METAL HALIDE HIGH-INTENSITY DISCHARGE (HID) LIGHTING

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1.0 SCOPE

This data sheet addresses the ignition potential from the rupture of metal halide high intensity discharge (HID) lighting.

1.1 Changes

October 2012. The following was done to address protection in existing locations (Section 2.1.2.1):

- Changed title from *Electrical Fires* to *Metal Halide High-Intensity Discharge (HID) Lighting.*
- Added lamp replacement recommendation.
- Removed all references relating to adequacy of sprinklers

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 High-Intensity Discharge Lighting

2.1.1 Introduction

Apply these recommendations to any wattage metal halide HID lighting.

2.1.2 Protection

2.1.2.1 Existing Locations

Where unprotected metal halide HID lamps are installed, ensure that replacement lamps are protected or borosilicate or tempered soda lime glass external shields are provided.

2.1.2.2 New Facilities

Where metal halide HID lamps are to be installed provide the following:

A. Fixtures and lamps that meet UL 1598, *Luminaires*, or the equivalent acceptable IEC or local standard, and

B. Protected lamps or enclosed fixtures with borosilicate or tempered soda lime glass external shields.

C. Where ignition sources must be tightly controlled due to the presence of readily ignited or highly smoke- sensitive materials, provide enclosed fixtures (external shields). Use external shields made of borosilicate or tempered soda lime glass that do no leave any gaps between the glass and the fixture. The lamp containment barrier will prevent fragments of hot glass or quartz from falling and igniting combustibles under them. Follow the lamp manufacturer's instructions for installation of the lamp to ensure proper application of the lamp, fixture, and associated auxiliary devices.

2.1.3 Operation and Maintenance

2.1.3.1 Cycle off HID lamps that do not have borosilicate or tempered soda lime glass external shields for at least 15 minutes each week.

2.1.3.2 Perform the following operation and maintenance on all HID lamps:

1. Maintain a record of lamp installation date and recommended manufacturer's service life.
2. Replace the lamp at or before the end of its rated life, preferably by group relamping.
3. Replace the lamp if the outer glass bulb has been scratched, cracked, or damaged in any way.
4. Protect the lamp from contact with liquid, moisture, dust, dirt, oils, etc.
5. Never touch the lamp with bare hands.

2.1.3.3 Always follow the requirements shown on manufacturers' bulletins.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Loss History

High Intensity Discharge (HID) lights can create an ignition source if they shatter. Over the last decade, FM Global clients reported an average of about 3 such incidents a year, with the loss experience largely involving only metal halide lights.

Many, but not all, of the lamp manufacturers have stated that metal halide HID lamps can fail violently. FM Global believes the possibility of violent failure of this type of lamp extends to all manufacturers.

3.1.1 High-Intensity Discharge Lighting

3.1.1.1 Introduction

High-intensity discharge (HID) electric lighting includes mercury vapor, metal halide, and high-pressure sodium lamps.

This type of lamp (Fig. 1) produces light by electrically exciting a mixture of metallic vapor and halides. The lamp consists of a fused silica/quartz arc tube that confines the electric discharge and the associated gases. The arc tube is dosed with mercury, metal halide salts and filled with the inert gas, argon. The arc tube is under a vacuum, 0.39 atm./0.5 psi when the lamp is at ambient temperature and de-energized. The arc tube is enclosed in a glass bulb or outer jacket to exclude air. The bulb is filled with nitrogen, which prevents oxidation of metal parts, stabilizes the operating temperature, and reduces UV radiation. High-intensity discharge lighting operates at very high temperatures and pressures (up to 2000°F [1100°C] and 50 psi [350 kPa]). Because it is a discharge lamp, it does not instantly re-light and will take some time (two or more minutes) to reach full brightness after a power loss.

3.1.1.2 Available Capacity (Wattage) of Lamps

Generally, the following wattage lamps are available: 75, 100, 150, 175, 250, 400, 1000, and 1500 W. The capacity of the lamp can be read off the markings on a spare lamp; purchase orders may also confirm the lamp type in use. ANSI markings (used by all American and some European and Japanese manufacturers) consist of five letters or numbers; the first letter denotes the type of lamp (H for mercury, M for metal halide, S or high-pressure sodium). The lamp capacity is listed after the five letters or numbers. For example, M95PK-400/BVU stands for a metal halide lamp with a nominal wattage of 400 W.

3.1.1.3 Burning Position

The lamp is designed to operate in a specific orientation in respect to the base. Typical positions are horizontal, vertical base up, or vertical base down. Again, the lamp manufacturer will specify the burning position. The wrong burning position will increase the likelihood of a violent failure.

3.1.1.4 Lamp Cycling

Many manufacturers recommend that continuously operated unshielded HID lamps be cycled off for a 15-minute period every week. HID lamps that continuously operate are not stressed in the same manner as lamps that are periodically turned off. Cycling the lamp(s) allows for the lamp(s) to cool and frequently will permit malfunctions to occur in a less harmful manner. If there are imperfections in the lamp, it may then fail in a passive manner and will not ignite upon re-energizing. While cycling is not a guarantee that the lamp will not fail during operation, it can reduce the potential.

3.1.1.5 Shrouded Lamps

A typical shrouded HID lamp is shown in Figure 3. The shroud may be constructed of quartz, alumina silicate, or steel mesh. Lamps with this design that have passed a consensus NEMA industry-developed test are rated as ‘‘O’’ bulbs for use in open fixtures. Based on this testing, these lamps are expected to always contain arc tube fragments in the case of a violent arc tube rupture. (Older lamps of this type may have an ‘‘MP’’ rating rather than the newer ‘‘O’’ rating.) This test was developed based on shrouded lamps and is only appropriate for lamps with that type of construction.

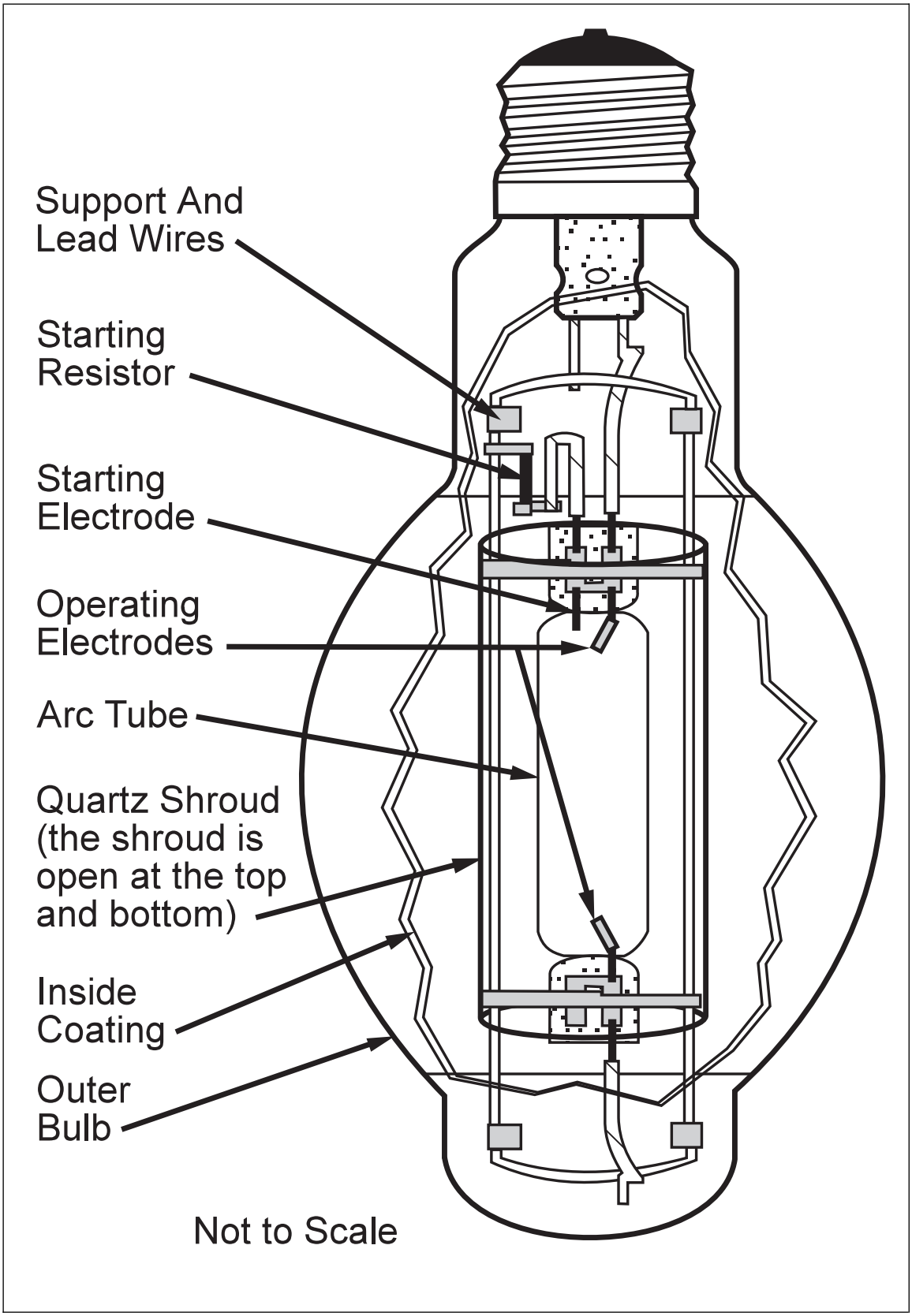


Fig. 1. Schematic of HID lamp

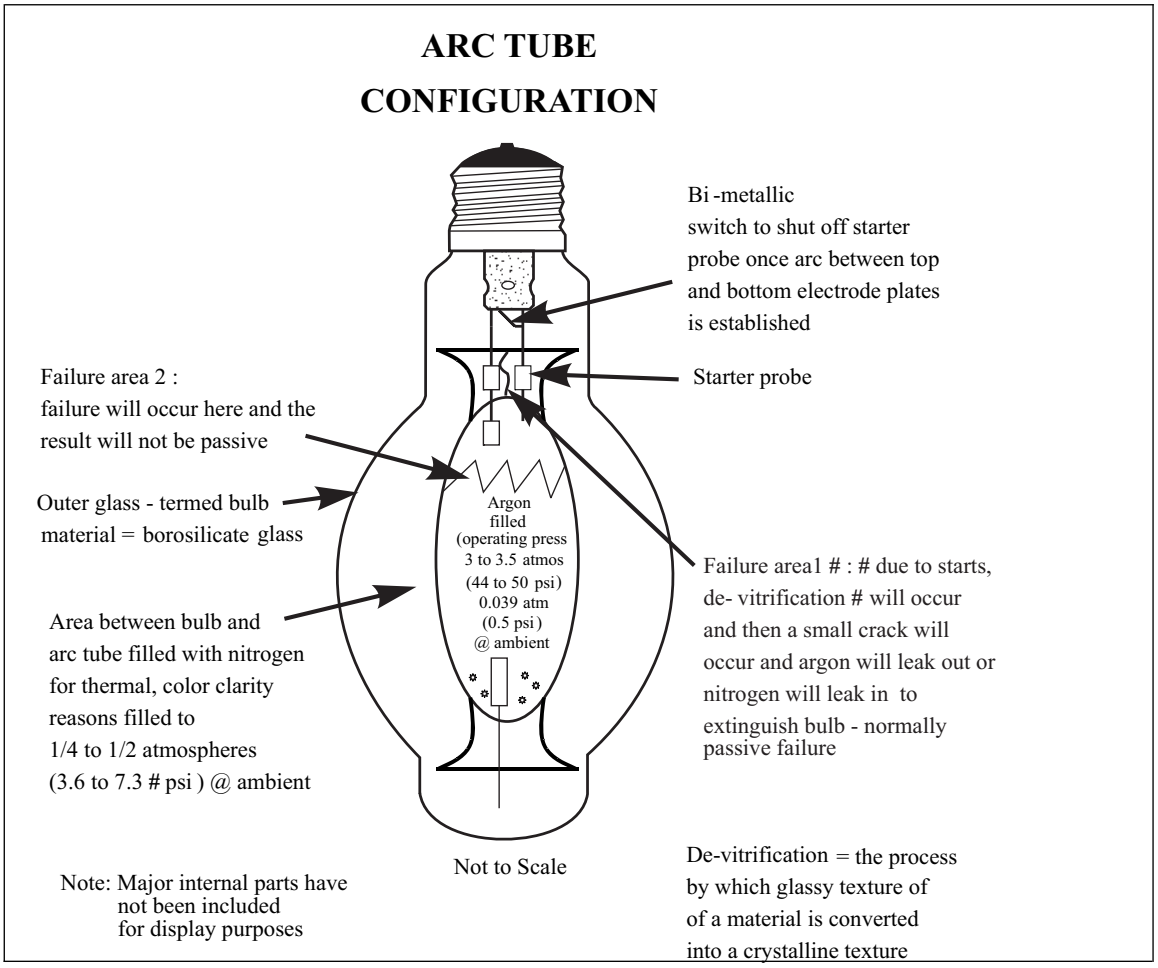


Fig. 2. Arc tube configuration

A recent enhancement to HID fixtures that are designed for only "O" rated lamps is that they have a special socket that only "O" rated lamps with special bases can fit into and operate. These "O" rated lamps will also work in standard sockets.

By comparison, unshrouded lamps may be rated "S" or "E." The "S" rating allows installation in an open fixture provided certain precautions are followed, such as orientation and cycling. "S" rated lamps are available in 360, 400, and 1000 watt ratings for use only in a vertical orientation. The "S" rating is based on empirical field experience that the lamps rarely explode if cycled weekly, and group relamping is performed in accordance with manufacturer recommendations. Lamps with an "E" rating are for use only in enclosed fixtures.

3.1.1.6 Service Life of Lamps

The specifications of various lamp manufacturers indicate that the life expectancy of lamps can range from approximately 3000 hr. (approximately 4 months) to 20,000 hr. (approximately 2¼ years).

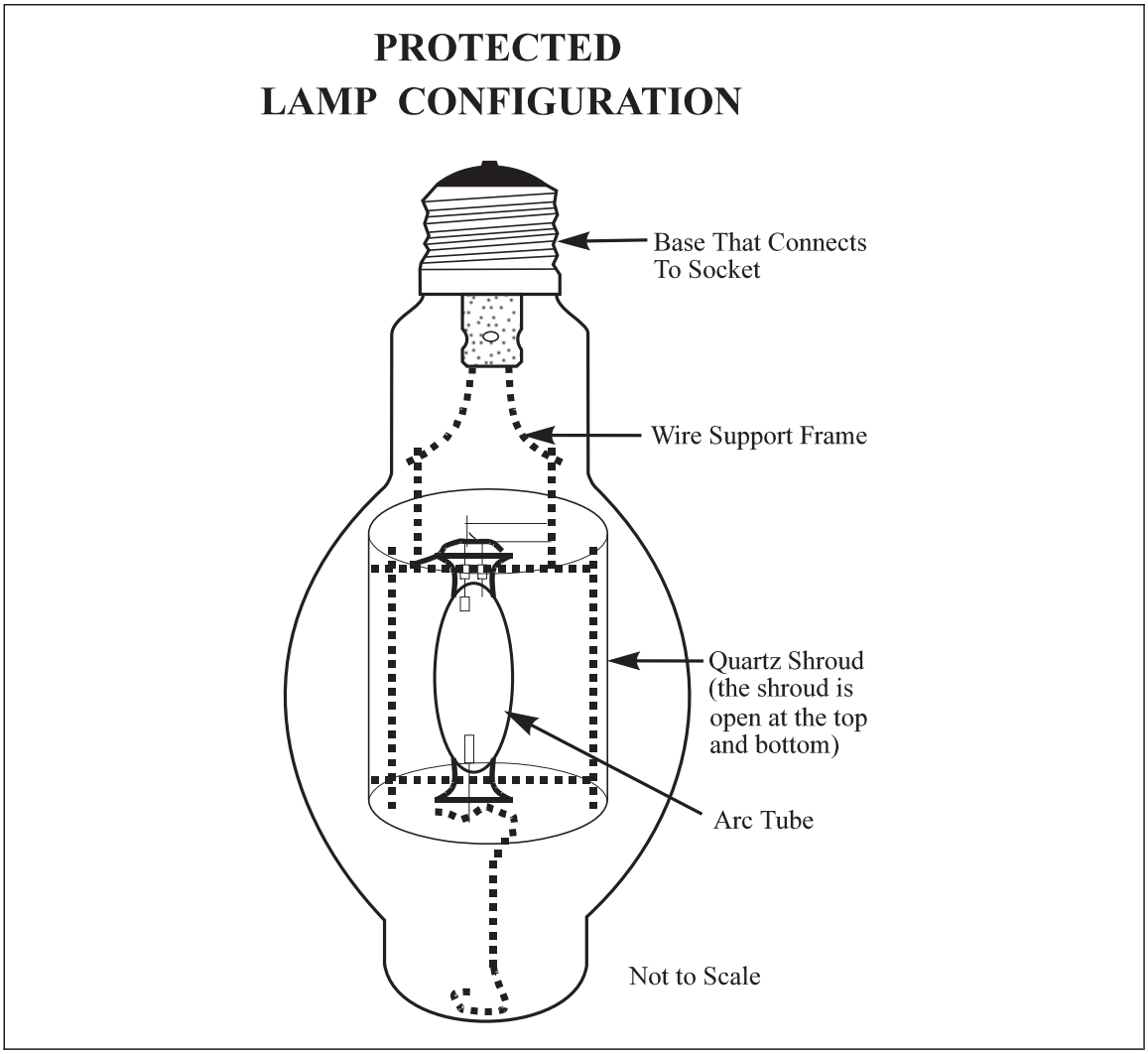


Fig. 3. Protected lamp configuration

The following table presents a range of operating service hours as found in product literature from various manufacturers.

Lamp Wattage, W	*Service Life, hr*
100	6,000 to 10,000
150	10,000
175	6,000 to 7,500
250	10,000
400	15,000 to 20,000
1000	9,000 to 12,000
1500	3,000 to 12,000

Factors that affect lamp life include high and low operating voltages, extremely high operating temperature, and marginally operating auxiliary equipment (ballasts, capacitors, ignitor, and/or power supplies. Most lamps fail to reignite at end of life. This is due to either the argon leaking out of the arc tube, or nitrogen (ion inhibiter) leaking into the arc tube. Most manufacturers recommend group relamping after approximately 60%-75% of rated life. Light output and color shift occur over the life of the lamp. This is the result of the loss of light-producing chemicals within the arc tube and the darkening of the inner walls of the arc tube. The light output of HID lamps decreases to approximately 60% of initial rated light output at about half of its rated life.

3.1.1.7 Failure Mode

Failure of a HID lamp can occur in several ways (Fig. 2). Scratches on the outer envelope, direct contact with water, or excessive pressure can cause these lamps to break. HID lamps and their arc tubes operate at extremely high temperatures and may shatter as a result of missapplication, incorrect burning position, system failure, or other factors. De-vitrification of the arc tube glass occurs when the quartz reacts with the halogen gas. A small crack will occur normally in the vicinity of the electrode, and either the argon will leak out of the arc tube or the nitrogen gas will leak into the arc tube. Normally the lamp will fail to reignite. The probability that the arc tube will implode towards end of life increases significantly. If the lamps are cycled on and off periodically, they are much more likely to fail to restart rather than fail violently at end of life.

If an arc tube ruptures under normal operating conditions, the arc tube fragments can penetrate the outer bulb if a shroud is not effective or present. Extremely hot glass and lamp parts can be released into the surroundings if fragments are not contained by the shroud or an external shield, causing a risk of fire if combustible materials are present.

3.2 Illustrative Losses

3.2.1 Retail Store

Two sprinklers promptly controlled a fire started by a high-intensity discharge (HID) lamp. The bulb jacket parted and spewed hot quartz pieces onto a plastic light diffuser beneath and the occupancy below, during an unattended period at a retail store. Sprinklers controlled the fire and limited damage.

The arc tube of the HID lamp ruptured and discharged hot (estimated 2000°F [1100°C]) quartz onto the plastic light diffuser beneath, which in turn dropped hot or flaming matter on the occupancy below.

The manufacturer had apparently advised purchasers of these HID lamps of this potential failure mode. A program to replace the plastic light diffusers beneath the lamp was being investigated. The lamp may have gone beyond its 10,000-hr rated life. The life rating is not described on the package in which the replacement bulbs are received. The preventive maintenance advice from the manufacturer (to turn the lamps off at least 15 minutes a week) was apparently being followed at this store. Energy conservation was also a factor in the lighting on and off cycle.

3.2.2 Storage of Granular Plastic Pellets

A fire started in double-row rack storage of bags containing granular plastic. It was probably caused by a defective electrical component associated with the lamps. The fire was promptly extinguished by the ceiling sprinkler system. Damage was limited to two burnt pallet loads of stock, and wetted adjacent storage.

Suspected cause of the fire is an arc on the mercury vapor lamp ignition condensor, resulting in hot particles falling on and igniting the storage in the rack. This warehouse is provided with mercury vapor lamps (125 to 250 W, 220 V) at the ceiling level. It could not be ascertained when these lamps were installed, but it was reported that this lighting system is approximately twenty years old. An ignition condensor of a mercury vapor lamp had been damaged in normal operation. This electrical component was not fully enclosed, thus allowing molten metal to escape.

3.2.3 Multi-tenanted Warehouse

Hot fragments released from a ruptured metal halide lamp or fixture are the probable cause of a fire that resulted in damage to client storage at this leased warehouse.

The storage involved in the fire was reported to be 6 to 8 ft (1.8 to 2.4 m) high and consisted mostly of plastic-wrapped and cartoned nylon ‘‘gear bags’’ and some corrugated carton flats. Higher storage ranging from 8 to 12 ft (2.4 to 3.7 m) high surrounded the storage area across the narrow access aisles from the area of origin. This storage included mostly vinyl inflatable rafts. The light fixtures were at least 10 ft (3.0 m) above the highest storage in the building, and about 18 to 20 ft (5.5 to 6.1 m) above the storage involved in the fire.

The building lights are turned off each night. The original lights in the warehouse, and those located over this fire incident and the office, were reported to be 1,000-W metal halide lamps. None of the fixtures have shields fitted.

This is a no-smoking facility, except for the office and breakroom. Indications are that this policy was strictly observed. No hot work had been conducted on site for months.

3.2.4 Synthetic Fabric Rack Storage

Sparks from a ruptured overhead mercury vapor lamp ignited rolls of synthetic fabric stored in multiple-row racks to 16 ft (4.9 m) high at a cloth-finishing plant. Ninety-six ceiling sprinklers operated. In-rack sprinklers were not provided. Ceiling sprinklers, strong water supplies, and prompt fire service response limited fire damage. Smoke and water damage were extensive.

The mercury vapor lamps did not have an enclosure to keep sparks from spreading to storage. Lack of a wall between the warehouse and a manufacturing building allowed smoke to damage production machines. Lack of in-rack sprinklers allowed the fire to operate an excessive number of ceiling sprinklers.

3.2.5 Roll Paper Storage

The bursting of a mercury vapor lamp is the probable cause of a fire occurring in a roll paper storage area at a tissue products manufacturing plant. The water density available from the hydraulically designed sprinkler system was inadequate for the occupancy because the system was designed to protect paper-converting lines. Paper rolls were stored on end, two high, to a height of 17 ft (5.2 m). The lamp that probably started the fire was the only one in the area not provided with a safety cover.

Damage was limited by a strong water supply and an effective emergency response team.

A total of about 2,000 tons (1,800 metric tons) of roll paper were burned, charred, or wet. Also damaged were aluminum roof panels, plastic skylights, and electric lights and wiring. Although paper-converting machines were not damaged, production was interrupted for two days for cleanup.

3.2.6 Plastic and Paper Storage Warehouse

A hot fragment from a ruptured metal halide lamp or fixture is the probable cause of a fire in a 200,000 ft^2 (19,000 m^2) warehouse with two tenants. The sprinklered building has precast concrete walls and a Class II insulated steel deck roof. The tenants stored promotional merchandise and paper business records.

The operation of five sprinklers confined the fire to a 500 ft^2 (46 m^2) area used for the storage of plastic and paper promotional items stored on pallets to a height of 8 ft (2.4 m). Water damage occurred over an area of 10,000 ft^2 (930 m^2). Smoke damage was observed throughout the building. No structural damage was reported.

3.2.7 Computer Equipment Assembly Plant Storage

An unshielded, 400-W metal halide lamp over rack storage ‘‘popped,’’ igniting rack storage of plastics at a computer equipment assembly plant. Sprinklers operated and controlled the fire. Nonthermal damage accounted for most of the loss.

About three years before the fire, FM had determined that the rack storage was inadequately protected and had recommended an upgrade. About two years later, the sprinkler system was reinforced in accordance with accepted plans.

About two years before the fire, FM had also recommended the metal halide lamps be cycled weekly. The client established a weekly cycling program, so the recommendation was reported as completed some four months before the fire. Unfortunately, in those four months, key personnel changes occurred and the cycling program was not being followed.

This loss illustrates the danger metal halide lights present as an ignition source and the importance of having adequate sprinkler protection.

4.0 REFERENCES

UL 1572, *High Intensity Discharge Lightning Fixtures*
UL 1598, *Luminaires*

APPENDIX A GLOSSARY OF TERMS

Accessibility Barrier: A material provided to limit access to uninsulated live parts; and live parts insulated with materials not intended to be subject to user contact. All or part of the barrier may also serve as an enclosure as defined below.

Arc tube: A completely sealed quartz tube where the electrical discharge (arc) occurs.

Ballast: An auxiliary piece of equipment designed to start and properly control the flow of power to the gas discharge light source such as HID lamps.

Base: The end of the lamp that inserts into the lamp socket.

Bulb: The outer jacket or envelope of a lamp, is the glass enclosure that covers the frame and arc tube assembly.

Enclosure: A material provided to enclose electrical parts and components that may be considered to involve a risk of fire. All or part of the enclosure may also serve as an accessibility barrier as defined above or as a recessed housing as defined below.

Field-Connected Ballast: A ballast that may or may not be provided with the fixture and that is intended to be electrically connected to the fixture during installation. The ballast may be mounted on the fixture or mounted remotely.

High Intensity Discharge (HID) Lamp: A general term for mercury, metal halide and high pressure sodium lamps. HID lamps contain compact arc tubes which enclose various gases and metal salts operating at high pressures and temperatures.

High Pressure Sodium Lamp: An HID lamp which produce light by an electrical discharge through sodium vapor operating at high pressure and temperature.

Lamp: The device, commonly called a light bulb or bulb, intended to be inserted into a lampholder (socket) to produce light.

Lamp Containment Barrier: A barrier that consists of the top, sides, and bottom that enclose the lamp compartment. The barrier may consist of a metal housing (recessed or otherwise), a polymeric enclosure, a glass diffuser or lens, a metal canopy, a metal screen, or the like.

Luminaire: A complete lighting unit consisting of a lamp, ballast, as required together with the parts designed to distribute the light, position and protect the lamps and connect them to the power supply (fixture).

Mercury Lamp: An HID lamp in which most of the light is produced by radiation from excited mercury vapor operating at high pressure and temperature. Phosphor coatings on some lamp types add additional light and improve color rendering.

Metal Halide Lamp: A high-intensity discharge (HID) lamp in which the major portion of the light is produced by radiation of metal halides and their products of dissociation.

Pendant Fixture: A fixture that is supported by and suspended from an outlet box by a chain, cord, stem, or cable.

Recessed Fixture: A fixture intended to be installed in a hole in a wall, ceiling, or in-ground surface such that all or part of the fixture is behind the mounting surface.

Recessed Housing: The metal of a recessed fixture that serves to close off the hole provided in a ceiling or wall surface to mount the fixture. It does not necessarily enclose wires or the like.

Remote Ballast: A ballast that is not mounted on a fixture or one that is mounted on the fixture 18 in. (457 mm) or more from the recessed housing as measured from the nearest point on the ballast to the nearest point (other than an incidental projection) on the recessed housing. The ballast may or may not be provided with the fixture.

Shroud: A quartz tube around the arc tube.

APPENDIX B DOCUMENT REVISION HISTORY

October 2012. The following was done to address protection in existing locations (Section 2.1.2.1):

- Changed title from *Electrical Fires* to *Metal Halide High-Intensity Discharge (HID) Lighting.*
- Added lamp replacement recommendation.
- Removed all references relating to adequacy of sprinklers

June 2009. Appendix B, Document Revision History was updated.

May 2002, DS 5-21, *Electrical Fires*, was published as a May 2002 revision of the January 2001 release.

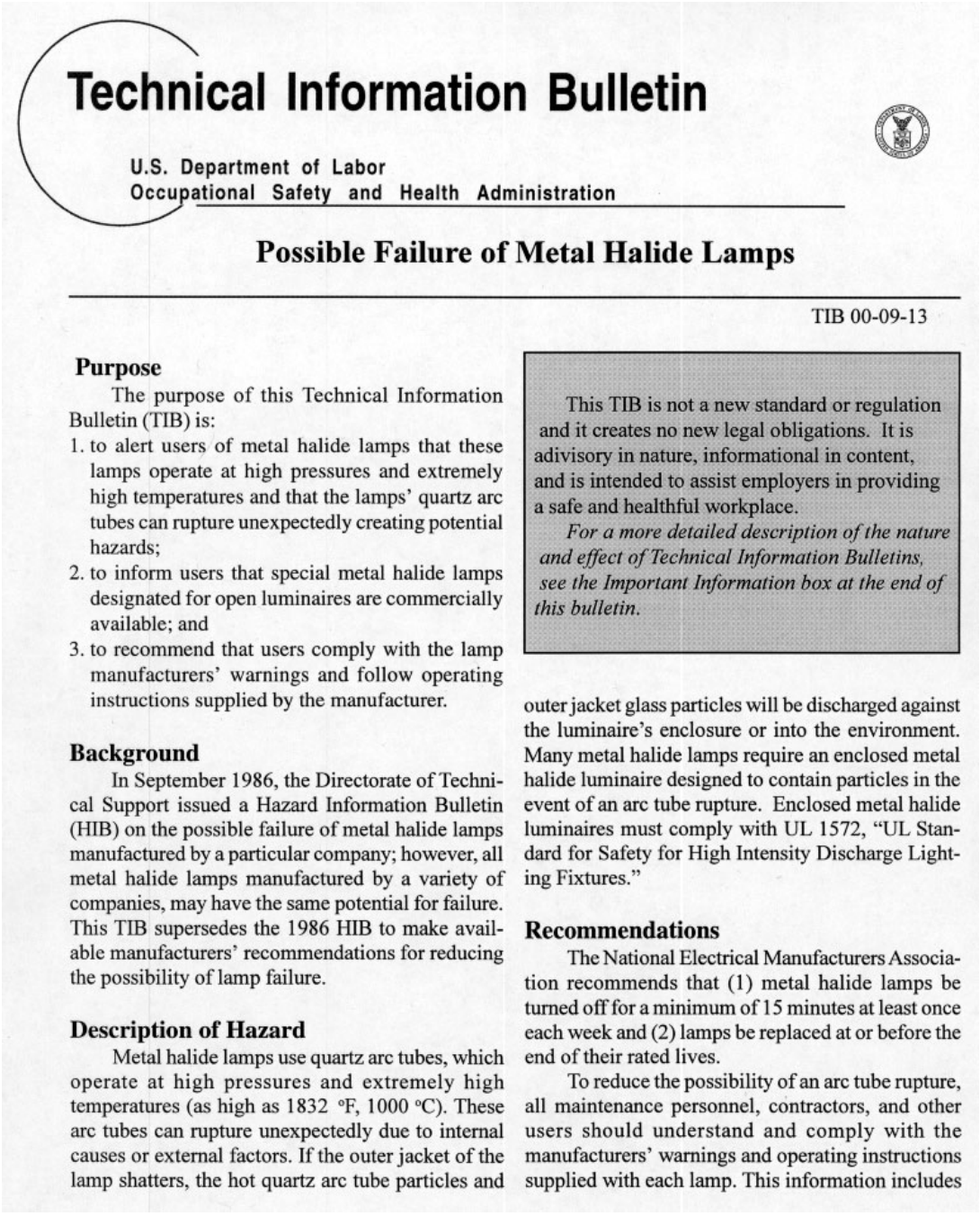
May 2001, DS 5-21, *Electrical Fires*, was published as a May 2001 revision to the January 2001 release.

January 2001, DS 5-21, *Electrical Fires,* was published as a document superseding the September 2000 release.

October 1999, DS 5-21, Electrical Fires, was published as a revised operating standard and as a new public data sheet.

APPENDIX C SUPPLEMENTAL INFORMATION

C.1 OSHA Technical Information Bulletin, TIB 00-09-13, Possible Failure Mode of Metal Halide Lamps



Technical Information Bulletin

U.S. Department of Labor
Occupational Safety and Health Administration

Possible Failure of Metal Halide Lamps

TIB 00-09-13

Purpose

The purpose of this Technical Information Bulletin (TIB) is:

1. to alert users of metal halide lamps that these lamps operate at high pressures and extremely high temperatures and that the lamps' quartz arc tubes can rupture unexpectedly creating potential hazards;
2. to inform users that special metal halide lamps designated for open luminaires are commercially available; and
3. to recommend that users comply with the lamp manufacturers' warnings and follow operating instructions supplied by the manufacturer.

This TIB is not a new standard or regulation and it creates no new legal obligations. It is adivisory in nature, informational in content, and is intended to assist employers in providing a safe and healthful workplace.

For a more detailed description of the nature and effect of Technical Information Bulletins, see the Important Information box at the end of this bulletin.

Background

In September 1986, the Directorate of Technical Support issued a Hazard Information Bulletin (HIB) on the possible failure of metal halide lamps manufactured by a particular company; however, all metal halide lamps manufactured by a variety of companies, may have the same potential for failure. This TIB supersedes the 1986 HIB to make available manufacturers' recommendations for reducing the possibility of lamp failure.

Description of Hazard

Metal halide lamps use quartz arc tubes, which operate at high pressures and extremely high temperatures (as high as 1832 °F, 1000 °C). These arc tubes can rupture unexpectedly due to internal causes or external factors. If the outer jacket of the lamp shatters, the hot quartz arc tube particles and outer jacket glass particles will be discharged against the luminaire's enclosure or into the environment. Many metal halide lamps require an enclosed metal halide luminaire designed to contain particles in the event of an arc tube rupture. Enclosed metal halide luminaires must comply with UL 1572, "UL Standard for Safety for High Intensity Discharge Lighting Fixtures."

Recommendations

The National Electrical Manufacturers Association recommends that (1) metal halide lamps be turned off for a minimum of 15 minutes at least once each week and (2) lamps be replaced at or before the end of their rated lives.

To reduce the possibility of an arc tube rupture, all maintenance personnel, contractors, and other users should understand and comply with the manufacturers' warnings and operating instructions supplied with each lamp. This information includes

Fig. 4. OSHA TIB (page 1)

luminaire and operating position requirements for the particular lamp, along with other important instructions.

Special metal halide lamps, which are designed to contain all particles in the event of a rupture, are commercially available. These lamps are designed so that the outer jacket remains intact if an arc tube ruptures. Users may wish to consider using these lamps as another option for open luminaires. These lamps can be found in the lamp manufacturer's literature or by contacting lamp suppliers.

*

Important Information on the Nature and Effect of Technical Information Bulletins

OSHA's Directorate of Technical Support (DTS) issues Technical Information Bulletins (TIBs) to provide information about occupational hazards and /or to provide information about noteworthy, innovative, or specialized procedures, practices and research that relate to occupational safety and health. DTS selects topics for TIBs from recognized scientific, industrial hygiene, labor, industry, engineering, and/or medical sources.

The *Occupational Safety and Health Act* requires employers to comply with hazard-specific safety and health standards. In addition, employers must provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm under Section 5(a)(1), the General Duty Clause of the Act. Employers can be cited for violating the General Duty Clause if there is a recognized hazard and they do not take appropriate steps to prevent or abate the hazard. However, the failure to implement TIB recommendations is not, in itself, a violation of the General Duty Clause. Citations can only be based on standards, regulations, and the General Duty Clause.

Further information about this bulletin may be obtained by contacting OSHA's Directorate of Technical Support at 202-693-2200

Fig. 5. OSHA TIB (page 2)