



Recommendations on Selection and Use of Personal Protective Equipment for First Responders against Ebola Exposure Hazards

I. Background

On 20 October 2014, the U.S. Department of Health and Human Services (HHS) Centers for Disease Control and Prevention (CDC) released “Guidance on Personal Protective Equipment To Be Used by Healthcare Workers During Management of Patients with Ebola Virus Disease in U.S. Hospitals, Including Procedures for Putting On (Donning) and Removing (Doffing).” The most current guidance is available at:

<http://www.cdc.gov/vhf/ebola/hcp/procedures-for-ppe.html>

This new guidance is based on observations of Personal Protective Equipment (PPE) practices specifically in hospitals and includes updated requirements for (1) repeated training and demonstrated competency for healthcare workers in the wearing and use of PPE, (2) selection of PPE so that no skin is exposed, and (3) supervised donning and doffing of PPE. Further details are provided in this guidance for PPE selection, donning, and doffing procedures.

In addition, the CDC and the HHS Office of the Assistant Secretary for Preparedness and Response (ASPR) have prepared the “Detailed Emergency Medical Services (EMS) Checklist for Ebola Preparedness,” found at:

<http://www.cdc.gov/vhf/ebola/pdf/ems-checklist-ebola-preparedness.pdf>

This checklist identifies basic types of PPE that first responder organizations (Emergency Medical Services [EMS]) should have on hand as part of their preparedness and response programs. The CDC

The InterAgency Board for Equipment Standardization and Interoperability (IAB) is a voluntary collaborative panel of emergency preparedness and response practitioners from a wide array of professional disciplines that represent all levels of government and the public safety sector. Based on direct field experience, IAB members advocate for and assist the development and implementation of performance criteria, standards, test protocols, and technical, operating, and training requirements for all-hazards incident response equipment with a special emphasis on Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) issues.

recognizes EMS personnel as any first responder including but not limited to law enforcement, fire services, and hazardous material teams. In this checklist, CDC and ASPR acknowledge the InterAgency Board (IAB) (see panel at bottom of previous page) as a source for additional information on nationally-recognized standards on appropriate PPE for protecting first responder (EMS) personnel from exposure to Ebola.

Recommendations for “EMS and Medical First Responders, Including Firefighters and Law Enforcement Personnel” are also provided in CDC guidance entitled “Interim Guidance for Emergency Medical Services (EMS) Systems and 9-1-1 Public Safety Answering Points (PSAPs) for Management of Patients with Known or Suspected Ebola Virus Disease in the United States.” The link for this guidance is:

<http://www.cdc.gov/vhf/ebola/hcp/interim-guidance-emergency-medical-services-systems-911-public-safety-answering-points-management-patients-known-suspected-united-states.html>

II. Approach

A. Selection

The IAB recommends applying standard specifications, design attributes, test methods and performance criteria when selecting PPE for first responders who may encounter Ebola Virus exposure hazards. These recommendations are intended to complement and supplement information provided by the CDC and ASPR, enabling responder organizations to make effective procurement and deployment choices addressing a wide range of missions, response environments, and varied work conditions.

WARNING
<p><i>Personal protective equipment alone is not sufficient to ensure protection from Ebola Virus Disease. Each organization has the responsibility to conduct its own risk assessment to determine the appropriate PPE for its individual members. In addition, each organization must develop specific standard operating procedures related to the selection, use (including proper donning and doffing), and care (decontamination, possible reuse or disposal) of PPE, and repeatedly train its members in these procedures.</i></p>

Figure II-1 provides recommendations for PPE protection levels for EMS personnel based upon a threat level determined by two major factors: the PPE wearer's possible exposure to Ebola, and proximity to symptomatic patients. This combination is further defined in CDC guidance.¹ The following definitions are used:

(Patient's) Ebola Exposure Level	Definition
Known or Suspected Exposure	Known disease, known contact with Ebola patient or travel within 21 days to an area with current Ebola cases.
Possible Exposure	Environmental or interpersonal exposure in an area with suspect or recent cases except as outlined in top box.
No Known Exposure	No known exposure to Ebola Virus Disease patients or travel to areas with known outbreak of the disease.
Symptoms Presented	Definition
Asymptomatic	No symptoms relevant to an infectious disease.
Fever	Measured temperature ≥ 100.4 F
Body Fluids	Patient has fever with vomiting, diarrhea, blood in vomitus and/or feces, is incontinent of urine or stool, or is sweating, salivating, or otherwise producing blood and body fluids to which emergency responders could be exposed.

¹ See <http://www.cdc.gov/vhf/ebola/hcp/case-definition.html>

Ebola Exposure Level	Symptoms Presented		
	Asymptomatic	Fever	Body Fluids
Known of Suspected Exposure	Low Risk*	Low Risk	High Risk
Possible Exposure	SOP	Low Risk	Low Risk
No Known Exposure	SOP	SOP	SOP

*PPE requirements will be determined by the situation. SOP may be also be appropriate if the risk is acceptable.

Figure II-1: PPE Level Selection Table

These two factors combine to produce one of three possible recommended PPE levels:

- **SOP-Recommended PPE**, which corresponds to the PPE dictated by the Standard Operating Procedure of the organization, as dictated by CDC guidance and the state/local jurisdiction
- **Low Risk² PPE**, an increased protection level corresponding to increased likelihood of responder or healthcare worker exposure
- **High Risk PPE**, the highest recommended protection level, corresponding to high likelihood of responder exposure

Each organization should determine the threat level—as shown in the table above—based on an assessment of the specific mission responsibilities and work environment that account for the specific exposure hazards present with their likelihood of member exposure. This risk assessment should consider:

- The amount and reliability of information on which the potential Ebola Virus Disease of an individual is based
- The expected proximity of the first responder to affected individuals
- The duration for which the first responder may be in proximity of an infected individual
- The likelihood for any exposure to body fluids or contaminated waste as part of the operations

The PPE is recommended in terms of a garment, gloves, eye/face/respiratory protection devices³, and footwear. However, the recommended PPE must form an “ensemble” of clothing and equipment that addresses the need for liquid penetration resistant interfaces (joints between different items of clothing and equipment, such as between gloves and garment sleeves) and the manner in which the ensemble is donned and doffed (particularly when contaminated).

² Descriptions and specifications for Low Risk and High Risk PPE are found in Appendices 1 and 2 of this document.

³ Respiratory protection equipment must be NIOSH-approved, and used in compliance with all elements of the [OSHA Respiratory Protection Standard, 29 CFR 1910.134](#), including fit testing, medical evaluation, and training of the first responder.

B. Decontamination

In addition to the expected deployment and use of PPE, prospective decontamination procedures and agents must be considered when selecting PPE items, as certain processes may degrade the ensemble during the doffing process and result in exposure.

The CDC has issued “Interim Guidance for Environmental Infection Control in Hospitals for Ebola Virus” available at:

<http://www.cdc.gov/vhf/ebola/hcp/environmental-infection-control-in-hospitals.html>

This guidance identifies use of specific disinfectants for use on non-porous surfaces. The CDC 20 October 2014 guidelines further indicate using alcohol-based hand wipes (ABHW) or a disposable wipe impregnated with a U.S. Environmental Protection Agency-registered hospital disinfectant with a label claim of potency at least equivalent to that for a non-enveloped virus (e.g., norovirus, rotavirus, adenovirus, poliovirus). *However, these products have not been evaluated for the effects on all PPE items.*

WARNING

Care must be taken in decontaminating PPE. Many recommended disinfectants are designed for use on surfaces rather than PPE. Improper decontamination processes or solutions can damage single-use PPE during the doffing process and cause exposure. Further, the impact of decontamination on multiple-use PPE items (e.g., respirator face pieces or the seams of multi-use garments) is not fully known. Multi-use PPE should be carefully inspected after decontamination and any deterioration monitored.

One common (and improper) approach to decontamination is the notion that increasing the strength of a bleach solution will improve effectiveness. This should NEVER be attempted when decontaminating PPE.

III. PPE Recommendations

Specific recommendations are provided for each category of personal protective equipment: garments, gloves, eye/face/respiratory protection devices, and footwear).

Appendix 1 provides a description of the recommended PPE items in terms of their physical features and general performance characteristics. Several alternative configurations are suggested, along with approaches for their integration as an overall ensemble.

Appendix 2 references specific certifications, standards, test methods, and performance levels for recommended PPE. These should be reviewed before procuring any equipment. It also provides links to sites which provide assistance in locating certified products where applicable.

Both tables must be used for the specification of the respective PPE items.

A. PPE Use – Donning

The selected PPE must be donned in the correct order in order to provide an effective protection against contact with individuals with Ebola Virus Disease or contamination. The specific donning order depends on the PPE items comprising the ensemble, as the donning process is affected by how interfaces are formed. All PPE should be donned in accordance with an established SOP, under supervision, and with assistance as needed.

WARNING
<p><i>While taping may be recommended for some interfaces, it is important to use tape that does not degrade protection. For example, when tape is removed during doffing (particularly a tape with strong adhesive such as duct tape) it can cause a tear in the garment. N95 respirators should never be taped to the hood of a protective coverall or other PPE – this can disrupt the fit of the respirator, which affects its protective performance.</i></p>

B. PPE Use – Doffing

Extreme care must be exercised when doffing PPE following use where contamination has occurred or is suspected. A specific sequence for doffing the PPE must be followed, in an order that prevents any contamination transfer from the PPE to the wearer or others. The following considerations should be included in operating procedures for doffing ensembles with known or suspected contamination:

- The wearer must assume that any surface could be contaminated.
- All doffing must be performed under supervision and with assistance as needed.
- The *last items removed* should be the face/eye protection or respirator, and inner gloves.

- Any time the wearer or an individual assisting the wearer in the doffing process touches a potentially contaminated surface or PPE item, the wearer or assisting individual must rinse their gloved hands with an appropriate decontamination solution that does not cause the gloves to degrade.
- For some types of ensembles, it is possible to cut off the garment to permit easier doffing without contacting contaminated surfaces. If cutting of the garment is performed, then the procedures used for the cutting process should be accounted for in the garment's design (e.g., the placement of seams and closures).

C. *Additional Considerations in PPE Selection and Use*

Each organization should ensure that it develops specific SOPs covering all elements of use including donning, doffing, and disposing PPE following use. If PPE is contaminated, it must be isolated, contained, and disposed in accordance with federal, state, and local regulations as applicable to the specific jurisdiction. Finally, all organizations that engage in response operations where there is the potential for using High Risk and Low Risk PPE for Ebola Virus exposure must repeatedly train their members in these procedures.

D. *Basis of IAB Recommendations*

The PPE recommendations herein are based wherever possible on recognized consensus standards that have been applied to PPE, including biological protective clothing and equipment. In some cases, specific recommendations are provided that reference standards for which no certified items are currently available; however, alternative or minimum requirements are also supplied for each type of item. *Referenced standards and attributes should be part of any purchase specifications for selecting PPE.*

Appendix 1 - PPE Descriptions

PPE Item	High Risk	Low Risk
Garments	<ul style="list-style-type: none"> • Full-body garment constructed of durable viral penetration resistant material and seams with sealable cover flap over closure: <ul style="list-style-type: none"> – Coverall with integrated hood when worn with full facepiece respirator; or – Coverall without hood when worn with hood-based or helmet-based powered air purifying respirator (PAPR) where hood provides sufficient overlap with garment, or where separate hood covers all portions of wearer’s head, face, and neck while providing sufficient overlap with garment and where hood material meets garment material viral-penetration resistance requirements • Preferred features include splash flaps on sleeves for covering the end of outer gloves and on legs for covering the top of footwear combined with a sock-like bootie extension of the coverall legs • Viral penetration resistant materials that are also “breathable” are preferred over non-breathable materials • Acceptable alternative garments include chemical splash suits and ensembles for chemical, biological, radiological, and nuclear (CBRN) protection 	<ul style="list-style-type: none"> • Full body garment constructed of disposable or more durable viral penetration resistant material and seams with sealable cover flap over closure: <ul style="list-style-type: none"> – Coverall with integrated hood; or – Coverall with separate hood also constructed of viral penetration resistant material and seams • Viral penetration resistant materials that are also “breathable” are preferred over non-breathable materials
Gloves	<ul style="list-style-type: none"> • Inner – Single use nitrile rubber inner examination glove (worn underneath coverall sleeve) • Outer – Extended cuff 11 mil or thicker unsupported nitrile, neoprene, or other rubber glove without interior fabric or flocking (worn over coverall sleeve and taped in place if not integrated with suit sleeve) 	<ul style="list-style-type: none"> • Inner – Single use nitrile rubber inner examination glove (worn underneath coverall sleeve) • Outer – Extended cuff single use nitrile rubber examination glove (worn over coverall sleeve and taped in place if not integrated with suit sleeve)

PPE Item	High Risk	Low Risk
Eye/Face/ Respiratory Protection	<ul style="list-style-type: none"> • Full facepiece (elastomeric) air-purifying respirator (APR) with P100 filters: or • Powered air purifying respirator (PAPR) with P100 filters with full face shield, helmet, or hood • Acceptable alternative respirators include open-circuit self-contained breathing apparatus (SCBA) and any CBRN respirator • Tape may be used to seal around the respirator if no gasket or other interface is provided by coverall, suit or ensemble in order to integrate liquid-penetration resistant respirator with garment hood 	<ul style="list-style-type: none"> • Fluid-resistant N95 or greater filtering facepiece worn in conjunction with splash-rated, non-vented or indirect-vented goggles and splash-rated full face shield • Tape may be used to seal hood around goggles or face shield if no gasket or other interface is provided by coverall, suit or ensemble to permit liquid-penetration resistant integration of these items with garment hood; the respirator should not be taped to the hood since this practice could affect the seal of the respirator against the wearer's face and degrade the respiratory protection
Footwear and other accessories	<ul style="list-style-type: none"> • Rubber boots that extend to at least lower calf; or • Footwear that incorporates viral-penetration barrier layer; or • Standard footwear that is covered by a footwear cover that extends beyond height of footwear constructed of viral penetration resistant footwear and that includes a durable wear surface • If garment does not have sock-like bootie extension, then end of coverall legs opening must be taped over boots or over footwear covers worn on top of standard footwear; taping must be performed in a manner that permits full movement of wearer without causing strain on garment material 	<ul style="list-style-type: none"> • Footwear that incorporates viral-penetration barrier layer; or • Standard footwear that is covered by a footwear cover that extends beyond height of footwear constructed of viral penetration resistant footwear and that includes a durable wear surface • If garment does not have sock-like bootie extension, then end of coverall leg openings must be taped over boots or over footwear covers worn on top of standard footwear; taping must be performed in a manner that permits full movement of wearer without causing strain on garment material

Appendix 2 - Detailed Specifications / Standards for Recommended PPE with Associated Standardized Equipment List⁴ (SEL) links

PPE Item	High Risk	Low Risk
Garments	<ul style="list-style-type: none"> • Garment/hood material and seams meet “pass” requirements of American Society for Testing and Materials (ASTM) F1671 and materials show high levels of tensile strength (≥ 250 N), tear resistance (≥ 75 N), and seam strength (≥ 125 N) when measured to test methods specified in NFPA 1999-2013 [See SEL Item 01EM-02-GARI] • “Breathability” demonstrated when garment material meets above requirements and meets one of the following criteria <ul style="list-style-type: none"> – Total heat loss (THL) values ≥ 450 W/m² (per ASTM F1868, Procedure. C); or – Evaporative resistance (R_{et}) ≤ 10 kPam²/W (per ASTM F1868, Procedure B or ISO 11092); or – Moisture vapor transport rates ≥ 650 g/m²-24 hr (ASTM E96 B) or $\geq 6,000$ g/m²-24 hr (ASTM E96 BW) • When and if available, garments certified to multiple-use garment requirements of NFPA 1999-2013 should be specified [See SEL Item 01EM-02-GARM]* • Splash protective garments [See SEL Item 01SP-02-GRMT] or ensembles certified to NFPA 1992-2012 [See SEL Item 01SP-01-ENSN]* • CBRN protective ensembles certified to Class 2 [See SEL Item 01CB-02-ENSM], Class 3 [See SEL Item 01CB-03-ENSM], or Class 4 requirements of NFPA 1994-2012 [See SEL Item 01CB-04-ENSM]* 	<ul style="list-style-type: none"> • Garment/hood material and seams meet “pass” requirements of ASTM F1671 and materials show high levels of tensile strength (≥ 50 N), tear resistance (≥ 17 N), and seam strength (≥ 50 N) when measured to test methods specified in NFPA 1999-2013 [See SEL Item 01EM-02-GARI] • “Breathability” demonstrated when garment material meets above requirements and meets one of the following criteria <ul style="list-style-type: none"> – Total heat loss (THL) values ≥ 450 W/m² (per ASTM F1868, Procedure. C); or – Evaporative resistance (R_{et}) ≤ 10 kPam²/W (per ASTM F1868, Procedure B or ISO 11092); or – Moisture vapor transport rates ≥ 650 g/m²-24 hr (ASTM E96 B) or $\geq 6,000$ g/m²-24 hr (ASTM E96 BW)

⁴ The Standardized Equipment List (SEL) is a list of generic equipment items recommended by the IAB to local, tribal, state, and federal government organizations in preparing for and responding to all-hazards mass casualty events, with an emphasis on CBRNE. An interactive version of the SEL is available at <https://iab.gov/SELint.aspx>

PPE Item	High Risk	Low Risk
Gloves	<ul style="list-style-type: none"> • Inner gloves certified to single-use examination glove requirements of NFPA 1999-2013 or meeting ASTM D6319 [See SEL Item 01EM-03-GLME]* • Outer glove [See SEL Item 01ZA-02-GLVD] requirements meet minimum requirements of ANSI/ISEA 105 for Detection of Holes, Level 1 cut resistance, Level 1 puncture resistance, Level 1 abrasion resistance, and Level 3 dexterity 	<ul style="list-style-type: none"> • Inner and outer gloves certified to single use examination glove requirements of NFPA 1999-2013 or meeting ASTM D6319 [See SEL Item 01EM-03-GLME]*
Eye/Face/Respiratory Protection	<ul style="list-style-type: none"> • Respirators certified by NIOSH for respective category – see specific respiratory types at http://www2a.cdc.gov/drds/cel/cel_form_code.asp <p>[See SEL Items 01AR-02-APR, 01AR-03-PAPA, 01AR-03-PAPM, 01AR-06-DISP, or 01AR-06-REUS]</p> <ul style="list-style-type: none"> • SCBA that meets NFPA 1981-2013 [See SEL Item 01AR-01-SCBA]* <p><i>Note: When a hooded PAPR is used, the hood material must meet the garment requirements above.</i></p>	<ul style="list-style-type: none"> • Respirators certified by NIOSH for respective category – see “Surgical N95 Respirators” at http://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/n95list1.html • Goggles and faceshield that meet ANSI/ISEA Z87.1-2010, including rating for splash [See SEL Item 01ZA-03-EYEP]
Footwear and other accessories	<ul style="list-style-type: none"> • Footwear certified to multiple use emergency medical footwear or emergency medical facility footwear requirement of NFPA 1999-2013 [See SEL Item 01EM-04-FTWR]*; or • Footwear certified to NFPA 1992-2012 [See SEL Item 01EM-04-FTWI]*; or • Footwear certified to Class 2, Class 3, or Class 4 requirements of NFPA 1994-2012 [See SEL Item 01EM-04-FTWI]* • Footwear covers materials and seams must meet “pass” requirements of ASTM F1671 [See SEL Item 01ZA-02-FTWC] 	<ul style="list-style-type: none"> • Footwear certified to multiple use emergency medical footwear or emergency medical facility footwear requirement of NFPA 1999-2013 [See SEL Item 01EM-04-FTWR]*; or • Footwear certified to NFPA 1992-2012 [See SEL Item 01EM-04-FTWI]*; or • Footwear certified to Class 2, Class 3, or Class 4 requirements of NFPA 1994-2012 [See SEL Item 01EM-04-FTWI]* • Footwear covers materials and seams must meet “pass” requirements of ASTM F1671 [See SEL Item 01ZA-02-FTWC]

* Products meeting these requirements are listed at www.seinet.org under “Certified Products” link or at www.ul.com under On Line Certifications Directory link (use category code QGWS for NFPA 1999, QGTT for NFPA 1992, and QGTE for NFPA 1994)