

Chapter 26 – High Pressure ARC Lamps (Xenon)

26.1 Scope

This chapter sets forth the general procedures for operating, handling, and using high pressure arc lamps at Glenn Research Center. It provides guidelines of standard safety practices for high pressure lamp systems.

26.2 Applicability

This chapter is applicable to the Cleveland Center, Plum Brook Station, and other facilities under Glenn' cognizance.

26.3 Authority

- Title 29 Code of Federal Regulations (CFR) Part 1910 Subpart H - Hazardous Materials.
- Title 29 CFR Part 1910.1200, Hazard Communication Standard.
- Title 29 CFR Part 1960, Basic Program Elements for Federal Occupational Safety and Health Programs.
- Title 40 CFR Part 355, Emergency Planning and Notification.
- Title 49 CFR, Parts 100-177, Transportation, Hazardous Materials Regulations.
- Executive Order 12196, Occupational Safety and Health Provisions for Federal Employees.
- Executive Order 12856, Occupational Safety and Health Programs for Federal Employees.
- Executive Order 13101 promotion of Federal Government's use of recycled products and environmental preferable products and services.

26.4 General Precautions for Handling All High Pressure Lamps

When compact arc lamps are cold, they are under several atmospheres of pressure, and therefore, must be handled with great caution since there is a possibility of a sudden, violent failure. High wattage cold lamps (10 to 20 kW) have internal pressures of 3 to 4 atmospheres. Lower wattage lamps have higher internal pressures, so failures of these lower wattage cold lamps can be more violent than failures of higher wattage lamps.

Persons who handle high pressure lamps must wear adequate safety apparel (flak suits) and approved face shields. All sorts of lamps, hot or cold, new or used, have been known to explode violently; therefore, use the buddy system during lamp changeover. Contact the Safety Branch (SB) and/or the Environmental Management Branch (EMB) for information on correct safety apparel and approved face shields.

Most high pressure lamps have a protective metal or plastic enclosure around them to protect against violent lamp explosions. To minimize lamp handling hazards, these enclosures should not be removed until the last possible moment before lamp installation.

Chapter 26 – High Pressure ARC Lamps (Xenon)

Do not allow the presence of a safety cover around a lamp to lull you into a sense of security. These vendor-supplied covers have not always been sufficient to contain a cold lamp explosion. Wear protective apparel and approved face shields when handling a lamp with a protective cover.

26.5 Regulations Applicable to Use of High Pressure Lamps

26.5.1 Lamp Enclosures (Shielding)

To guard personnel and surroundings against lamps that fail at high operating pressure, high pressure lamps should be operated only in an enclosed housing. These enclosures shall be constructed so as to:

- a. Shield personnel and equipment from strong ultraviolet radiation and the high intensity light of the lamp.
- b. Protect personnel and the surroundings from the hot fragments of an exploding lamp.
- c. Assist in maintaining the proper lamp temperature by appropriately channeling air flow past the lamp.

26.5.2 Lamp Installation

Most high pressure lamps must be installed so that the lamp is operated in a vertical or near vertical position with anode (positive terminal) up. In addition, there are certain other requirements that apply to lamp installation:

- a. Proper lamp polarity must be observed when the lamp is connected to the power supply. Incorrect connection can cause lamp failure. The large electrode (anode) must be connected to the positive terminal of the supply.
- b. The lamp leads shall be arranged in such a way that there is no danger of their coming together and forming a short circuit in the event of a violent lamp failure.
- c. Personnel shall take care to keep fingerprints off the quartz bulb envelope. Skin oils, when heated on the bulb envelope, cause devitrification of the quartz and degradation of light transmittance. Use alcohol to wipe off the quartz bulb immediately after handling. Cotton gloves, flak suits, and face protection are mandatory during this operation.

26.5.3 Lamp Operation

Lamp operations shall be discussed with the Area Safety Committee and addressed through the Safety Permit process, outlined in Chapter 1.

Records must be kept for nominal voltage and current output of individual lamps. These are useful references since abnormal conditions can be indicated by voltage deviation at nominal current.

Chapter 26 – High Pressure ARC Lamps (Xenon)

Lamps should not be operated beyond their normal lifetime. Heavy blackening of the bulb envelope indicates that the lamp's life will end soon. Operation beyond this stage may cause violent failure.

The manufacturers' design life for most lamps is 1,000 hours. This is at rated power with an average decrease in output of less than 30 percent. Tests to date at Glenn and other facilities indicate that a life rating of 300 to 500 hours at a 30 percent decrease in light output is more reasonable. Facilities must relamp when the light output drops below this level.

Preventive maintenance for such lamps includes inspection of the bulb envelope for darkening, scratches, and evidence of excessive heating at terminals (oxidation of connections). Protective clothing and face masks must be worn for these inspections. Failure of a high pressure lamp is probable under any of the following conditions, so proper action should be taken for lamp removal:

- a. If the seal temperature exceeds 175 C. The seal temperature of the lamp is the governing criterion of the cooling requirements.
- b. If there is an abrupt change in the output voltage/current relationship. This indicates a loss of pressure in the lamp.
- c. If a power input increase is required to maintain the initial lamp radiance output of 70 to 75 percent. Replace lamp(s) when visible output is down 30 percent from the initial value.

26.6 Hazards of High Pressure Lamps

26.6.1 Skin Injury

The same ultraviolet (UV) rays that cause sunburn are present in high pressure lamps. Exposure to 140 milliwatts per square centimeter of direct or indirect UV radiation for 40 seconds can produce reddening of the skin. Overexposure to these UV rays can cause very painful reddening of the skin, and fluid containing blisters. The skin damage is similar to ordinary sunburn, but the skin does not build up a tolerance and tanning does not occur since the wavelengths that produce tanning are not present. The wavelengths involved are almost exclusively those that cause burning.

Overexposure of the skin is defined as direct or indirect UV radiation intensities in excess of 0.5 microwatt per square centimeter during an 8-hour period or 0.1 microwatt per square centimeter continuously for an indefinite period. If signs of overexposure occur, report to Medical Services.

A minimum of two layers of heavy cloth is required to protect skin from 0.1 microwatt per square centimeter of UV radiation. Particular attention should be paid to gaps

Chapter 26 – High Pressure ARC Lamps (Xenon)

between sleeves and gloves and between shirt/coat and face shield. A complete face hood (one that extends around the shoulders) would take care of the neck gaps.

Personnel and/or visitors near an area where there is the possibility of a lamp-caused hazard should be cautioned about the UV radiation hazard. Protective clothing and face shields shall be provided for personnel entering a lamp area, and signs or flashing lights shall be posted to warn of the potential hazards. In addition, care shall be taken to eliminate all reflective materials and surfaces from the test plane of the area. The Environmental Management Branch should be notified when new lamps are installed so that radiation levels may be measured.

26.6.2 Eye Injury

High pressure lamp(s) produce radiation in both the ultraviolet (UV) and infrared (IR) regions of the spectrum. Radiation from either of these regions is dangerous and can produce severe and even permanent eye damage. Both direct and reflected UV radiation can cause inflammation, pain, and the pressure sensation of a foreign body in the eye. Report to Medical Services if your eyes have been overexposed to direct or reflected UV radiation.

Reflected UV radiation is a subtle hazard (compared to direct radiation) and may cause injury without the victim being aware of it. A short exposure, on the order of seconds, may cause significant eye problems. However, 85 to 90 percent of the UV radiation can be filtered by safety glasses with a minimum thickness of 0.04 inch. Such glasses must have side shields to keep reflected UV rays from reaching the eye. Exercise care, however, in selecting dark glasses. Make sure that they do not transmit IR rays, which can cause retinal burns similar to those caused by observing a solar eclipse through darkened negatives.

To prevent eye injury, the high pressure lamp housing shall be designed so as to make difficult the direct observation of the high pressure lamp beam. Furthermore, all unauthorized personnel shall be made to stay a reasonable distance from the source lamp beam. Visitors shall be informed of the potential hazards by warning lights and signs, and they shall be issued approved safety glasses with side shields.

26.6.3 Ozone

Ozone may be produced when oxygen in the air is exposed to UV light (typical of high pressure lamps). Although ozone has a toxic rating of 3 (severe) and its threshold limit is 0.1 parts per million in air, the hazard posed by high pressure lamps can generally be controlled by proper ventilation.

Ozone can be detected by smell; concentrations of 1 part per million produces disagreeable sulfur-like odor. This concentration may cause headache and upper

Chapter 26 – High Pressure ARC Lamps (Xenon)

respiratory irritation-symptoms that will disappear after the victim leaves the ozone exposure area. Ozone is a subtle hazard, though, since personnel working in an ozone area often fail to detect its smell. If you smell ozone or think you do, leave the area and contact the Environmental Management Branch. The Environmental Management Branch will measure the ozone concentration in the area and determine if a hazard exists.

26.7 Storage of High Pressure Lamps

All lamps shall be stored in approved protective containers or lockable metal storage cabinets. (Contact the Safety Branch for information on approved lamp containers.) On these protective containers write "**HIGH PRESSURE LAMP INSIDE-DANGER!**"

Manufacturer-packed lamps may be stored in their original shipping containers, if each container holds only one lamp and the containers are stored in lockable metal cabinets. If lamps are stored in a locked metal cabinet, the following steps must be taken:

- a. Post a list of personnel who are authorized to open and enter the cabinet.
- b. Place a sign or poster on the cabinet stating: **DANGER-HIGH PRESSURE LAMPS INSIDE-AUTHORIZED PERSONNEL ONLY.**
- c. To prevent chain reaction lamp explosions, provide separate compartments for each lamp, if more than one lamp is stored in the storage cabinet. To be effective in stopping flying lamp parts, spacers between lamps (enclosures) must have the strength equivalent to 18-gauge sheet steel.
- d. Wear safety clothing and approved face shields while placing lamp(s) into protective containers or cabinets.

26.8 Procurement of High Pressure Lamps

26.8.1 Purchase

Purchase Requests for high pressure xenon lamps shall be made in accordance with the Glenn Environmental Programs Manual Chapter 22, Acquisition of Hazardous Chemicals and Materials. The requester shall note on the Purchase Request to the proposed vendor(s):

- a. That the shipping package shall be constructed to fully contain an explosion of the high pressure quartz envelope.
- b. That all shipping documents shall be fastened to the exterior of the lamp package.
- c. That the package shall be marked in bold as follows:

CAUTION-HAZARDOUS MATERIAL-DO NOT OPEN ON RECEIPT CALL
_____ (responsible person's phone number)

Chapter 26 – High Pressure ARC Lamps (Xenon)

26.8.2 Shipping

Vendor to Government.- The vendor shall properly describe, package, mark, and label the item(s) being procured under contract (or purchase order, as appropriate) in accordance with the following regulations:

- a. Department of Transportation regulations for the transportation of explosives or other dangerous articles by land, water, and air, or
- b. The Maritime Administration rules and regulations for export shipments, or
- c. The U.S. Post Office rules and regulations for shipments made via the U.S. Mail, as prescribed in the Postal Manual Government to vendor.-The Government shall properly describe, package, mark, and label an item being sent back to the vendor.

The procedures used shall be the same as those applicable to shipments from the vendor (see the preceding paragraph in this section). For shipment, high pressure lamps shall be properly packaged by authorized personnel using protective clothing (flak suits) and face shields. A NASA form C-260, "Property Turn-In/Transfer," shall be marked in bold letters: **DO NOT OPEN – HAZARDOUS** and attached to the outside of the package, which shall then be sent to Shipping.

26.9 Disposal of High Pressure Lamps

High pressure lamp disposal shall be conducted through agreements with the Environmental Management Office, the user(s) of the lamps, and the lamp manufacturer. Protective apparel (flak suits, protective face shields, and gloves) for those disposing of lamps shall be required at the discretion of the SB, the lamp user, and the lamp manufacturers.

26.10 Training

Handling, maintenance and operation of High Pressure Arc lamps shall be done by personnel who have been trained in the safety measures required and the proper use of protective clothing. The Buddy System shall be adhered to in all operations.

26.11 References

- Dangerous Properties of Industrial Materials Report. 1980. Journal. Bi-monthly. Vol. 1, No. 1-Sept. /Oct. 1980.
- Laue, E.G. 1966. Safety Aspects of Solar Radiation Simulation. J. Environ. Sci., vol. 9, Apr. 1966, pp. 32-37.
- Glenn, R.J., Sr. 1992. Sax's Dangerous Properties of Industrial Materials. Eighth ed. Van Nostrand Reinhold, New York.