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Best Practices for Metal Halide Lighting Systems Relative to Lamp Rupture Risks

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1 Introduction

Metal halide lighting systems represent one of the great innovations in lighting applications. Today’s systems provide the ability to deliver a variety of light levels, from low to very high output, with high-energy efficiency, long life, and excellent color. In addition, since metal halide lamps are compact sources, these systems offer the ability to direct and focus light in a manner not possible with more diffused high-efficiency light sources, such as fluorescent lamps.

Since metal halide lamps operate at elevated internal pressures compared with most other general-purpose light sources, manufacturers have historically provided explicit instructions on their proper use. In addition, manufacturers provide warning information designed to reinforce the need to follow these instructions, since failure to do so can significantly increase the risk of a lamp rupture. A lamp rupture can eject hot particles into the luminaire, and potentially into the surrounding space, if the luminaire does not completely enclose and contain all hot particles. If hot particles land on combustible materials, there is risk of fire. Despite the large number of metal halide lamps used, there are very few reported instances of property damage claims resulting from the rupture of metal halide lamps. When even this small risk of rupture is not acceptable, glass-enclosed luminaires should be used, or where glass-enclosed luminaires are undesirable, Type O lamps should be used.

One goal of NEMA manufacturers is to reduce risk as much as possible without unreasonably sacrificing product utility, by continually striving to improve the application and use of metal halide systems.

2 Objective of This Paper

The objective of this paper is to provide updated educational information for the selection, operation, and maintenance of metal halide lighting systems, with specific emphasis on those items pertinent to the risks associated with lamp rupture.

3 References

This best practice incorporates reference provisions from other publications. These references are cited at the appropriate places in the text, and the publications are listed below. For undated references, the latest edition of the publication referred to applies (including amendments).

- ANSI C78.380, Annex B, American National Standard for Electric Lamps—High Intensity Discharge Lamps, Methods of Designation
- ANSI C78.389 American National Standard for Electric Lamps—High Intensity Discharge—Methods of Measuring Characteristics
- NEMA LSD 14 Guidelines on the Application of Dimming to High-intensity Discharge Lamps
- NFPA 70 National Electrical Code® (NEC)
- UL 1598 Luminaires/CSA C22.2 No. 250.0-00, Luminaires/NMX-J-307/1-ANCE (These three standards are the Tri-national Luminaire Safety Standard.)
- UL 1029 Ballasts, High Intensity Discharge Lamp/CSA C22.2 No. 74.0, Equipment for Use with Electric Discharge Lamps
4 Metal Halide Arc Tube Failure Mechanisms and Lamp Rupture

Virtually all metal halide lamps reach end of life in a benign manner. Because of the high internal operating pressure of the arc tube, however, there is the potential for an arc tube rupture. With only a glass outer envelope surrounding the arc tube, the outer envelope might be breached by particles from an arc tube rupture. If this occurs, hot particles might be ejected from the lamp.

The small, but existing, possibility of a rupture is why most, if not all, lamp manufacturers provide strongly worded warning statements with metal halide lamps.

Chemical reaction of the arc tube wall material with the metal halides might, over time, weaken areas of the arc tube sufficiently that it might fail because of a crack or excessive thinning. If this happens during the heating and cooling that occurs when the lamp is cycled, the typical result is a lamp that extinguishes and does not re-ignite. If the failure occurs when the arc tube is at full wattage and pressure, the tube might shatter.

5 Metal Halide Lamp Classifications

Every metal halide lamp is classified by the lamp manufacturer as to the recommended manner in which it should be used. The three American National Standards Institute, Inc. (ANSI) classifications follow:1

1) Lamps classified as **Type E** are to be used only in suitably rated enclosed luminaires, in accordance with UL 1598 and CSA C22.2 No. 250.0.2. UL 1598 prohibits the use of Type E lamps in certain types of luminaires with polymeric (plastic) lamp enclosures.

2) Lamps classified as **Type S** have historically been used in open and enclosed luminaires. Their use in open luminaires is restricted to operation in the vertical position. This category is limited to certain lamps in a 360-1000 W range. Since 2005, however, new installations regulated by the National Electrical Code® (NEC) do not allow the option of using Type S lamps in open luminaires (see earlier comment about replacement lamps). UL 1598 also prohibits the use of certain wattage Type S lamps with certain types of indoor luminaires that have polymeric lamp enclosures (see section 7).

3) Lamps classified as **Type O** can be used in open or enclosed luminaires. Type O lamps comply with ANSI Standard C78.3893 for containment testing

6 National Electrical Code® (NEC)

The current edition of the NEC requires that luminaires which use metal halide lamps (except for thick-glass PAR lamps) in new installations be enclosed or to have some physical means to ensure that only Type O lamps can be used in them. This means that, in practice, open luminaires will utilize a special lamp holder that will accept only Type O lamps. (Type O lamps have a slightly different lamp base [ mogul] or bulb neck diameter [ medium] compared with typical Type E and Type S lamps.) Since Type E lamps should be used only in enclosed luminaires, this requirement is to ensure the use of Type O lamps in open luminaires for those installations under the jurisdiction of the 2005 NEC and later editions.

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The experience with Type O lamps is that even in those rare instances when an arc tube ruptures, Type O lamp construction is effective in preventing the rupture particles from penetrating the outer bulb, thus preventing hot particles from falling into the surrounding space. This increased security does not in any way diminish the safety record of properly maintained and operated Type S lamps.

NEMA strongly recommends that open luminaires and indoor luminaires with polymeric lamp enclosures use Type O lamps.

7 Listed Metal Halide Luminaires

Since April 17, 2014, UL 1598 prohibits the use of a polymeric lens for a lamp containment barrier with anything but Type O lamps in new indoor luminaires for vertically oriented metal halide lamps that are rated from 175-400 W.

Metal halide luminaires manufactured prior to 2014 that use polymeric lenses and Type E or Type S lamps will continue to exist. Type E lamps will continue to be available for those customers who wish to use them in existing polymeric lensed luminaires in accordance with appropriate lamp and luminaire manufacturer warnings and instructions issued with the luminaire at time of purchase.

When operated in accordance with manufacturer’s warnings and instructions, polymeric-lensed luminaires with Type-E and Type S lamps can be a safe and effective lighting alternative. When warnings and instructions are not heeded, however, the operation of a polymeric-lensed luminaire with a Type E or Type S lamp can potentially present an elevated level of fire risk (in some applications) that would not exist with lighting systems employing a Type-O lamp. Existing polymeric-lensed luminaires will accommodate Type O lamps without a lamp holder change.

NEMA lamp and luminaire manufacturers support UL 1598, since it simplifies the metal halide systems options available and reduces the potential risks associated with failure to properly follow the warnings and instructions for systems that specify polymeric-lensed luminaires.

8 Essential Practices for Minimizing Risks from Metal Halide Lamp Rupture

*To significantly reduce the risk of lamp rupture, the lamp manufacturer's warnings and operating instructions must be followed.*

Furthermore, all NEMA lamp manufacturers strongly recommend that lamps be group replaced at or before their rated life.

NEMA lamp manufacturers require that certain types of metal halide lamps be turned off at least once a week for a minimum of 15 minutes to reduce the possibility of rupture in continuously operating installations. Some NEMA lamp manufacturers, however, no longer require that Type O lamps be turned off once a week for a minimum of 15 minutes in continuously operating installations, since Type O lamps incorporate an integral self-shielding technology designed to minimize any ejection of hot particles from the lamp. While not required, some manufacturers note that cycling can be employed as an additional measure if possible failure of the lamp containment mechanism would be considered unacceptable in a given installation.

9 Metal Halide Lighting System Luminaire Options and Trade-offs

There are reasons, driven by application needs, to offer both open and enclosed luminaires. Users should assess the consequences of a possible ruptured arc tube (and broken outer bulb) when choosing a lighting system. Relative to Type-S lamps in open luminaires, enclosed luminaires and Type-O lamps in open luminaires offer more protection in the event of arc tube rupture. It is acceptable to, and recommended by, the industry to install an O-rated lamp in a Type S–rated luminaire. It is therefore
important to include risk management as a selection criterion. It is not practical to simply dictate that all luminaires be one type or the other.

The following factors should be considered in any choice of system components:

a) Desired maintained light level
b) Light distribution pattern
c) Number of luminaires required
d) Efficiency of the system
e) Initial acquisition and installation costs
f) Cost of operating the system—electricity
g) Cost and ease of maintenance—cleaning luminaires, changing lamps
h) Probable conditions at the site once in use, (including the location of lighting relative to combustible items)
i) Level of acceptable risk from a ruptured arc tube
j) Specifier requirements
k) Aesthetics
l) Commitment of the user to following lamp operating instruction and good maintenance practices

The final decision by any end user is typically a combined consideration of all factors.

10  Practices for Minimizing Risk from Metal Halide Systems

The following practices should be followed, regardless of the specific type of metal halide system that is installed and regardless of the specific use or application environment (store lighting, warehouse, industrial, indoor sporting facilities, for example).

a) Users must become familiar with and heed the lamp and luminaire manufacturers’ warnings and follow their instructions with respect to safety, installation, maintenance, and reduction of risk. This information can be found on the product packaging or insert sheet, in separate literature for the product, on Web sites, or in published catalogs. The user's failure to follow the manufacturers' warnings and instructions will increase the risk for those installations. NEMA manufacturers have professional applications experts who can assist users if they have additional questions regarding any aspect of application.

b) Always group re-lamp metal halide installations at the time recommended by the lamp manufacturer. Although some spot re-lamping may be necessary for any installation, using spot re-lamping as the only replacement practice increases risk and is strongly discouraged.

c) Do not operate lamps past their rated life. Doing so increases the risk of lamp rupture.

d) Follow lamp manufacturer instructions for lamp cycling as applicable for specific lamp types. Products are available that will automatically cycle lamps/luminaires, on a scheduled or random basis, depending on what is best for a user’s needs. Such automatic cycling controllers, which can be as simple as a time clock, can be installed for new or existing metal halide applications.

e) Operate metal halide lamps on ballasts that are designed to provide the appropriate wattage for the lamp. Ballasts should be compliant with UL 1029 or CSA C22.2 No. 74.0 and follow ANSI lamp wattage requirements. Operating the lamp on an incorrect ballast can increase the risk of lamp failure.

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4 Cycling means turning off lamps at least once per week for a minimum of 15 minutes when they are in continuous operation.
f) Ensure that luminaires for metal halide lamps are third-party listed to UL 1598 or CSA C22.2 No. 250.0 by an accredited NRTL.  

g) When installing and maintaining luminaires, ensure that all manufacturer-supplied components are installed properly. Failure to install supplied components, such as a lens, will void third-party listing. The user’s failure to install a lens properly during luminaire installation or during routine maintenance could increase the risk of hot particles escaping the luminaire in the unlikely event of a lamp rupture.

h) The luminaire manufacturer must be consulted if a user wishes to add a protective lens to an existing luminaire. In some instances, the addition of a lens might still leave an opening at the top of the reflector, which could allow the ejection of hot particles. Adding a cover lens to a luminaire where none was intended can raise the lamp and ballast temperatures to unacceptable levels, increasing risk of failure. In addition, lens covers, when used, must themselves be operated within approved temperature limits for correct performance as a safety device. Failure to consult the luminaire manufacturer when adding such a cover might void its third-party listing.

i) Follow lamp manufacturer and NEMA recommendations and guidelines for dimming metal halide lamps. Excessively deep dimming (beyond manufacturer and industry guidelines) might increase the risk of rupture for some metal halide lamps. If dimming is to be employed, consult the lamp manufacturer for recommendations.

j) Special care should be taken when storing flammable, combustible, or oxidizing materials under metal halide luminaires. In warehouse applications, for example, locate luminaires over the center of aisles, not over racks or products.

k) Do not use luminaires in an application where the ambient temperature exceeds the rated temperature for the luminaire.

l) Damaged lenses must be replaced immediately. Failure to replace a damaged lens increases the risk that the luminaire will not adequately contain a lamp rupture if one should occur.

m) Comply with all applicable codes, including the NEC.

11 Summary of Common Metal Halide Systems

This section presents common system options and the advantages and disadvantages of each. The underlying assumption is that all manufacturers’ warnings and instructions are followed. See the following table:

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6 NRTL stands for a Nationally Recognized Testing Laboratory, accredited by the Occupational Safety and Health Administration.

7 NEMA publication LSD 14, Guidelines on the Application of Dimming to High-intensity Discharge Lamps, National Electrical Manufacturers Association, Rosslyn, Virginia.
### Common Metal Halide Systems

<table>
<thead>
<tr>
<th>System Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Open Luminaire</strong></td>
<td>Lowest initial cost system</td>
<td>No containment barrier</td>
</tr>
<tr>
<td><strong>Type S Lamp (Non-exclusionary Lamp Holder Design)</strong></td>
<td>Fewer luminaires and less energy consumption than the same product with a lens (for a specified illumination level)</td>
<td>Only available for lamps 360-1000 W</td>
</tr>
<tr>
<td></td>
<td>No lens to maintain or to reduce light output</td>
<td>Required vertical lamp operation limits available luminaire types</td>
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<tr>
<td></td>
<td>Easy lamp replacement</td>
<td>Does not prevent mis-lamping with Type E lamp</td>
</tr>
<tr>
<td></td>
<td>Typically shorter hot re-strike time than for enclosed luminaires</td>
<td>Lamp more susceptible to damage than in enclosed luminaire</td>
</tr>
<tr>
<td><strong>Open Luminaire</strong></td>
<td>Provides a containment barrier within the lamp</td>
<td>Higher lamp cost</td>
</tr>
<tr>
<td><strong>Type O Lamp (Non-exclusionary Lamp Holder Design)</strong></td>
<td>Fewer luminaires and less energy consumption than the same product with a lens (for a specified illumination level)</td>
<td>Does not prevent replacement with Type S or Type E lamps</td>
</tr>
<tr>
<td></td>
<td>No lens to maintain or to reduce light output</td>
<td>Lamp more susceptible to damage than in an enclosed luminaire</td>
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<tr>
<td></td>
<td>Easy lamp replacement</td>
<td>Type O lamps may have slightly reduced lumen output compared with Type S or Type E lamps of similar design</td>
</tr>
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<td>Typically shorter hot re-strike time than in enclosed luminaires</td>
<td></td>
</tr>
<tr>
<td><strong>Open Luminaire</strong></td>
<td>Provides a containment barrier within the lamp</td>
<td>Higher lamp cost and lamp holder cost</td>
</tr>
<tr>
<td><strong>Type O Lamp (Exclusionary Lamp Holder Design)</strong></td>
<td>Does not allow Type S or Type E lamps to be installed</td>
<td>Lamp more susceptible to damage than in enclosed luminaire</td>
</tr>
<tr>
<td></td>
<td>Fewer luminaires and less energy consumption than the same product with a lens (for a specified illumination level)</td>
<td>Type O lamps may have slightly reduced lumen output compared with Type S and Type E lamps of similar design</td>
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</tr>
<tr>
<td><strong>Third Party–listed Polymeric Lens Luminaire</strong></td>
<td>Provides external containment barrier</td>
<td>Higher initial cost than open systems</td>
</tr>
<tr>
<td><strong>Type S and Type E Lamps (Non-exclusionary Lamp Holder Design)</strong></td>
<td>Can use Type S or Type E lamps</td>
<td>Not available in higher wattages and ambient temperature ratings</td>
</tr>
<tr>
<td></td>
<td>Might be required for certain applications (e.g., food handling)</td>
<td>Requires operation within stated ambient temperature for proper containment</td>
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<td></td>
<td>Prismatic lenses might provide better lighting performance</td>
<td>Potential degradation of lens over time</td>
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<tr>
<td></td>
<td></td>
<td>Degradation or damage of lens requires replacement</td>
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<tr>
<td></td>
<td></td>
<td>More difficult to re-lamp than open luminaire</td>
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<tr>
<td>• Third Party–listed Polymeric Lens Luminaire</td>
<td>• Must use Type O lamps</td>
<td>• Higher initial cost than open systems</td>
</tr>
<tr>
<td>• Type O Lamps (Exclusionary Lamp Holder Design)</td>
<td>• might be required for certain applications (e.g., food handling)</td>
<td>• Not available in higher wattages and ambient temperature ratings</td>
</tr>
<tr>
<td>NOTE—This system complies with the NEC and UL 1598.</td>
<td>• Prismatic lenses might provide better lighting performance</td>
<td>• Potential degradation of lens over time</td>
</tr>
<tr>
<td>• Temperled or Borosilicate Glass Lens Luminaire</td>
<td>• Provides external containment barrier</td>
<td>• Degradation or damage of lens requires replacement</td>
</tr>
<tr>
<td>• Type S, Type O, and Type E Lamps</td>
<td>• Can use Type S, Type O, or Type E lamps</td>
<td>• More difficult to re-lamp than open luminaire</td>
</tr>
<tr>
<td>NOTE—This system complies with the NEC and UL 1598.</td>
<td>• Can be used in higher temperature environments and with higher wattage lamps than comparable product with polymeric lenses</td>
<td>• Higher initial cost than open system</td>
</tr>
<tr>
<td></td>
<td>• Potential for longer lens life than polymeric</td>
<td>• Potential for lens shattering due to mechanical stress</td>
</tr>
<tr>
<td></td>
<td>• Prismatic lenses might provide better lighting performance</td>
<td>• Tempered glass can shatter due to thermal shock or spontaneous breakage</td>
</tr>
<tr>
<td>12 Conclusion</td>
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</table>

Metal halide lamps and systems offer significant benefits to users. Metal halide systems offer distinct performance features that will continue to make them the optimum system choice for many applications.

To reduce the risk of rupture from such systems, users should carefully follow manufacturers’ warnings and instructions. Users should study the industry information provided in this report to make informed choices when considering whether existing or new systems are being operated or specified in a manner that appropriately assesses risk and when considering which additional measures might be appropriate based on individual circumstances.

Consult manufacturers of metal halide lamps and luminaires if there are specific questions regarding their products that might relate to any topics in this report. Lighting users that do not understand the terminology or content of this paper should consult a lighting professional.

NEMA manufacturers are committed to providing the finest metal halide products available for all applications. This information will be periodically reviewed and updated. NEMA manufacturers reserve the right to revise and change the information, recommendations, and guidelines contained within this report, as appropriate.