



Technical Data Bulletin

OH&ESD

Tech Data Bulletin #159 May 2003 (Revised February 2009) Recommended Use of CBRN Full Facepiece Air Purifying Respirators

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) issued their “Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Full Facepiece Air Purifying Respirator (APR)” on March 7, 2003. It was subsequently updated on April 4, 2003. This standard contains performance criteria for a full facepiece and canister system. Some of the tests include breathing resistance, field of view, communication, carbon dioxide build-up, particulate filtration, laboratory protection level (quantitative fit test), canister service life, and permeation and penetration resistance against distilled sulfur mustard (HD) and Sarin (GB). The reader is encouraged to read the standard in its entirety as found on the NIOSH website: <http://www.cdc.gov/niosh/homepage.html>.

As of February 2009 NIOSH and the Occupational Safety and Health Administration (OSHA) have only published limited guidance on proper use of CBRN approved products. The OSHA standard for Hazardous Waste Operations and Emergency Response (HAZWOPER – 29 CFR 1910.120) and National Fire Protection Association standard NFPA 471 Recommended Practice for Responding to Hazardous Materials Incidents provide instruction in the proper selection and use of personal protective equipment (PPE) during exposure to hazardous materials. Guidance can also be taken from the cautions and limitations on the NIOSH CBRN approval label. General respirator use information is given in the OSHA standard for respiratory protection (29 CFR 1910.134). OSHA has a series of non-regulatory documents related to emergency preparedness and protective equipment at: <http://www.osha.gov/SLTC/emergencypreparedness/responder.html>.

NIOSH’s Interim Guidance on Using CBRN Canisters for Activities Other Than Response to Terrorist Events is available at the NIOSH website: <http://www.cdc.gov/niosh/npptl/guidancedocs/intercbrn091505.html>.

OSHA HAZWOPER 1910.120 and NFPA 471

Both the OSHA 1910.120 and NFPA 471 standards give guidance on how to respond to incidents involving hazardous materials. The reader is encouraged to read both standards in their entirety. They may be found on www.osha.gov or www.nfpa.org respectively.

Often an incident area will be divided into “hot,” “warm” and “cold” zones. The hot zone is the area immediately surrounding the agent release. The warm zone is where decontamination and limited patient treatment will most likely occur. The cold zone is an area of very low or no hazards. These zones are defined for emergency management purposes, but the required type of respiratory protection is not necessarily specified. Respirators must be selected based upon the contaminant,

exposure level, exposure limit, immediately dangerous to life or health (IDLH) level and the assigned protection factor of the respirator.

Four PPE ensembles are described for four different levels of hazards. Level A PPE is for the highest level of both skin and respiratory protection and must be worn until the agent identity is known and the concentration has been determined. This includes a totally encapsulating chemical protective suit, SCBA, gloves, and boots. Level B requires the same level of respiratory protection, but a lesser level of skin protection. Level C implies a lesser need for both skin and respiratory protection. It includes an air purifying respirator, hooded chemical-resistant clothing, gloves and boots. Air purifying respirators can only be worn if the agent identity is known, concentrations are within the capabilities of the respirator, there is an appropriate cartridge or filter and sufficient oxygen is present. Level D implies a work uniform affording minimal protection.

NIOSH CAUTIONS AND LIMITATIONS

NIOSH requires that a number of cautions and limitations be listed on the CBRN canister and included in the user instructions. The respirator is only approved within the scope of these cautions and limitations. Therefore, guidance on proper use can be taken from these statements. The following cautions have particular significance with relation to use of PPE in CBRN environments. 3M comments are listed afterwards in italics.

- Not for use in atmospheres containing less than 19.5 percent oxygen.
- Not for use in atmospheres immediately dangerous to life and health or where hazards have not been fully characterized.
- If during use, an unexpected hazard is encountered such as a secondary CBRN device, pockets of entrapped hazard or any unforeseen hazard, immediately leave the area for clean air.

3M Comment: Air purifying respirators do not supply oxygen. They can not be used in oxygen deficient environments. Self contained breathing apparatus (SCBA) must be selected for use in IDLH or unknown environments. Air purifying respirators may only be used in areas where the contaminant and concentration are known. Respirators must be selected based upon the exposure limit, assigned protection factor and the IDLH level. Air purifying respirators must not be used in unknown environments.

- All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations.

3M Comment: OSHA describes the requirements for a respirator program in their standard for respiratory protection (29 CFR 1910.134). A written program must include, but is not limited to, procedures for selection, training on the potential hazards, training on proper use and maintenance, fit testing, medical evaluation, and program evaluation.

- Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazard. Failure to do so may result in personal injury even when the respirator is properly fitted, used, and maintained.

3M Comment: Warfare agents and industrial contaminants may be hazardous through various routes of exposure including skin exposure. Full facepiece CBRN respirators only help reduce exposure to

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the face and respiratory system. Use of the respirator without appropriate dermal protection may result in sickness or death.

- This respirator provides respiratory protection against inhalation of radiological and nuclear dust particles. Procedures for monitoring radiation exposure and full radiation protection must be followed.

3M Comment: The CBRN canister contains a particulate filter that helps reduce exposure to radiological particles from a “dirty bomb.” However, the respirator will not stop all forms of radiation that may be emitted by these particles or radiation released from a nuclear attack. In the case of exposure to radiation, dosage will be a function of the type of radiation, exposure time, distance from the source and shielding (if any). Respirators will provide little to no protection from radiation in a nuclear attack, but may help reduce exposure to dust or radionuclide particles after the attack.

- Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death.
- Direct contact with CBRN agents requires proper handling of the respirator after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the respirator after decontamination.

3M Comment: It is important to wear respirators during all times of potential exposure. The wearer must be familiar with signs and symptoms of exposure to warfare agents and toxic industrial materials. Care needs to be taken by those who might handle the respirator after the incident. Dermal protection may be required.

- The respirator should not be used beyond eight (8) hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation. If liquid exposure is encountered, the respirator should not be used for more than two (2) hours.

3M Comment: To obtain CBRN approval, the respirator must be resistant to distilled sulfur mustard (HD) and Sarin (GB) vapor penetration for at least 8 hours and liquid HD permeation for at least 2 hours. Since the test is stopped at this point, it is not known how much longer the respirator will resist penetration. Therefore, the respirator must be discarded after these time limits to help ensure no chemical warfare agent penetration.

- When used at defined occupational exposure limits, the rated service time cannot be exceeded. Follow established canister change out schedules or observe End of Service Life Indicators to ensure that canisters are replaced before breakthrough occurs.

3M Comment: Canister service life must also be considered. A canister change schedule must be developed based upon the contaminants, concentration, breathing rate and environmental conditions. Some manufactures have service life information or software programs on their web sites to aid in calculating cartridge change schedules. For example, 3M™ Service Life Software is available free of charge at www.mmm.com/occsafety/html/cartridgechange.html. There are currently no End of Service Life Indicators for this type of respirator. 3M Technical Data Bulletin #180 Determination of Service Life for NIOSH CBRN approved 3M™ Cartridges and Canisters available at
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www.3M.com/occsafety may also help.

QUESTION AND ANSWERS

Are first responders required to use CBRN approved respirators?

No. At this time there is no requirement to use CBRN approved equipment.

Can a first responder use non-CBRN approved respirators to help reduce exposure to hazardous materials including chemical warfare agents?

Yes. Four different levels of PPE containing non-CBRN approved respirators are listed in both the OSHA HAZWOPER and the NFPA 471 standards. PPE needs to be chosen based on required levels of both skin and respiratory protection.

Why would a first responder want to use a CBRN approved respirator?

A CBRN approved respirator must pass a number of different tests. One such requirement is that the respirator resist penetration and permeation from distilled mustard (HD) and Sarin (GB). However, according to the OSHA HAZWOPER standard, level C PPE (air purifying respirators) may only be used where lower levels of skin and respiratory protection are required. Level C PPE can not be used during exposure to liquid splashes of warfare agents or where use of a self contained breathing apparatus (SCBA) is required because of the contaminant concentration. Additional guidance must be developed regarding the proper use of CBRN approved respirators.

Where can first responders use air purifying respirators?

Air purifying respirators can only be used if all of the following conditions are met:

- Oxygen concentration is at least 19.5%;
- Contaminant is identified;
- Concentration is quantified and below the maximum use concentration (maximum use concentration is the contaminant exposure limit times the respirator's assigned protection factor, or the IDLH level, whichever is lower);
- There is not a significant health risk from exposure to the skin that would require a totally encapsulating chemical protective suit;
- The contaminant can be removed by an air-purifying element (i.e., there exists an effective cartridge, canister or filter); and
- If the contaminant is a gas or vapor, a cartridge or canister change schedule has been developed.

What is the assigned protection factor (APF) for a negative pressure air purifying full facepiece respirator?

APF is the expected level of reduction in respiratory exposure when a properly functioning respirator is correctly fitted and worn by a trained wearer in the workplace. APFs are given in the OSHA standard for respiratory protection (29 CFR 1910.134). Full facepiece respirators that have been quantitatively fit tested to the wearer are assigned an APF of 50. Those that have been qualitatively fit tested to the wearer have an APF of 10. Quantitative fit testing uses an instrument to measure the challenge agent inside and outside the respirator. Qualitative fit testing relies on the subject's sensory response (e.g. taste, smell or irritation) to detect a challenge agent.

There is a requirement in the NIOSH CBRN standard for "laboratory respiratory protection level (LRPL)" greater than or equal to 2000. The LRPL is a quantitative fit test using a corn oil aerosol. This is part of the NIOSH respirator certification process, but is not a replacement for fit testing of

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the wearer. It is not known at this time if the LRPL has any relation to protection levels achieved in the workplace.

Where are first responders most likely to use full facepiece air purifying respirators?

Selection and use of full facepiece air purifying respirators depends upon many factors (please see previous questions). Those responsible for crowd control on the edge of the cold zone may wish to use a full facepiece respirator even though this is designated as an area of minimal contamination.

Are first responders required to wear SCBAs?

No. Both the HAZWOPER and NFPA 471 standard allow the use of air purifying respirators. SCBAs are required in unknown environments or when the contaminant concentration is above the maximum use concentration for the air purifying respirator. The maximum use concentration is the contaminant occupational exposure limit times the respirator's assigned protection factor, or the IDLH level, whichever is lower.

What type of PPE is required in the hot or warm zones, or for decontamination?

PPE must be selected based upon both the skin and respiratory hazards present.

Against which contaminants may a CBRN negative pressure full facepiece respirator be used to help reduce exposure?

The canister is tested against ammonia, cyanogen chloride, cyclohexane, formaldehyde, hydrogen cyanide, hydrogen sulfide, nitrogen dioxide, phosgene, phosphine, and sulfur dioxide. These were chosen to represent both toxic industrial chemicals (TICs) as well as chemical warfare agents (CWAs). The following rationale was given by NIOSH in the Sept. 16, 2002 concept version of the full facepiece CBRN standard (<http://www.cdc.gov/niosh/npptl/cbrnconsep16.html>):

“NIOSH has been evaluating various lists of chemicals that could be deployed as a result of a terrorist incident... Some of the test chemicals were considered to be redundant, since other test chemicals would guarantee the carbon effectiveness against the chemicals in question (Chlorine, Hydrogen Chloride, Hydrogen Fluoride, Arsine, CS & CN Tear Gases). Cyclohexane is the representative chemical for organic vapors. Meeting the organic vapor test for a cartridge will provide protection for all organic vapors having vapor pressures less than that of cyclohexane. From the CWA /TIC list, approximately 61 organic chemicals are cover[ed] by this logic, including GB and HD. The acid gases (32 chemicals) are covered by cyanogen chloride, hydrogen cyanide, hydrogen sulfide, and sulfur dioxide. Ammonia represents the base gases, and covers another 4 chemicals on the list. Formaldehyde, phosgene, phosphine and nitrogen dioxide are considered special case chemicals.”

OSHA allows the use of organic vapor cartridges against organics that are more volatile than the representative organic vapor as long as an appropriate cartridge change schedule is used. Therefore, the canister could be used against vapors of organic liquids that are more volatile than cyclohexane, for example, acetone. However, service life may be fairly short for these volatile compounds.

The CBRN canister is also required to contain a P100 particulate filter. Particulate filters may be used to help reduce exposure to particles including biological aerosols and radionuclides. Again, it is important to consider both the level of skin and respiratory protection needed. Respirators help reduce exposure, but they do not eliminate the risk of exposure, illness or death.

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How would responders choose between canisters rated to 15, 30, 45, 60, 90 or 120 minutes?

Canisters are tested by NIOSH under specific laboratory conditions. Actual service life when used may be shorter or longer than the rated time. The user must develop a canister change schedule based upon the contaminants, concentration, breathing rate and environmental conditions expected during use. Longer service life does not result in higher protection, just longer service life. The user may also wish to consider the possible increased weight and breathing resistance associated with a larger canister.

SUMMARY

NIOSH has published a standard for CBRN full facepiece air purifying respirators. Although facepiece and canister systems approved under this standard must pass rigorous testing, it is unclear how these systems may be used. Current OSHA and NFPA standards allow the use of non-CBRN approved respirators to help reduce exposure to hazardous materials, including during emergency response situations. Responders need to consider the required level of both skin and respiratory protection before selecting the appropriate level of PPE.