

Personal Protective Equipment (PPE) for Ebola Virus Disease (EVD)

Purpose

3M has received a number of inquiries regarding the appropriate personal protective equipment for potential exposures to Ebola Virus Disease (EVD). Following are responses to many of the most commonly asked questions. It is important to note this FAQ is not a substitute for the guidance of the United States Centers for Disease Control and Prevention (CDC), World Health Organization (WHO), the European Centres for Disease Prevention and Control (ECDC) and your local health authority. Please consult their websites frequently for the most current information and infection control procedures regarding EVD.

Websites for Reference

U.S. CDC	https://www.cdc.gov/vhf/ebola/index.html
European CDC	http://ecdc.europa.eu/en/healthtopics/ebola_marburg_fevers/Pages/index.aspx
WHO	http://www.who.int/csr/disease/ebola/en/
U.S. OSHA	https://www.osha.gov/SLTC/ebola/control_prevention.html

For further information related to PPE use, please contact your local 3M Personal Safety Division Technical Services team.

As selection of appropriate PPE should be based upon a site-specific risk assessment conducted by qualified individuals, there is no '3M recommended list' of PPE. Specific scenarios and PPE selection will differ depending on many factors including the location and type of work (e.g. caring for patients vs. laboratory tasks; hospitals outside of W Africa preparing for potential patients versus health care in W Africa). As with any use of PPE, there are no standardized solutions, and proper selection and use is critical to protection. There are a variety of options available within the different categories of PPE and associated advantages and disadvantages to the different types and models. It is the responsibility of each facility or organization to determine the appropriate level of protection by conducting a risk assessment which includes elements such as working conditions, tasks, and accessibility to decontamination facilities. As much as possible, engineering and administrative controls should be implemented. 3M cannot select PPE but can assist in helping purchasers identify the specific PPE models that meet or exceed the desired level of protection and the specifics of their situation.

What is Ebola Virus Disease (EVD)?

Ebola Virus Disease (also known as Ebola hemorrhagic fever) is a severe, often-fatal disease caused by infection with a species of Ebola virus. EVD is a severe acute viral illness often characterized by the sudden onset of fever, intense weakness, muscle pain, headache and sore throat. This is followed by vomiting, diarrhea, rash, impaired kidney and liver function, and in some cases, both internal and external bleeding.

Outbreaks of Ebola have occurred sporadically in parts of Africa, South America, the Middle East and Eastern Europe, with fatality rates ranging up to 90%.

How is it Transmitted?

Ebola is spread through direct contact with blood or body fluids (including, but not limited to urine, saliva, sweat, feces, vomit, breast milk and semen) of an infected person or animal, or through contact with objects that have been contaminated with the blood or other body fluids of an infected person, dead or alive. Transmission is believed to occur via contact with mucous membranes and non-intact skin (i.e., rashes, cuts, etc.). Risk of infection by inhalation of contaminated aerosols by healthcare workers has not been documented but is thought to be low at this time based on case history evidence.

Ebola virus is readily killed by soap, bleach, direct sunlight, or drying. Machine washing clothes that have been contaminated with fluids will destroy Ebola virus. Ebola virus survives only a short time on surfaces that are in the sun or have dried.¹

WHO PPE Recommendations Against Ebola Virus Disease

WHO recommendations for PPE are included in “[Interim Infection Prevention and Control Guidance for Care of Patients with Suspected or Confirmed Filovirus Hemorrhagic Fever in Health-Care Settings, with Focus on Ebola.](#)” (August 2014)

Two documents provide additional detail on PPE specification for recommendations made in the August 2014 document linked above. These documents are complementary to the August 2014 document; they do not supersede it:

1. “[Personal protective equipment \(PPE\) in the context of filovirus disease outbreak response. Technical specifications for PPE equipment to be used by health workers providing clinical care for patients October 2014](#)”
2. “[Personal Protective Equipment in the Context of Filovirus Disease Outbreak Response. Rapid advice guideline October 2014](#)”

It is important that anyone involved in infection control for Ebola Virus Disease (EVD) thoroughly read and understand these documents.

WHO emphasizes the importance of consistent use and implementation of Standard Precautions by all health care workers when providing care to all patients, regardless of their diagnoses. These precautions include a wide range measures, including the use of PPE.

The prevention of Ebola virus infection depends on avoiding contact with blood and body fluids of infected individuals and with objects contaminated with these fluids. Barrier precautions are used to prevent skin or mucous membrane exposure of the eyes, nose, and mouth with blood, other body fluids, secretions (including respiratory droplets), or excretions. For those working to control the Ebola Virus Disease (EVD) outbreak and treat patients, the WHO recommends that all health care workers have the mucous membranes of their eyes, mouth and nose completely covered by PPE. The recommended personal protective equipment for most activities includes:

- Two pair of gloves (double gloving)
- Waterproof boots
- Face shield or goggles
- Protective clothing (fluidresistant disposable gown / fluid resistant disposable coverall and waterproof apron; head cover)
- Mask or respirator (fluid resistant if worn with goggles rather than face shield)

Some tasks require additional body protection. Certain tasks – including administering aerosol-generating medical procedures, certain laboratory tasks, and autopsies – require respiratory protection.

Hand hygiene is strongly emphasized. It is of the highest importance that hand hygiene be performed thoroughly and often, including before and after donning and before and after doffing PPE.

The WHO states that a risk assessment must be done by competent experts appointed by the employer. PPE should be selected based primarily on the potential exposures and need for protection against infective fluids and agents. However, work conditions, environmental conditions, tasks and accessibility to decontamination facilities should also be considered.

Health workers should be trained on the risks, mitigating effects of the PPE, and their use. Training should be mandatory and thorough and followed by mentoring before workers engage in any activities.

PPE can help provide a barrier to infectious material. However, it is very important that all local infection control protocols and manufacturer’s user instructions be followed when removing (doffing) the equipment to avoid contamination. Additionally, local infection control practices and manufacturer’s user instructions should be followed when cleaning any reusable PPE. The WHO guidance contains recommendations for donning, doffing and cleaning PPE.

A more complete summary of the WHO PPE recommendations as well as the US CDC, ECDC and United Kingdom's PPE recommendations for EVD can be found in Appendix 4.

Eye Protection

Eye protection provides a barrier to infectious materials from entering the eye and is often used in conjunction with other personal protective equipment (PPE) such as gloves, gowns, and masks or respirators. See Appendix 1.

Goggles

Goggles are designed to fit snugly, but not necessarily seal around the wearer's eyes. NIOSH states²: "appropriately fitted, indirectly-vented goggles* with a manufacturer's anti-fog coating provide the most reliable practical eye protection from splashes, sprays, and respiratory droplets. However, to be efficacious, goggles must fit snugly, particularly from the corners of the eye across the brow. While highly effective as eye protection, goggles do not provide splash or spray protection for other parts of the face.

* Directly-vented goggles may allow penetration by splashes or sprays; therefore, indirectly-vented or non-vented goggles are preferred for infection control."

Face Shields

Face shields are designed to help protect portions of the wearer's face to certain exposures. While goggles help protect a wearer's eyes from splashes, sprays, and droplets, a face shield can help reduce exposure to both the eyes and other facial areas.* Face shields should have crown and chin protection and wrap around the face to the point of the ear. This will help reduce the possibility of splash, sprays and droplets from going around the edges of the shield and reaching the eyes or other facial areas.

*The CDC notes that ANSI Z87.1 recommends face shields should be used in addition to goggles, not as a substitute for goggles, in a chemical exposure or industrial setting.

Safety Glasses

Safety glasses provide impact protection but do not provide the same level of splash or droplet protection as goggles and generally should not be used for infection control purposes.

For more information, consult [3M Tech Data Bulletin #192 – Eye Protection for Infection Control](#).

Protective Clothing

Selection of personal protection ensembles should be based on a site-specific PPE hazard assessment and consideration of recommendations made by health authorities. Performance Requirements and Test Methods for Protective Clothing Against Infective Agents should be considered. See Appendix 2.

In general, protective clothing offering the highest level of protection from infective agents, such as the 3M™ Protective Coverall 4570, is also the least breathable and may introduce hazards related to heat stress and dehydration.

Breathable protective clothing offers less protection but may be desired for tasks in extremely hot conditions where the risk of contacting infective agents is low, where sufficient decontamination facilities are available at the completion of work tasks, and where the risk of harm from heat stress and dehydration is high.

Selection for EVD should be based primarily on the potential exposures and need for protection against infective fluids and agents. However, work conditions, environmental conditions, tasks and accessibility to decontamination facilities should be considered.

In 2018 CDC released guidance on Personal Protective Equipment (PPE) to be used by healthcare workers during management of patients in two scenarios; 1) patients with confirmed Ebola or persons under investigation for Ebola who are clinically unstable or having bleeding, vomiting, or diarrhea in U.S. hospitals, including procedures for donning and doffing PPE 2) patients under investigation for Ebola who are clinically stable and do not have vomiting or bleeding.

[Guidance on Personal Protective Equipment \(PPE\) | Personal Protective Equipment \(PPE\) | Public Health Planners | Ebola \(Ebola Virus Disease\) | CDC](#)

This document provides details on the principles of PPE, training and correct use and selection of PPE for both scenarios stated above. Specifically, for coveralls it suggests impermeable coveralls to be used in scenario one, with confirmed patients and fluid-resistant coveralls to be used in scenario two, with patients under investigation, but clinically stable.

It provides a table to explain the difference between impermeable vs fluid resistant coveralls and gowns, including which testing standards to look for with each classification (see description below)

	ISO Test Standard
Impermeable coverall *CDC suggested for confirmed Ebola or unstable patient under investigation	ISO 16604 Blood-borne pathogen penetration resistance
Fluid-resistant coverall *CDC suggested for patient under investigation	ISO 16603 Synthetic blood penetration resistance

Respiratory Protection

Surgical/medical masks or respirators are another type of PPE recommended for those in contact with potential EVD cases. These products may need to be fluid resistant depending upon the eye and face protection being worn. This section discusses the use of respiratory protection.

For more information on the differences between surgical masks and respirators, please consult [3M Technical Data Bulletin #231 - Respirators and Surgical Masks: A Comparison](#).

A **respirator** is a device designed to help provide the wearer with respiratory protection against inhalation of a hazardous atmosphere.

To help reduce nose, mouth and respiratory system exposures to airborne particles, particulate-filtering respirators are often recommended. Particulate respirators are available as:

1. A filtering half facepiece respirator, where the filter is the entire respirator
2. An elastomeric (reusable) half mask with a particulate filter
3. An elastomeric (reusable) full facepiece with a particulate filter
4. A powered air purifying respirator (PAPR) that includes a particulate filter
5. A supplied air respirator.

Particulate respirators are designed to help reduce the wearer's exposure to certain airborne particles. Currently, health authorities have not documented EVD as being transmitted from infected individuals via airborne Ebola virus. However, droplets containing the Ebola virus that have become aerosolized (e.g. from coughing, sneezing, vomiting, medical procedures, and surfaces etc.) may have the potential to come into contact with a person's mucous membranes in their nose or mouth or non-intact skin. Therefore, respiratory protection may be helpful in providing a barrier to help prevent infectious materials from contacting a wearer's mucous membranes. They may also help limit inadvertent touching of the nose, mouth and/or eyes (if a full-facepiece or powered-air respirator is used). Respiratory protection is recommended for workers performing certain tasks such as aerosol-generating procedures, laboratory procedures, and autopsies.

See Appendix 3 for examples of different types of respirators.

For more information consult [3M Tech Data Bulletin #174 – Respiratory Protection for Airborne Exposures to Biohazards](#).

Advantages and Disadvantages of Different Types of Respirators

Respiratory protection may be a component of the PPE selected based upon the risk assessment. A control banding approach has been suggested for choosing between different levels of respiratory protection based on the organism, generation rate, level of control and respirator protection factor.

<http://www.cidrap.umn.edu/news-perspective/2014/09/commentary-healthworkers-need-optimal-respiratory-protection-ebola>

Following are some general advantages and disadvantages of different types of respirators.

Disposable Filtering Facepiece Respirator

- Disposable, no maintenance
- Lightweight
- Less expensive
- Need separate eye and face protection
- Fit testing required in certain countries, including the US, to ensure respiratory protection

Reusable Half mask or Full Facepiece Respirator

- Often available in multiple sizes
- Facepieces can be disinfected and reused
- Full facepieces may provide eye and face protection
- Fit testing required in certain countries, including the US, to ensure respiratory protection
- Facepieces must be maintained
- Unit needs to be maintained

Powered Air Purifying (PAPR) Respirator

- Some elements can be disinfected and reused
- No fit testing required for systems with loose fitting head covers
- May not need separate eye and face protection depending on the head covering
- Batteries need to be charged and entire unit maintained
- Higher initial cost
- Unit needs to be maintained
- Wearer may not need to be clean-shaven, depending on the type of head cover and style of facial hair

Supplied Air Respirators

- Some systems provide cooled air to the wearer
- Some components can be disinfected and reused
- No fit testing required for systems with loose fitting head covers
- May not need separate eye and face protection depending on the head covering
- Need adequate supply and pressure of compressed breathable air (Grade D)
- Unit needs to be maintained
- Higher initial cost

Please see [3M Technical Data Bulletin: Cleaning Reusable Respirators and Powered Air Purifying Respirator Assemblies](#) following potential exposure to the Ebola virus.

Summary

Those who will be exposed to individuals with known or suspected cases of EVD should wear PPE that provides a barrier to help prevent infectious material from contacting mucous membranes (mouth, nose, eyes) and non-intact skin (i.e., rashes, cuts, etc.). Respiratory protection should be utilized if there is a risk of aerosolized particles (i.e. aerosol-generating procedures, certain laboratory tasks, autopsies), or according to local health authorities. Always ensure that PPE users are properly trained in the benefits and limitations of the equipment per all applicable guidance and regulations and the manufacturer's user instructions. Please consult your occupational safety and health professional, the appropriate health authority and the PPE manufacturer with questions.

References and Resources

1. ECDC Information to Travellers. http://www.ecdc.europa.eu/en/healthtopics/ebola_marburg_fever/informationtravellers/Pages/information-travellers.aspx
2. National Institute for Occupational Safety and Health (NIOSH). Eye Protection for Infection Control. September 2004. <http://www.cdc.gov/niosh/topics/eye/eye-infectious.html>
3. US CDC <http://www.cdc.gov/vhf/ebola/index.html>
4. WHO <http://who.int/mediacentre/factsheets/fs103/en/>
5. WHO "Interim Infection Prevention and Control Guidance for Care of Patients with Suspected or Confirmed Filovirus Hemorrhagic Fever in Health-Care Settings, with Focus on Ebola." http://www.who.int/csr/resources/publications/ebola/filovirus_infection_control/en/
6. Infection Prevention and Control Recommendations for Hospitalized Patients with Known or Suspected Ebola Hemorrhagic Fever in U.S. Hospitals. <http://www.cdc.gov/vhf/ebola/hcp/infectionprevention-and-control-recommendations.html>
7. The European Centre for Disease Prevention and Control has published "Outbreak of Ebola virus disease in West Africa. Third update, 1 August 2014." <http://www.ecdc.europa.eu/en/publications/Publications/ebola-outbreak-west-africa-1-august-2014.pdf>
8. ECDC Factsheet about Ebola and Marburg virus diseases. <https://www.ecdc.europa.eu/en/ebola-and-marburg-fevers/facts/factsheet>
9. The United Kingdom Advisory Committee on Dangerous "VIRAL HAEMORRHAGIC FEVERS RISK ASSESSMENT (Version 6: 15.11.2015)" http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317135155050
10. "Health workers need optimal respiratory protection for Ebola" Lisa Brosseau, Rachael Jones. Center for Infectious Disease Research and Policy Sept. 7, 2014. <http://www.cidrap.umn.edu/news-perspective/2014/09/commentary-health-workers-need-optimal-respiratory-protection-ebola>
11. WHO "Personal Protective Equipment in the Context of Filovirus Disease Outbreak Response. Rapid advice guideline October 2014" http://apps.who.int/iris/bitstream/10665/137410/1/WHO_EVD_Guidance_PPE_14.1_eng.pdf?ua=1
12. ECDC Critical aspects of the safe use of personal protective equipment. <https://www.ecdc.europa.eu/en/news-events/ecdc-tutorial-critical-aspects-safe-use-personal-protective-equipment>
13. WHO "Personal Protective Equipment for Use in a Filovirus Disease Outbreak: Rapid Advice Guideline." (2016) <http://www.who.int/csr/resources/publications/ebola/personal-protective-equipment/en/>

Appendix 1 - Specifications for Examples of 3M Protective Eyewear

EN Tested, CE Approved (Marked)

		Goggles			Face Shields
Image					
Product		2890SA	Alternative: 2890S	71360-0015M	H8 Headgear with WP Series Visors
Description		2890SA Goggle Sealed Acetate AF (anti-fog)	2890S Goggle Sealed PC AS/AF (anti-scratch/anti-fog)	Fahrenheit™ Goggle Nonvent Acetate AS/AF (anti-scratch/anti-fog)	H8 Headgear, with either of: WP96 – 2mm PC visor, or WP98 – 2mm Acetate visor
Protection	Liquids (splashes)	Yes	Yes	Yes	Yes
	Large particles (suspended droplets > 5µm)	Yes	Yes	Yes	No
	Gases/Fine particles (air-borne particles < 5µm)	Yes	Yes	No	No

Meeting ANSI Standards

		Goggles			Face Shields	
Image						
Product		GG501 SGAF	GG501 NSGAF	GG6001 NSGAF-BLU	2891-SGAF	82501-00000 and 82582-00000
Description		3M™ GoggleGear™ 500 Series, Clear Scotchgard™ Anti-fog		3M™ GoggleGear™ 6000 Series, Blue Shroud, Scotchgard™ Anti-Fog Coating, Clear AF-AS Lens, Neoprene Strap	3M™ 2890 Safety Goggles, Indirect Vented, Scotchgard™ Anti-Fog, Clear Lens, 10ea/case	3M™ Ratchet Headgear H8A with 3M™ Clear Polycarbonate Faceshield WP96X
Eye Protection (Splashes, sprays, and droplets)		Yes	Yes	Yes	Yes	Yes (Secondary Protector)
Face Protection (Splashes, sprays, and droplets)		No	No	No	No	Yes

Appendix 2 - Specifications for 3M Protective Apparel

i IMPORTANT NOTE

These products will not eliminate the risk of infection. Currently there is no established guidance specifying performance criteria for protective clothing specific to EVD. This information is presented to help safety professionals make informed decisions as part of a site and task specific PPE hazard assessment.

		3M™ Protective Coverall 4570	3M™ Protective Coverall 4565	3M™ Protective Coverall 4545
PPE Directive Approval		CE Category 3	CE Category 3	CE Category 3
Fabric Type		Multi-layered laminate	Non-breathable laminate	Micro-porous laminate
Image				
General Data	Test Method			
Suit Type	ISO 16602:2007	Type 3	Type 4	Type 5/6
Seam construction	N/A	Serged & Taped	Serged & Taped	Serged
Protection against Infective Agents				
Synthetic blood penetration resistance	ISO 16603:2004	6/6	6/6	3/6
Blood-borne pathogen penetration resistance	ISO 16604:2004	6/6	0	0
Contaminated solid particle penetration resistance	EN ISO 22612:2005	3/3	3/3	3/3
Contaminated liquid aerosol penetration resistance	ISO/DIS 22611:2003	3/3	3/3	3/3
Wet bacteria penetration resistance	EN ISO 22610:2006	6/6	6/6	6/6

Appendix 3 - Specifications for 3M Respiratory Protective Devices

	Half-face		Full Face	PAPR	
	Filtering Facepiece	Elastomeric Facepiece	Elastomeric Facepiece	Loose Fitting Head gear	Loose Fitting Hood/Helmet
Image					
Eye Protection (splashes, sprays, and respiratory droplets)	No	No	Yes	Limited	Yes
Face Protection (splashes, sprays, and respiratory droplets)	No	No	Limited	Limited	Limited
Head Protection (splashes, sprays, and respiratory droplets)	No	No	No	Limited	Limited
Respiratory Protection* (airborne aerosols and respiratory droplets)	Yes	Yes	Yes	Yes	Yes

* When equipped with appropriate and approved filter and/or cartridge.

Examples of Disposable Respirators, EN Tested, CE Approved (marked)

						
Product	3M™ Particulate Respirator 8810	3M™ Particulate Respirator 8822	3M™ Aura™ Particulate Respirator 9320+ and 3M™ Aura™ Surgical & Health Care Disposable Particulate Respirator 1862+	3M™ Aura™ Particulate Respirator 9322+ and 3M™ Aura™ Surgical & Health Care Disposable Particulate Respirator 1872+	3M™ Aura™ Particulate Respirator 9330+ and 3M™ Aura™ Surgical & Health Care Disposable Particulate Respirator 1863+	3M™ Aura™ Particulate Respirator 9332+ and 3M™ Aura™ Surgical & Health Care Disposable Particulate Respirator 1873+
Valve	Unvalved	Valved	Unvalved	Valved	Unvalved	Valved
Classification	EN 149:2001+A1:2009 FFP2 NR D	EN 149:2001+A1:2009 FFP2 NR D	EN 149:2001+A1:2009 FFP2 NR D	EN 149:2001+A1:2009 FFP2 NR D	EN 149:2001+A1:2009 FFP3 NR D	EN 149:2001+A1:2009 FFP3 NR D
	N/A	N/A	EN14683:2005 Type IIR	N/A	EN14683:2005 Type IIR	N/A
Fluid Splash Tested	No	No	Yes (1862+ only)	No	Yes (1863+ only)	No
PPE Regulation Approval	Yes	Yes	Yes	Yes	Yes	Yes
MD Regulation Approval	No	No	Yes (1862+ only)	No	Yes (1863+ only)	No

Examples of Disposable Respirators Approved by the US National Institute for Occupational Safety and Health (NIOSH)

					
Product	3M™ Particulate Respirator 8210	3M™ Particulate Respirator 8511	3M™ Health Care Particulate Respirator and Surgical Mask 1860	3M™ Aura™ Health Care Particulate Respirator and Surgical Mask 1870+	3M™ VFlex™ Health Care Particulate Respirator and Surgical Mask 1804
Valve	Unvalved	Valved	Unvalved	Unvalved	Unvalved
Size	8210 - one size	8511 - one size	1860 - regular 1860S - small	1870+ - one size	1804 - regular 1804S - small
Classification	N95	N95	N95	N95	N95
Fluid Resistant	No	No	Yes	Yes	Yes
FDA Clearance	No	No	Yes	Yes	Yes

Note: Other models of 3M disposable respirators are available, but supply may be constrained if demand increases.

Examples of Reusable Respirators: EN Tested, CE Approved (marked)

	Half Masks		Full Face Masks	Particulate Filters	
Image					
Product	3M™ Half Mask 6000	3M™ Half Mask 7500	3M™ Full Face Mask 6800	3M™ 2135 P3 R	3M™ 6035 P3 R
Description	6100 - small (light grey) 6200 - medium (grey) 6300 - large (dark grey)	7501 - small (grey blue) 7502 - medium (light blue) 7503 - large (dark blue)	6700 - small 6800 - medium 6900 - large	Particulate filter	Encased particulate filter
Classification	EN 140:1998	EN 140:1998	EN 136:1998 Class 1	EN 143:2000 P3 R	EN 143:2000 P3 R

Examples of Reusable Respirators Approved by the US National Institute for Occupational Safety and Health (NIOSH)

	Half Facepiece Respirator			Full Facepiece Respirator			Particulate Filters	
Image								
Product	3M™ Half Facepiece 6000 Series	3M™ Half Facepiece 6500 Series	3M™ Half Facepiece 7500 Series	3M™ Full Facepiece 6000 Series	3M™ Full Facepiece FF-400 Series	3M™ Full Facepiece 7800 Series	3M™ 2291 P100	3M™ 7093 P100
Description	6100 - small 6200 - medium 6300 - large	6501 - small 6502 - medium 6503 - large	7501 - small 7502 - medium 7503 - large	6700 - small 6800 - medium 6900 - large	FF-401 - small FF-402 - medium FF-403 - large	7800S-S - small 7800S-M - medium 7800S-L - large	Particulate filter	Encased particulate filter

Note: Chemical cartridges are available to help reduce exposures to chemical disinfectants (e.g. chlorine).

Examples of Powered Air Respirators: EN Tested, CE Approved

	S-Series		M-Series				
Powered Air Turbo Unit						Breathing Tube & Cover	
	3M™ Versaflo™ Headcovers	3M™ Versaflo™ Hoods	3M™ Versaflo™ Faceshield	3M™ Versaflo™ Helmet	3M™ Versaflo™ Helmet		
	S-133 or S-333G	S-433 or S-533	M-206	M-306	M-406		
 3M™ Versaflo™ Powered Air Turbo TR-300+ with TR-3712EP Filter	EN 12941:1998+A2:2008 TH3 EN 166:2001 2:F:3		EN 12941:1998+A2:2008 TH3 EN166:2001 1:BT:3		EN 12941:1998+A2:2008 TH3 EN166:2001 1:BT:3		 3M™ Versaflo™ Breathing Tube BT-20S (735mm) or BT-20L (965mm)
 3M™ Versaflo™ Powered Air Turbo TR-600 with TR-6710E Filter							

Examples of Powered Air Purifying Respirators (PAPRs) by the US National Institute for Occupational Safety and Health (NIOSH)

	S-Series			M-Series
				
Models	S-403, S-433, S-533	S-655/S-657	S-855/S-857	M-405
Assigned Protection Factor	1000	1000	1000	1000
	Breathing Tube			
 3M™ Versaflo™ TR-300+ PAPR with TR-3712N HEPA Filter	 3M™ Versaflo™ Breathing Tube BT-20, BT-30, BT-40			
 3M™ Versaflo™ Powered Air Turbo TR-600 with TR-6710N Filter	 3M™ Versaflo™ Breathing Tube Disposable Cover BT-922			

	S-Series
	
Models	S-403
Assigned Protection Factor	1000
 TR-630/TR-659 battery and adapter	 BE-324

Note: Other PAPR's, hoods, helmets and headcovers are available.

Appendix 4

WHO Guidance

In October 2014, WHO published two documents:

1. [“Personal protective equipment \(PPE\) in the context of filovirus disease outbreak response. Technical specifications for PPE equipment to be used by health workers providing clinical care for patients October 2014”](#)
2. [“Personal Protective Equipment in the Context of Filovirus Disease Outbreak Response. Rapid advice guideline October 2014”](#)

These documents provide additional detail on PPE specification for recommendations made in the August 2014 document [“Interim Infection Prevention and Control Guidance for Care of Patients with Suspected or Confirmed Filovirus Hemorrhagic Fever in Health-Care Settings, with Focus on Ebola.”](#)

It is important that anyone involved in infection control for Ebola Virus Disease (EVD) thoroughly read and understand these documents. Below is a short summary of personal protective equipment recommendations both in text and table form. However, the WHO documents contain extensive information regarding PPE specifications, donning and doffing procedures, and cleaning methods.

Hand hygiene is strongly emphasized, and it is of the highest importance that hand hygiene be performed thoroughly and often, including before and after donning and before and after doffing PPE.

At a minimum, the WHO recommends a basic suite of PPE for most activities, which includes gloves, a gown, boots or closed-toe shoes with overshoes, a mask, and eye protection. Some tasks require additional body protection. Certain tasks require respiratory protection.

Everyone entering the patient isolation rooms should perform hand hygiene and wear at least gloves, gown, boots / closed-toe shoes with overshoes, and a mask and eye protection. This recommendation includes visitors. Additionally, this ensemble of PPE is recommended for those handling soiled linen from patients.

If a health care worker is undertaking any strenuous activity, such as carrying a patient, or performing any tasks in which contact with blood and body fluids is anticipated, they should also wear two sets of gloves and a waterproof apron over the gown, if the gown is non-impermeable. Disposable overshoes and leg coverings should also be used if boots are not available.

Those examining remains or handling a dead body are instructed to wear an impermeable gown, mask, eye protection, double gloves, and closed-toe shoes or boots.

When cleaning the environment or handling infectious waste, workers should wear heavy-duty rubber gloves, an impermeable gown, and closed-toe shoes (e.g. boots). If the cleaning activities have a risk of splash or contact with blood or bodily fluids, facial protection, such as a mask and goggle or face shield, should be used.

Summary of WHO PPE Recommendations by Task

Task	Recommended PPE
Work in Patient Areas	<ul style="list-style-type: none"> • Gloves • Gown: disposable impermeable • Medical mask • Eye protection (eye visor, goggles, or face shield) • Shoes: closed, puncture and fluid resistant (e.g. rubber boots)
Strenuous tasks or exposure to blood and body fluids	<ul style="list-style-type: none"> • Gloves, double set • Gown: disposable impermeable • Apron: waterproof (if gown is not impermeable) • Medical mask • Eye protection (eye visor, goggles, or face shield) • Boots: rubber. Or disposable overshoes and leg coverings with shoes.
Aerosol Generating Medical Procedures	<ul style="list-style-type: none"> • Gloves • Gown: disposable impermeable • Respirator: FFP2, NIOSH N95 or equivalent • Eye protection (eye visor, goggles or face shield) • Shoes: closed, puncture and fluid resistant (e.g. rubber boots)
Handling Infectious Waste	<ul style="list-style-type: none"> • Gloves, heavy duty/rubber • Gown: impermeable • Eye protection (eye visor, goggles, or face shield); Goggles preferred for liquid handling • Shoes: closed, puncture and fluid resistant (e.g. rubber boots)
Laboratory Personnel handling potential Ebola specimens	<ul style="list-style-type: none"> • Gloves • Gown: disposable impermeable • Respirator* • Eye protection (eye visor, goggles, or face shield) • Shoes: closed with overshoes or boots
Handling of Human Remains	<ul style="list-style-type: none"> • Gloves, double set • Gown: disposable impermeable • Mask • Eye protection (eye visor, goggles, or face shield) • Rubber boots or closed puncture or fluid resistant shoes and overshoes
Autopsies of known or suspected Ebola virus disease cases	<ul style="list-style-type: none"> • Gloves, double set • Gown: disposable impermeable • Respirator: FFP2, NIOSH N95 or equivalent or a PAPR • Eye protection (eye visor, goggles, or face shield) • Shoes: closed or boots

* FFP2, NIOSH N95 or equivalent for handling. PAPR for aliquoting, centrifugation or other aerosol generating procedures.

Eye Protection

The WHO states the use of goggles or a face shield is strongly recommended, and both styles of eye protection are acceptable. Indirectly vented goggles are recommended. Goggles should form a good seal with the face, have a flexible frame to fit to the face without much pressure, cover the eyes and surrounding areas and accommodate prescription glasses, be fog- and scratch-resistant, and have an adequate band to secure to the head.

Faceshields should be clear and provide good visibility to the patient and wearer. The band should be adjustable to attach around the head and fit snugly to the forehead and completely cover the sides and length of the face. Fog resistance is preferable.

Goggles and faceshields should comply with EU standard directive 86/686/EEC, EN 166/2002 or ANSI/ISEA Z87.1-2010. Goggles and faceshields may be reused if there are adequate arrangements for decontamination. WHO recommends that goggles and faceshields not be used together.

Respiratory Protection

Respiratory protection is strongly recommended for several applications, including administering aerosol-generating procedures to a patient, performing laboratory operations, and during autopsies. If aerosol-generating procedures are necessary, the health care worker should wear a respirator, such as an EN-certified FFP2 or NIOSH N95 or equivalent. The WHO cites examples of aerosol-generating procedures as those that stimulate coughing or those that could generate aerosols, such as bronchoscopy, endotracheal intubation, airway suctioning, positive-pressure ventilation via a face mask, or administration of aerosolized or nebulized medication. FFP2 or N95 disposable filtering facepiece respirators are recommended for laboratory personnel handling potentially infected clinical specimens, as well as closed-toe shoes with overshoes or boots, gloves, a disposable impermeable gown, and eye protection or face shields. Workers aliquotting, performing centrifugation, or undertaking any other procedures that may generate aerosols should use a powered air purifying respirator (PAPR). Persons performing autopsies are instructed to wear a particulate respirator (FFP2 or equivalent or NIOSH N95) or a PAPR as well as eye protection, double gloves, disposable impermeable gowns and closed shoes or boots.

Fluid-resistant particulate respirators are recommended if goggles are utilized for eye protection. If a face shield is used, the respirators do not need to be fluid-resistant. The respirator should be of a shape that will not collapse easily and have high filtration efficiency and good breathability. Respirators should be NIOSH N95, EN 149 FFP2, or equivalent. If fluid resistance is appropriate, then a respirator also meeting the 80-mmHg minimum pressure test based upon ASTM F1862, ISO 22609, or equivalent should be selected.

In the 2014 WHO guidance document "[Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care](#)," April 2014, the WHO also recommended "particulate respirators at least as protective as a NIOSH-certified N95, EU FFP2 or equivalent" for those performing aerosol-generating procedures. They cited examples of acceptable disposable particulate respirators in use in various parts of the world:

- Australia/New Zealand: P2 (94%), P3 (99.95%)
- China: II (95%), I (99%)
- European Union: CE-certified filtering face-piece class 2 (FFP2) (95%), or class 3 (FFP3) (99.7%)
- Japan: 2nd class (95%), 3rd class (99.9%)
- Republic of Korea: 1st class (94%), special (99.95%)
- United States: NIOSH-certified N95 (95%), N99 (99%), N100 (99.7%)

Protective Clothing

A disposable gown and apron or a disposable coverall and apron are recommended. The gown or coverall should be made of fabric that is tested for resistance to penetration by blood or body fluids or to blood-borne pathogens. The technical description for gowns can be found in the document. Disposable coveralls should be single-use, of a light color, and available in different sizes. Thumb / finger loops should be available to anchor sleeves in place. The garment should either be:

- Tested for resistance to blood and body fluid penetration: meets or exceeds ISO 16603
Or
- Tested for resistance to blood-borne pathogen penetration: meets or exceeds ISO 16604

It is noted that heat stress and breathability should be considered when selecting a garment. The second option listed above may result in higher potential for heat stress, which can reduce wear time.

It is conditionally recommended that a separate head cover be used that is single-use, fluid-resistant, and adjustable. The facial opening should be constructed without elastic. The recommendation for a separate head cover is conditional because, as the WHO stated, "there was no comparative evidence of effectiveness in preventing transmission between a separate head cover and a head cover that is integrated in the coverall. When a separate head cover is not available, a coverall with hood can be worn provided that the hood is put on after eye, nose and mouth protection so that mucosal protection is maintained after taking off the hooded coverall."

The document also addresses technical specifications for surgical masks, rubber boots, waterproof aprons and gloves.

U.S. CDC

On August 30, 2018 the US CDC updated "[Guidance on Personal Protective Equipment \(PPE\) To Be Used by Healthcare Workers During Management of Patients with Confirmed Ebola or Persons Under Investigation \(PUIs\) for Ebola who are Clinically Unstable or Have Bleeding, Vomiting, or Diarrhea in U.S. Hospitals, Including Procedures for Donning and Doffing PPE](#)".

It is important that anyone involved in infection control for Ebola Virus Disease (EVD) thoroughly read and understand this document. Below is a short summary of the personal protective equipment recommendations in the US CDC guidance.

Similar to the WHO, the US CDC emphasizes hand hygiene and instructs that hand hygiene be performed thoroughly and often including before and after donning and before and after doffing PPE. US CDC PPE recommendations for U.S. Healthcare Workers include the following:

- Single-use (disposable) impermeable gown that extends to at least midcalf or single-use (disposable) impermeable coverall without integrated hood. Coveralls with or without integrated socks are acceptable. Consider selecting gowns or coveralls with thumb hooks to secure the sleeves over the inner glove.
- Two pairs of single-use (disposable) examination gloves with extended cuffs.
- Single-use (disposable) boot covers that extend to at least mid-calf. Single-use (disposable) shoe covers are acceptable only if they will be used in combination with a coverall with integrated socks.
- Single-use (disposable) apron that covers the torso to the level of the mid-calf should be used over the gown or coveralls if patients with Ebola are vomiting or have diarrhea; or routinely if using a coverall with an exposed, unprotected front zipper
- Powered air purifying respirator (PAPR) with full faceshield, helmet, or headpiece; or N95 respirator. Any reusable PAPR headgear must be covered with a single-use (disposable) hood that extends to the shoulders, fully covers the neck and is compatible with the PAPR.

For additional information, please see US CDC's "[Infection Prevention and Control Recommendations for Hospitalized Patients Under Investigation \(PUIs\) for Ebola Virus Disease \(EVD\) in U.S. Hospitals](#)".

European Centre for Disease Prevention and Control

The European Centre for Disease Prevention and Control has published "[Outbreak of Ebola Virus Disease in West Africa. Third update, 1 August 2014](#)".

Their recommendations are very similar to those of the WHO. **It is important that anyone involved in infection control for Ebola Virus Disease (EVD) thoroughly read and understand this document.** The ECDC recommends that patient handling be conducted under droplet hygiene precautions; in case of invasive, potentially aerosol-generating procedures airborne transmission, precautions should be employed. The PPE, donning and doffing procedures that should be used by health care workers treating patients infected with Ebola are described in detail

Safe use of personal protective equipment in the treatment of infectious diseases of high consequence Dec 2014
<https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/safe-use-of-ppe.pdf>

Tutorial on the safe use of personal protective equipment Dec 2016
<https://www.ecdc.europa.eu/en/publications-data/tutorial-safe-use-personal-protective-equipment>

Additionally the ECDC has published a Factsheet about Ebola and Marburg virus diseases
<https://www.ecdc.europa.eu/en/ebola-and-marburg-fevers/facts/factsheet>

United Kingdom

The United Kingdom Advisory Committee on Dangerous Pathogens has written a document "[Management of Hazard Group 4 viral haemorrhagic fevers and similar human infectious diseases of high consequence](#)".

This document, updated in November, 2015 "VIRAL HAEMORRHAGIC FEVERS RISK ASSESSMENT (Version 6: 15.11.2015)," also addresses health care worker PPE.

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