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Introduction

Heavy industrial environments such as steel mills, power generation plants, pulp and paper mills, cement production facilities, foundries, mining operations, and shipbuilding yards provide some of the biggest challenges for LED lighting systems. Excessive heat, moisture, vibration, dust, and power quality fluctuations caused by harsh production processes can all contribute to premature LED failure, eliminating the potential maintenance and safety benefits. These demanding industrial environments deserve only the toughest LED luminaires to deliver superior illumination with unparalleled protection to operate across your facility without incident.

Preventing Accidents

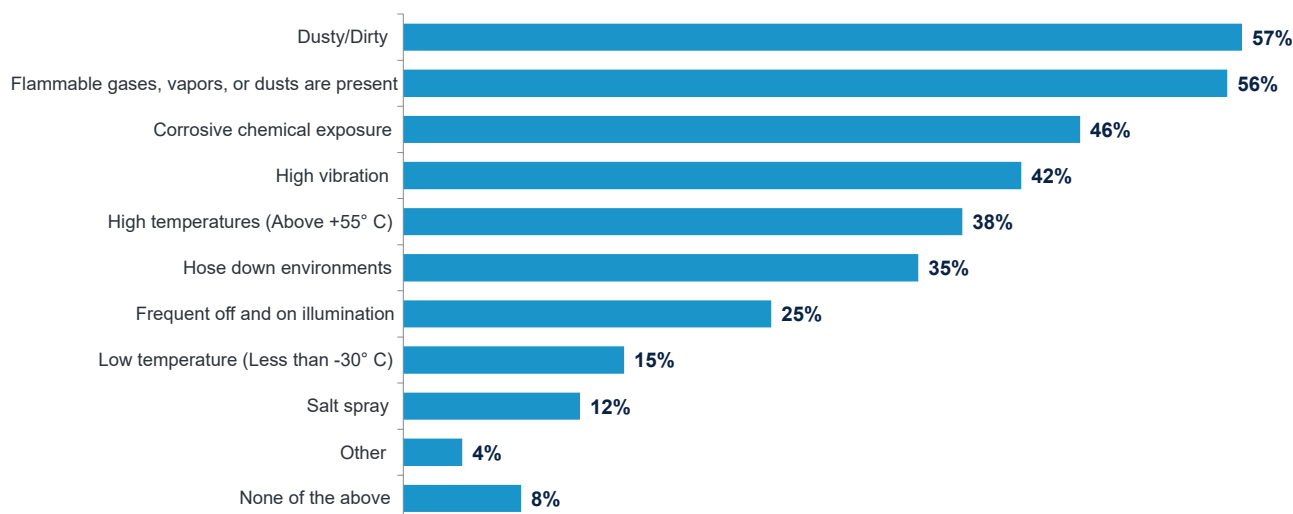
Premature lighting failures or underperforming luminaires due to the adverse effects of wet, harsh locations result in more than downtime — they can lead to very serious accidents to employees and the destruction of equipment. While a multitude of variables can contribute to an industrial accident, inadequate illumination is an often underestimated

risk factor. Malfunctioning or dim lighting makes it difficult for employees to detect obstacles, exposing them to common workplace injuries such as slips, collisions, and other similar incidents. Fatigue, eyestrain, and drowsiness owing to exposure to glare, shadows, or uneven illumination are also contributors to accidents, specifically in situations where precision is required. Poor lighting is responsible for hundreds, if not thousands, of serious injuries each year in areas that could be safely navigated with ease under appropriate lighting conditions. These injuries can be considered negligence with the victim often entitled to damages for injuries, lost time at work, and for pain and suffering.

Emerson offers an extensive line of Appleton™ LED Luminaires designed to outshine in the most demanding applications due to the ruggedly reliable design, quality construction, and rigorous testing required to achieve robust environmental ratings; resulting in safe, comfortable, and consistent light.

Adverse Conditions in Facilities

In a 2018 private survey by Informa Engage of industrial facility managers, respondents reported on the conditions in their buildings that may adversely impact lighting fixture performance



Note: Multiple answers were permitted.



Environmental Challenges

Reliable, purpose-built, industrial grade lighting is essential to improving operational efficiency, creating a safer work environment, and reducing maintenance costs. LED luminaires need to perform in environments subject to extreme temperatures, heavy vibration, corrosive atmospheres, electrical disturbances, and dust, often while running 24/7/365.

Be sure to compare manufacturers' product specifications when comparing heavy duty lighting solutions to typical commercial grade luminaires.

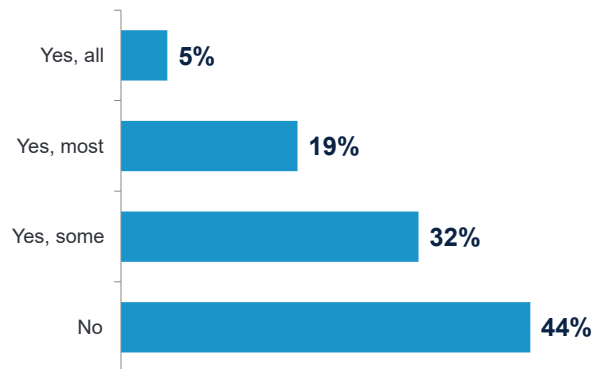
Extreme High Temperatures

LEDs convert electricity to light directly within the luminaire. They retain heat, instead of radiating it, resulting in higher temperatures within the luminaire. Heat is the enemy of electronics, like LEDs and drivers, and must be dissipated effectively through convection or conduction. A poor thermal design which does not dissipate heat well leads to shorter component lifetimes. A superior thermal design keeps LEDs cooler for longer, increasing operating lifetimes.

Processing temperatures inside steel mills, glass plants, paper plants, and other industrial plants can reach over 2204 °C (4000 °F), with ceiling temperatures approaching 65 °C (149 °F) or greater. When selecting LED luminaires, be

Heat-Related Lighting Problems

In the aforementioned survey, 56% of industrial facility managers report lighting problems were heat-related



aware that an off-the-shelf light duty luminaire designed for a stable heat environment likely will not have the proper heat sinking and high temperature gaskets required for extreme heat installations.

Since electronic components are sensitive to heat, an optimal thermal design can be the determining factor for a product achieving its lifetime claims and avoiding quality issues. LED color shift, driver failures, short circuits, and more can all be tied to poor thermal design.

Emerson's Solution

Appleton LED Luminaires emphasize thermal performance first and foremost to provide long term field reliability. Extensive thermal simulation and testing during the design process ensures driver electronics and LED semiconductor devices operate within their thermal limits even at the fixture's maximum rated ambient temperature. No failure prone fans or other active thermal management devices are employed. Our patented designs optimize housing thermal conduction, maximize radiating surface areas, and employ strategically placed thermal conduction breaks to balance heat flows within each LED fixture. Appleton LED Luminaires deliver rated illumination through their full ambient operating temperature range, with no foldback, to make sure your facility is safely lit even when the going gets hot. Appleton LED Luminaires have been tested to extreme ambient temperatures and are typically rated for 60,000 hours or more without noticeable lumen depreciation.



Corrosive and Wet Atmospheres

Exposure to caustic chemicals and solvents, adverse weather, salt water, and moisture will corrode unprotected luminaires, leading to premature failure. Many electric, electronic, and mechanical component failures are caused by corrosion. The World Corrosion Organization estimates the worldwide annual cost of corrosion at \$2.2 trillion, more than 3 percent of global GDP.

Emerson's Solution

Emerson takes several steps to prevent corrosion in its Appleton LED Luminaires, therefore extending service life, while reducing downtime, service, and repair costs. Most importantly, a proprietary Epoxy Powder Coating is applied on housings, guards, and mounting hoods to protect and seal. This finish comes standard, providing superior protection at no extra cost. It lasts longer than a standard paint finish used for commercial fixtures, and provides strong protection against salt water, heat, and harsh chemicals. Fixture hardware, such as bolts and safety cables, are constructed of corrosion resistant stainless steel.

Appleton LED Luminaires are cast from copperfree aluminum. Copperfree aluminum provides excellent corrosion-resistance in locations exposed to salt atmospheres, chemical fumes, and many other corrosive compounds commonly found in harsh industrial manufacturing environments.

Appleton LED Luminaires are suitable for use in wet locations and undergo rigorous testing procedures, achieving Marine Outside Type (Salt Water) and American Bureau of Shipping (ABS) ratings, as part of the listing requirements of a sub group of UL 1598A, Supplemental Requirements for Luminaires for Installation on Marine Vessels.

NEMA Enclosure Types

Type	Fixture Use	IP Code Rating
3R —	Indoor or outdoor use, rain, sleet, external formation of ice	—24
4 —	Indoor or outdoor use, rain, sleet, wind blown dust and rain, splashing water, hose directed water, external formation of ice	—66
4X —	Indoor or outdoor use, rain, sleet, wind blown dust and rain, splashing water, hose directed water, corrosion, external formation of ice	—66

Test requirements include:

Hose test: 25.4 mm (1 in) nozzle, under a pressure of 103 kPa (15 lbs) per square in from a distance 3.05 m (10 ft) for 5 minutes

Corrosion test: Salt spray (fog) testing for 200 hours

Long-life gaskets keep water on the outside and are critical to reliability. It is important to understand the NEMA Enclosure Type and Ingress Protection ratings of a luminaire prior to installation in a demanding environment.

Appleton LED Luminaires are purpose-built for damp, wet, and corrosive installations, carrying Type 3R, 4, and 4X ratings, with most fixtures having an IP66/67 rating.



Heavy Vibration

Another issue adversely affecting the performance of industrial lighting is vibration. For example, a coal crusher generates strong vibrations throughout a power plant when crushing coal blocks. Vibration from the crusher can disengage fixtures from mountings, as well as endanger the safety of employees who may be struck by components coming apart and plunging into work areas or process machinery. Severe vibrations will damage a standard commercial fixture beyond repair and leave employees without lighting.

When deciding on an LED luminaire for your facility, factor in the strength of the vibratory load, the distance between the luminaire and the vibrations, and whether vibrations are intermittent or continuous. Fortunately, LEDs generate light using solid state engineering that is largely impervious to vibration. However, LED drivers do contain wires and connections. In a lower quality luminaire, excess vibration will loosen these connections, which in turn will cause flickering or failure.

Emerson's Solution

The reliability of Appleton LED Luminaires in high vibration work environments begins with the use of the highest quality electronic components, all of which undergo rigorous qualification and production testing. Captive hardware and integral redundant die-cast safety retention points prevent parts from being disconnected. An optional stainless steel safety cable can be slipped around housings through casted retention points as an added precaution.

Emerson conducts extensive vibration tests on Appleton LED Luminaires. These tests involve sweeping through a range of frequencies and resonance points in the x, y, and z axes with Gs well beyond expected application levels. To ensure interior components remain protected, impact tests are performed to IEC and NEC/CEC standards after material aging and temperature cycling to verify robust performance.



Dust Accumulation

Dust is an especially destructive agent to luminaires. In addition to accelerating the corrosive process, dust will affect the cooling of the luminaire by acting as insulation, preventing heat from escaping. Dust will accumulate inside unsealed luminaires, creating problems with conductivity, moisture ingress, electrical shorts, increased arcing and carbon tracking, and ultimately, premature failure.

Dust absorbs water. The more dust particles that settle on a luminaire, the more water that could come into contact with its metal surfaces and promote corrosion, especially in humid air conditions. This gives rise to the formation of pinholes and local pit sites on the surface. Dust can contain oils, organic materials, minerals, and chemicals, all of which can diminish the reliability and life span of the luminaire. It can also contain small amounts of carbon-based debris that might act as a conductor, or prevent conduction of electricity, and could cause serious damage to the internal workings of an LED luminaire.

The increasing frequency of dust storms, particularly in the Middle East, has made dust settlement one of the challenging problems in this region for luminaires. But the fact is, dust is everywhere, from mining to paper mills.

Emerson's Solution

Appleton LED Luminaires meet IP6x enclosure ratings (66, 67) as being "dust proof." Epoxy powder coating prevents dust from corroding the luminaires, while silicone gaskets seal out dust particles from their sensitive electronics. Emerson conducts a number of extended duration product life tests on its gaskets, exceeding operating specifications and verifying long-term field reliability. Aging tests include thermal endurance, humidity levels of 95% RH, dust blanket, and continuous Ultra Violet (UV) exposure. Only top-grade, long-lasting material composed of high-performance closed cell silicone foam is used for the gaskets. The low-compression set characteristics deliver years of reliable service in the most dust intensive areas.

In addition, the Mercmaster™ Series by Appleton offers an easy to install pendant cone mounting hood option to shed dust away from area and task luminaires. Several Appleton fixtures also utilize vertical radiating surfaces, such as fins, to let the dust fall through, translating into a longer operating life by not allowing dust layers to build up on the heat dissipation surfaces of a luminaire.



Electrical Disturbances

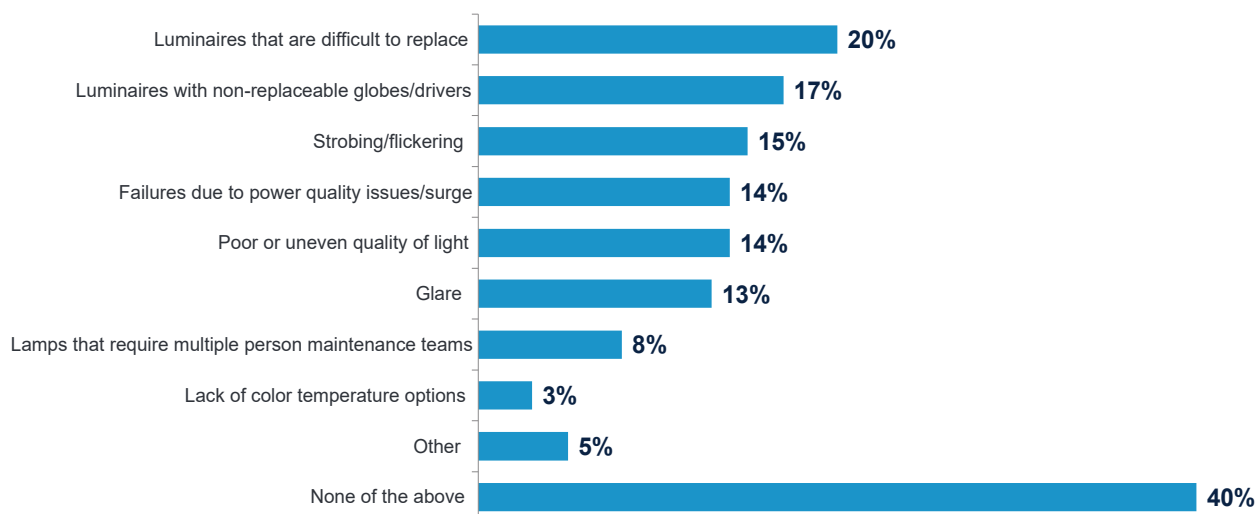
The term “dirty power” refers to abnormalities in an electrical signal that compromises quality. Caused by electromagnetic interference, dirty power will lead to lighting irregularities such as flashing, strobing, flickering or premature luminaire failure. There may also be a noticeable loss of brightness due to damage to the LED driver. The most common form of dirty power are voltage surges, also known as transients. Surges can be caused by lightning, power outages, overloaded circuits, damaged wiring or simply turning on motors, pumps or furnaces. Voltage surges have a destructive impact upon LED lighting systems by wearing out LED drivers and increasing service interruptions.

Emerson's Solution

Appleton LED Luminaires have a minimum built-in 6kV surge suppression that shortens or absorbs the spike in electrical current during a power surge. Preventing surges from damaging the luminaire is a major contributor to delivering 100% availability of the lighting for undisturbed working and production processes as well as employee safety. Optional 10 and 20kV surge protection is available on select Appleton LED Luminaires installed in high surge risk areas.

LED Lighting Problems

In a 2018 private survey by Informa Engage of industrial facility managers, 60% of respondents reported LED lighting problems with 14% citing failures due to power quality issues and surges



Note: Multiple answers were permitted.



24/7 Manufacturing Operations

In industrial environments running round-the-clock, a well lit facility leads to higher productivity, safer machine operation, improved product quality, and accident prevention. However, this can result in over-lighting, which adds to the already high energy costs of 24/7 operations.

Emerson's Solution

Because Appleton LED Luminaires are more energy efficient than their HID predecessors, a watt for watt replacement would yield significantly higher than desired light levels. Generally, an equivalent Appleton LED luminaire produces the same light levels consuming 1/3 to 1/2 the energy of the HID fixtures they replace.

Appleton LED Luminaires also have specialty optics that direct light precisely where it's needed, eliminating wasted light on unnecessary areas. With Appleton LED Luminaires, manufacturers get the energy-efficient lighting they need, where they need it, often with far fewer luminaires.

In addition, Appleton LED Luminaires are instant-on, delivering full output the moment a switch is flipped. This enables them to be equipped with energy-saving occupancy sensors, daylight harvesting, and programmed dimming for times when employees are not in a specific area.

Conclusion

When specifying LED luminaires for wet and/or harsh industrial environments, there are a number of performance factors to consider. However, while the criteria can vary depending on a specific application, there are common performance metrics that need to be incorporated into the luminaire to ensure reliability, safety, and energy-efficiency.

1. LED reliability depends on good thermal design.
2. Understand Ingress Protection and NEMA Enclosure Type ratings.
3. Consider the corrosive elements luminaires will be subjected to in the work environment.
4. Recognize that transient surges pose a threat to LED lighting installations.
5. Employee safety and performance is a factor of the quality of light and the overall reliability of the LED luminaire.

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