

Recommendations for the Selection and Use of Respirators and Protective Clothing for Protection Against Biological Agents

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The approach to any potentially hazardous environment, including one with biological hazards, must be made with a plan that includes an assessment of hazard and exposure potential, respiratory protection needs, dermal protection needs, entry conditions, exit routes, and decontamination strategies. Plans involving a biological hazard should be based on relevant infectious disease or biological safety recommendations by the Centers for Disease Control and Prevention (e.g., <http://emergency.cdc.gov/bioterrorism>) and other expert bodies including emergency first responders, law enforcement, and public health officials. The need for pre/post exposure treatment of first responders with antibiotics, vaccination, or other medications should be determined in consultation with licensed medical personnel.

This document is based on current understanding of the potential agents and existing recommendations for biological aerosols and is oriented toward acts of terrorism. The recommendations provided here do not address and are not applicable to controlled use of biological agents in biosafety laboratories. [For information on precautions in the laboratory settings.](#)

NIOSH is providing the recommendations in this document on the basis of the following considerations:

- Biological weapons may expose workers to bacteria, viruses, or toxins as fine airborne particles. Biological agents are infectious through one or more of the following mechanisms of exposure, depending upon the particular type of agent: (1) inhalation, with infection through respiratory mucosa or lung tissues; (2) ingestion; (3) contact with the mucous membranes of the eyes or nasal tissues; or (4) penetration of the skin through lesions or abrasions.
- Biological agents, as liquid or solid organic airborne particles, behave the same in the air as inert or inorganic particles because they share the same aerodynamic characteristics.
- Because biological weapons are particles, they will not permeate the materials used in the construction of respirators or protective clothing in the same way that some chemicals can permeate through them. However, biological particles potentially can penetrate through seams, closures, interfaces, pores, and gaps in protective apparel. Careful attention to properly selected,

assembled and fitted personal protective equipment (PPE) is essential to ensuring necessary protection for first responders.

- Some devices used for intentional biological terrorism may have the capacity to disseminate large quantities of biological materials in aerosols. High levels of protection (i.e., level A ensembles) will be necessary when hazards and airborne concentrations are either unknown or expected to be high. PPE providing lower levels of protection (i.e., level B or C ensembles) are generally allowed once conditions are understood and exposure are determined to be at lower levels.
- Chemical, biological, radiological, and nuclear (CBRN) NIOSH-approved respirators in conjunction with protective ensembles certified to National Fire Protection Association (NFPA) standards are recommended for responders in situations where the hazard potential from a potential terrorist event exists. Respirators and protective ensembles certified for CBRN-rated protection have been evaluated with warfare agents for resistance against permeation and penetration of the materials used in their construction (e.g., rubber, elastomeric, barrier, and selectively permeable materials). CBRN respirators provide a high level of protection against airborne hazards when properly fitted to the user's face and properly used in an [Occupational Safety and Health Administration \(OSHA\)-compliant respiratory protection program](#).
- During an intentional release of a biological agent, a concurrent or secondary release of other types of hazards, such as a chemical, may occur. Therefore, when selecting appropriate levels of PPE, information regarding potential of exposures to non-biological hazards should be factored in to any selection decisions.

Guidance and Standards Associated with the Selection and Use of Protective Clothing and Respirators

Respiratory protection and other PPE should be used in the context of a comprehensive program or incident command system that provides for a safety and health program. The program should contain the following elements:

- Job safety analyses and a health and safety plan
- Provision for a health/safety surveillance and medical monitoring program (on-site medical monitoring for fatigue, heat stress, behavioral health, and other elements as appropriate.)
- Pre-exposure immunization and post-exposure responder prophylaxis and medical monitoring.

When using respiratory protection, the type of respirator is selected on the basis of the hazard and its airborne concentration. Recommendations for selection of respirators can be found in the [NIOSH Respirator Selection Logic 2004](#) [DHHS (NIOSH) Publication No. 2005-100]. Additionally, guidance specific for CBRN incidents can be found in the NIOSH document [Guidance on Emergency Responder Personal Protective Equipment \(PPE\) for Response to CBRN Terrorism Incidents](#)  [DHHS (NIOSH) Publication No. 2008-132]

For a biological agent, the air concentration of particles will depend upon the method used to release the agent, the initial amount of agent in the dispersal device, the particle size (very small particles will remain suspended in the air for prolonged periods, while large particles fall more quickly out of the air), and the elapsed time since the release. Secondary re-aerosolization generated from disturbing the contaminated area may contribute to an increase in particle concentration in the air. NIOSH-approved CBRN self-contained breathing apparatus (SCBA), which many first responders currently use for entry into potentially hazardous atmospheres, will provide responders with respiratory protection against biological exposures associated with a suspected act of biological terrorism. When site concentrations

allow for the use of lower levels of protection, NIOSH-approved CBRN full facepiece air-purifying respirators (APRs) or CBRN full facepiece powered air-purifying respirators (PAPRs) may be used.

Protective clothing, including garments, gloves and booties, also are necessary for the response to a suspected act of biological terrorism to reduce exposures to potential dermal, chemical, and physical hazards. Protective clothing must have physical performance properties adequate for the mission (e.g. tensile strength, puncture resistance, seam breaking strength, abrasion resistance). Protective clothing is used to prevent skin exposures and/or contamination of other clothing. The type of protective clothing needed will depend upon the biological agent, concentration, route of exposure, and anticipated work operations.

NFPA 1994 Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents (2007 Edition), NFPA 1991 Standard on Vapor Protective Ensembles for Hazardous Materials Emergencies (1995 Edition), NFPA 1999 Standard on Protective Clothing for Emergency Medical Operations (2008 Edition) are nationally accepted and Department of Homeland Security (DHS)-adopted performance standards. Protective clothing ensembles certified to these standards should be the first choice when selecting protective clothing for protection against biological agents. Ensembles certified by these standards may be used to meet the applicable level of protection (i.e., A, B, C, and D) outlined by OSHA in the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, Appendix B. There are also other protective ensembles and clothing items that meet OSHA's specifications available on the market that will provide protection to biological agents. [Detailed information on the NFPA standards in relationship to CBRN terrorism events](#) 

NFPA 1999 Standard on Protective Clothing for Emergency Medical Operations, 2008 Edition specifies design, performance and certification requirements for protective clothing, including garments, helmets, gloves, footwear, and face protection devices used by emergency medical responders and medical first receivers. This standard includes requirements for a multi-use emergency medical protective ensemble providing minimum protection for upper and lower torso, head, hands, foot and face protection from only biological agents. Protective ensembles certified to requirements in NFPA 1999 should be considered for protection against biological agents.

Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents Resulting from a Suspected or Known Terrorism Event

The recommendations for personal protective equipment, including respiratory protection and protective clothing, are based upon the anticipated level of exposure risk associated with different response situations, as follows:

- Responders should use a NIOSH-approved, CBRN SCBA in conjunction with a Level A, protective ensemble (use equipment certified to NFPA 1991 when available as a first choice) in responding to a suspected biological incident where any of the following information is unknown or the event is uncontrolled:
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 - The type(s) of airborne agent(s);
 - The dissemination method(s);
 - If dissemination via an aerosol-generating device still is occurring, or it has stopped but there is no information on the duration of dissemination or what the exposure concentration might be;
 - Other conditions may present a vapor or splash hazard.

- Responders may use a Level B protective ensemble (use equipment certified to NFPA 1994 Class 2, NFPA 1992, or NFPA 1971 CBRN protective ensembles when available as a first choice) with an exposed or enclosed NIOSH-certified CBRN SCBA if the situation can be defined in which:
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 - The suspected biological aerosol is no longer being generated;
 - Other conditions may present additional hazards, such as a splash hazard. (Note: NFPA 1994 Class 4 does not have a requirement to provide limited protection against liquid or chemical hazards).
- Responders may use a level C protective ensemble (use equipment certified to NFPA 1994 class 3 or 4 or certified as NFPA 1999 protective ensemble when available as a first choice) with a CBRN full facepiece APR or CBRN full facepiece powered air-purifying respirator (PAPR) when it can be determined that:
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 - The suspected biological aerosol is no longer being generated;
 - The biological agent and hazard level have been defined;
 - Dissemination was by a letter or package that can be easily bagged.

When a risk assessment has been conducted by qualified safety and health experts, responders may use alternate PPE, including non-CBRN level C protective ensembles with a full facepiece particulate respirator (N100 or P100 filters) or PAPR with high efficiency particulate air (HEPA) filters, in conjunction with disposable hooded coveralls, gloves, and foot coverings as appropriate.

In certain specialized situations, half-mask filtering facepiece respirators in conjunction with reduced levels of dermal protection may be considered, but it should be recognized that this level of PPE may not provide sufficient exposure reduction for many situations. Several parameters must be assessed when making a decision to downgrade the ensemble. These include knowledge of the source and extent of contamination, the level of uncertainty in the risk assessment, specific activities to be conducted, investigator experience, contingency/backup plans, length of time in the contaminated area, provision for immunization and post-exposure prophylaxis, etc. A decision of this nature should be carefully evaluated and made by industrial hygiene, safety, and medical personnel in conjunction with the incident commander and other appropriate public health authorities.

NIOSH recommends against wearing standard firefighter turnout gear into potentially contaminated areas when responding to reports of terrorist activities involving biological agents, provided there are no other hazards that would require turnout gear.

Proper decontamination of protective equipment and clothing will ensure that any particles that might have settled on the outside of protective equipment are removed before taking off gear. Decontamination sequences currently used for hazardous material emergencies should be used as appropriate for the level of protection employed and agent encountered. For example, PPE can be decontaminated using soap and water, and 0.5% hypochlorite solution (one part household bleach to 10 parts water) with an appropriate contact time can be used. Note that bleach may damage some types of firefighter turnout gear (one reason why it should not be used for biological agent response actions). After taking off gear, response workers should shower using copious quantities of soap and water. Bleach should not be used to decontaminate response workers. Note that all NFPA 1994 ensembles are intended to be disposable after a single exposure use.