Guidance for Powered Air-Purifying Respirators (PAPRs) Used in Hazardous Classified Locations

PAPRs are often used in Hazardous Classified Locations, so it is important to understand the regulatory and practical implications. This document provides a brief overview of Hazardous Locations (HazLoc) in general, as well as some specifics with regards to PAPRs.

Overview
A Hazardous Classified Location is an area where fire or explosion hazards exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

- Classes: Classes define an area with respect to type of hazard presiding in the area.
- Divisions: Divisions further define an area with respect to whether potentially explosive conditions reside normally or abnormally.
- Groups: Groups further define Class I and Class II areas by the nature of the flammable substances.

Temperature Codes
Because mixtures of hazardous gases and air may ignite in contact with a hot surface, equipment that is certified for hazardous locations receives a temperature code indicating the maximum surface temperature of the equipment. These range from a T6 rating of 185 F to a T1 rating of 842 F. Below is a summary from the National Electric Code (NEC) Articles 501-503 and referenced in OSHA's Hazardous Classified Locations Outreach Training for the Construction Industry.

Summary of Class I, II, III Hazardous Locations				
Class		Group	Division	
			1	2
I	**Gases, Vapors, Liquids** Examples include: Petroleum refineries, spray finishing area, and pharmaceutical manufacturing plants.	A. Acetylene B. Atmospheres such as butadiene, ethylene oxide, propylene oxide, acrolein, or hydrogen (or gases or vapors equivalent in hazard to hydrogen) C. Atmospheres such as cyclopropane, ethyl ether, ethylene, or gas or vapors of equivalent hazard D. Atmospheres such as acetone, alcohol, ammonia, benzene, benzol, butane, gasoline, hexane, lacquer solvent vapors, naphtha, natural gas, propane, or gas or vapors of equivalent hazard	Normally Explosive and Hazardous	Not normally present in an explosive concentration (but may accidentally exist).
II	**Dusts** Examples include: Grain elevators, flour mills, coal preparation plants, and pharmaceutical manufacturing plants.	E. Metal Dusts. Aluminum and magnesium dusts and other metal dusts of similar nature. F. Atmospheres containing such materials as carbon black, charcoal dust, coal, and coke dust. G. Grain dusts, flour, starch, cocoa, and similar types of materials.	Ignitable quantities of dust normally are or may be in suspension, or conductive dust may be present.	Dust not normally suspended in an ignitable concentration (but may accidentally exist). Dust layers are present.
III	**Fibers and Flyings** Examples include: Textile Mills, cotton gins, and saw mills.	H. Textiles, woodworking, etc (easily ignitable, but not likely to be explosive)	Handled or used in manufacturing.	Stored or handled in storage (exclusive of manufacturing).

From OSHA 1910.399 Class I locations. Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Class I locations include the following:

(1) A Class I, Division 1 location is a location:
(i) In which ignitable concentrations of flammable gases or vapors may exist under normal operating conditions; or
(ii) In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or
(iii) In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, **and** might also cause simultaneous failure of electric equipment.

(2) A Class I, Division 2 location is a location:
(i) In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in the event of accidental rupture or breakdown of such containers or systems, or as a result of abnormal operation of equipment; or
(ii) In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or
(iii) That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Note to the definition of "Class I, Division 2:" This classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used, but which would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location.

HazLoc Equipment

Equipment used in Hazloc areas is designed with the prevention of a fire or explosion in mind. There are three ingredients necessary for a fire or explosion. A flammable material (such as the gas, vapor, or dust), an oxidizer (like air or oxygen), and an ignition source (such as a spark or high heat). Equipment designers employ a variety of techniques to prevent their equipment from being an ignition source, from coming in contact with flammable materials, and from coming in contact with oxidizers that can fuel a fire. Enclosures can be designed so that the flammable material stays outside the enclosure, any sparks stay inside the enclosure, and only a limited supply of air (oxidizer) exists within the enclosure. Materials are selected so that a spark isn't generated from friction or impact. Circuits are designed so that electrical sparks are minimized. Further considerations result in designs that limit the temperature rise of the equipment to prevent surface ignition which can occur at the Auto-Ignition Temperature (ATI) or spontaneous ignition temperature at which a hazardous substance will spontaneously ignite without further energy. Finally, design techniques can be taken to limit energy. These protective techniques have names that include explosion proof, dust ignition-proof, dust tight, nonincendive, and intrinsic safety.

PAPR Specifics:

PAPRs are typically designed with one of two protective design techniques: nonincendive or intrinsic safety. According to the Fire Protection Handbook, intrinsically safe is defined as "…equipment and wiring incapable of releasing sufficient energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture." This protective technique can receive certification for Division 1 environments. Nonincendive equipment is incapable, under normal operating conditions, of causing ignition of a specified flammable gas-air, vapor-air, or dust-air mixture due to arcing or thermal means. This protective technique can receive certification for Division 2 environments.

Certification

There are several factors that determine the type of certification a piece of electrical equipment will receive. For a battery powered device such as a PAPR, the amount of energy in the battery, the operational voltage, the location of battery contacts and the inductance of the motor are all factors. PAPR users often desire features in the blower unit that make achieving the highest hazardous classified location certifications difficult. Higher airflow and longer battery run time require higher levels of energy. Removable batteries, for sharing a blower across shifts, make battery contact design very challenging. At the end of the day the designers must balance the features requested by the customers with the limitations imposed by the certification standards. The implication is that the higher the performance of the PAPR, the less likely the PAPR will be designed with the intrinsic safety protective technique.

Bullard Hazloc PAPRs:

Bullard has (1) HazLoc PAPRs:

1. The EVAHL which is certified by CSA for Class I, Div 2, Groups A, B, C, D; Class II, Div 2, Groups F, G; Class III

Key Points to Remember

- Equipment used in any Hazardous Classified Location must match the classification of the location.
- The presence of a flammable substance isn't the sole criteria to determine Division 1 or Division 2 designation (see 1910.399).
  - The **concentration** level of the gas/vapor is a key determining factor.
  - The simultaneous failure of electrical equipment is key if the abnormal release of an ignitable concentration is being considered.

Key References

Underwriters Laboratory (UL) North American Protective Techniques Comparison
http://www.ul.com/global/documents/offerings/services/hazardouslocations/CI_protection_methods.pdf

Factory Mutual (FM) Hazardous Locations Resources
http://www.fmglobal.com/page.aspx?id=50010107

Canadian Standards Association (CSA) HazLoc Certification in North America
http://www.csa-international.org/product_areas/hazloc_equip/hazloc_for_north_america/

OSHA's Hazardous Classified Locations Outreach Training
http://www.osha.gov/doc/outreachtraining/htmlfiles/hazloc.html

Key Regulations

OSHA 29 CFR 1910.399 Subpart S Electrical, Definitions
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9976

OSHA 29 CFR 1910.307 Subpart S Electrical, Hazardous (Classified) Locations
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9884&p_table=standards

OSHA 29 CFR 1910.134 Subpart I Personal Protection Equipment, Respiratory Protection
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=12716

Americas:
Bullard
1898 Safety Way
Cynthiana, KY 41031-9303 • USA
Toll-free within USA: 877-BULLARD (285-5273)
Tel: +1-859-234-6616
Fax: +1-859-234-8987

Europe:
Bullard GmbH
Lilienthalstrasse 12
53424 Remagen • Germany
Tel: +49-2642 999980
Fax: +49-2642 9999829

Asia-Pacific:
Bullard Asia Pacific Pte. Ltd.
LHK Building
701, Sims Drive, #04-03
Singapore 387383
Tel: +65-6745-0556
Fax: +65-6745-5176

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