrow – Used in undivided tunnels, equal lumens are directed with and against the traffic flow. Similar to IES type II asymmetric long and narrow distribution, the length of the distribution is aligned with the tunnel roadway.

WCR, wall mount crossbeam – Employed in undivided tunnels, equal lumens are directed with and against traffic flow. Distribution is oriented perpendicular to the traffic flow.

UDP, wall mount underpass - Recommended for underpass applications where illuminance required is IES type 4 distribution.