

EBOLA VIRUS

Garment Fabric, Construction, and Seam Integrity



Ebola is transmitted through direct contact with infected bodily fluids, such as blood, vomit, and urine. Because Ebola is not an airborne virus, garment selection should focus on protection against liquid contact, sprays, splashes, and contamination from bodily fluids.

This means protective clothing should be evaluated in two ways:

1

Fabric Barrier Performance:

Whether the material resists penetration by contaminated liquids or infectious agents.

2

Garment Construction:

Whether seams, closures, and other construction points maintain that barrier throughout the finished garment.

FABRIC PERFORMANCE: EN 14126

EN 14126 evaluates the ability of protective clothing materials to resist penetration by infectious agents. The standard includes multiple test methods that assess fabric performance against different ways contamination may occur.

For Ebola-related protection, the most relevant tests are:

- **ISO 16604 – Resistance to penetration by contaminated liquids under hydrostatic pressure.** Evaluates protection against direct contact with contaminated liquids, such as blood, vomit, or other bodily fluids.
- **ISO 22611 – Resistance to penetration by biologically contaminated aerosols.** Tests protection against sprays or aerosols of infected body fluids, such as those distributed from coughing or sneezing.
- **EN 14126 Annex A – Resistance to penetration through mechanical contact with substances containing contaminated liquids.** Assesses protection when the garment contacts contaminated liquids through surfaces, materials, or other mechanical contact.

Equivalent ASTM test methods include ASTM F1670, which is a preparatory test to identify a starting pressure where strikethrough may occur, and ASTM F1671, which evaluates resistance to blood-borne pathogens using real Phi-X174 bacteriophage as the challenge organism to assess penetration.

Phi-X174 is smaller than the Ebola virus and is therefore considered an appropriate surrogate for viral barrier testing. This makes ISO 16604 and ASTM F1671 especially relevant when evaluating fabrics for Ebola-related protection.

Recommended Minimum Fabric Performance

Lakeland recommends ISO 16604 as the minimum relevant fabric test for Ebola-related liquid viral barrier assessment. Where alignment with ASTM F1671 is required, ISO 16604 Class 5 is the closest EN 14126 classification because it uses a 14 kPa pressure level, which is close to the 13.8 kPa pressure used in ASTM F1671.



CONSTRUCTION AND SEAMS: PROTECTING THE COMPLETE GARMENT

While EN 14126 provides important information about fabric barrier performance, there are no requirements for garment or seam construction integrity. A fabric may pass relevant infectious-agent barrier tests, but the finished garment can still be compromised if seams, closures, or other construction points allow liquid penetration. The high hazard presented by Ebola indicates construction and material should be a critical consideration. EN14126 certification is intended to be combined with one or more CE garment type certifications appropriate for the media containing the infectious agent.

The Table Below Shows the Applicable CE Standards:

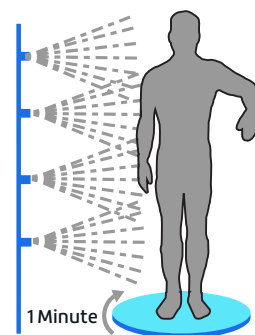
Standard	Title	Relevant Garment Test	Test Requirements
EN 13034: 2005+A1:2009	Protective clothing offering limited protective performance against liquid chemicals	ISO 17491-4 modified for Type 6 Determination of resistance to penetration by a spray of liquid (spray test)	Pass/Fail
EN 14605: 2005+A1:2009	Performance requirements for clothing with liquid-tight (Type 3) or spray-tight (Type 4) connections	ISO 17491-4 Type 4 spray test Determination of resistance to penetration by a spray of liquid (spray test)	Pass/Fail
EN 14605: 2005+A1:2009	Performance requirements for clothing with liquid-tight (Type 3) or spray-tight (Type 4) connections	ISO 17491-3 Type 3 Jet spray test Determination of resistance to penetration by a jet of liquid (jet test)	Pass/Fail

SPRAY AND SPLASH PROTECTION: SELECTING THE RIGHT TEST LEVEL FOR EBOLA

The Type 3, Type 4, and Type 6 tests all evaluate finished garments for liquid penetration, but the key difference is the severity of the liquid challenge, including the pressure and volume applied during testing. This makes the testing especially relevant because it simulates real-world exposure scenarios, such as common decontamination procedures where disinfectants may be sprayed onto workers as they exit contaminated areas.

- **Type 6: Limited spray protection** – Type 6 garments are tested against a lower-level liquid spray challenge. While this may be appropriate for limited splash or light spray applications, for Ebola-related response, where exposure may involve body fluids, disinfectant spray, or liquid collecting around seams and folds, Lakeland recommends a higher level of garment performance.
- **Type 3: Jet liquid protection** – Type 3 testing involves a strong jet of liquid directed at potential weak points of the suit, such as seams, closures, and other garment interfaces. This provides a severe liquid challenge, however, for many Ebola-response environments, this level of jet spray exposure is unlikely and may exceed the anticipated hazard.
- **Type 4: Spray-tight protection** – Type 4 testing exposes the finished garment to liquid sprayed from multiple nozzles. Although the spray pressure is lower than the Type 3 jet test, the volume of liquid is sufficient to wet the garment surface, run across the fabric, and collect in creases, folds, and seam areas. This creates a meaningful challenge for the full garment system, including areas where inward leakage is most likely to occur.

Type 4 Finished Garment Spray Test



For the purposes of Ebola virus protection, Lakeland believes EN 14605 Type 4 provides the most relevant balance of protection and practicality. It better reflects the types of liquid-contact scenarios healthcare and response workers may encounter during patient care, environmental contamination, or decontamination procedures. Where EN 14605 certification is not applicable, such as in the USA, the same principle should be applied by selecting garments with proven liquid barrier performance and sealed seam construction.

SEALED SEAMS: PRESERVE GARMENT INTEGRITY

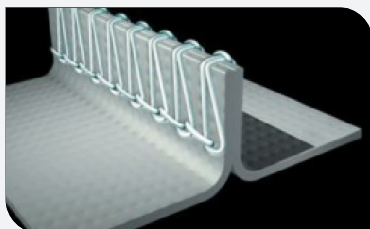
Since the garment must perform as a complete system during tests and real-world applications, garment construction can introduce vulnerabilities if seams are not designed to support the same level of protection. A protective garment is only as strong as its weakest point.

Many Type 6 and other lower-level protective garments use simple stitched seams, creating multiple holes through the barrier material, leaving gaps between joined fabric panels, and introducing thread that may wick liquid through the seam. Bound seams may offer improvement over standard stitched seams, but they are still stitched and can present similar concerns in liquid exposure environments.

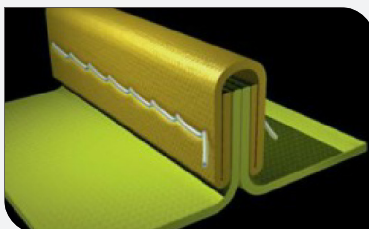
The suggested Type 4 test challenges the complete garment with a higher-volume spray exposure, generally requiring a more protective seam construction. This supports the use of sealed seams which help maintain barrier integrity across the finished garment and reduce the potential for inward leakage at common weak points.



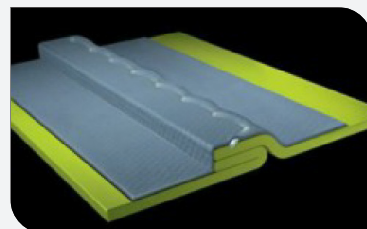
Seam Types on Disposable Protective Clothing



Stitched or Serged



Bound



Stitched & Taped

LIQUID PENETRATION MUST BE MINIMIZED

In Ebola-related response, even small amounts of inward leakage can create serious contamination concerns. Workers may wear protective garments for extended periods, and perspiration or condensation inside the suit can make it difficult to identify whether penetration has occurred.

If liquid reaches under clothing, that clothing needs to be treated as contaminated, complicating doffing, handling, laundering, and infection control procedures. It can also create additional opportunities for contact during or after PPE removal.

For this reason, garment selection should prioritize a finished garment design that helps reduce the potential for inward leakage throughout the suit, including the fabric, seams, and other construction points.



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