



PPE Cleaning Validation

Validation of Cleaning Procedures for Fire Fighter Personal Protective Equipment (PPE)

(for more information see www.nfpa.org/PPECleaning)

PROJECT SUMMARY

Last updated: 23 February 2019

Background: Fire fighter exposure to dirty, soiled, and contaminated personal protective equipment (PPE) is an increasing concern for long-term fire fighter health. This exposure to persistent harmful contaminants in PPE is an extremely serious problem. Fire fighters are exposed to highly toxic substances (including a variety of carcinogens) on the fireground, and more insidiously to an increasing range of infectious pathogens while caring for patients and while operating at different emergency incidents.

Recognizing that fire fighter PPE becomes contaminated during these incidents and cleaning gear without validating the cleaning process is not enough (and there are no industry standards that conclusively and reliably show that clothing is being adequately cleaned). While general cleaning procedures have been established in NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, there are no procedures or requirements to demonstrate whether current cleaning practices, including those specified in NFPA 1851, will remove contaminants from fire fighter PPE. This project is intended to establish clear and definitive guidance to the fire service for applying cleaning and decontamination procedures that effectively remove both chemical and biological contaminants.

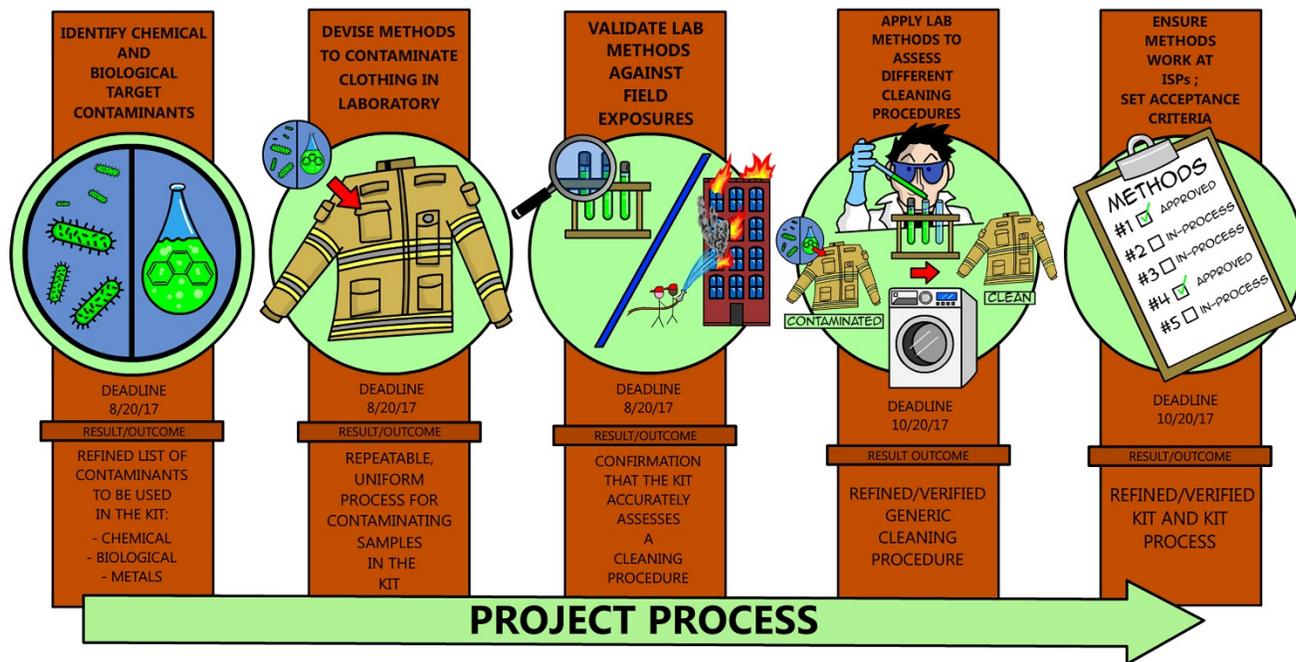
Project Inception and Research Team: The project was conceived in response to a standards development need identified by the NFPA 1851 Cleaning Task Group under the Technical Committee for Structural and Proximity Fire Fighting Protective Clothing and Equipment. As part of its 2019 revision effort for NFPA 1851, research support was sought to investigate the types of persistent contaminants found in turnout gear and to determine if current methods were effective for their removal. The Fire Protection Research Foundation (FPRF) initially established a small preliminary project to investigate contamination types and devise approaches for understanding how cleaning method efficacy could be determined. This work was performed by Intertek Testing Services and led to an interim report with preliminary recommended test procedures. In the course of this work, FPRF was provided a 3-year AFG Fire Prevention & Safety Grant from the U.S. Department of Homeland Security/ Federal Emergency Management Agency for developing comprehensive procedures to evaluate cleaning in removing both chemical and biological contaminants. As part of this larger effort, FPRF is leading a unique research team partnership that also includes the National Institute for Occupational Safety and Health (NIOSH), International Personal Protection (IPP), and selected Independent Service Providers (ISPs).



Research Goal and Objectives, and Conceptual Approach: The overall goal of this project is to improve fire fighter safety and health by reducing repeated exposure to harmful contaminants in unclean or inadequately cleaned PPE. There are two main tasks (each with multiple subtasks) that need to be completed in order to accomplish the goal of this study: (1) characterize fireground and emergency scene contamination leading to these exposures and develop the methodology for the consistent measurement of cleaning effectiveness; and

(2) determine implementable cleaning, decontamination, and disinfection strategies that effectively reduce fire fighter exposures to persistent contaminants.

The approach being taken in this project is illustrated below.



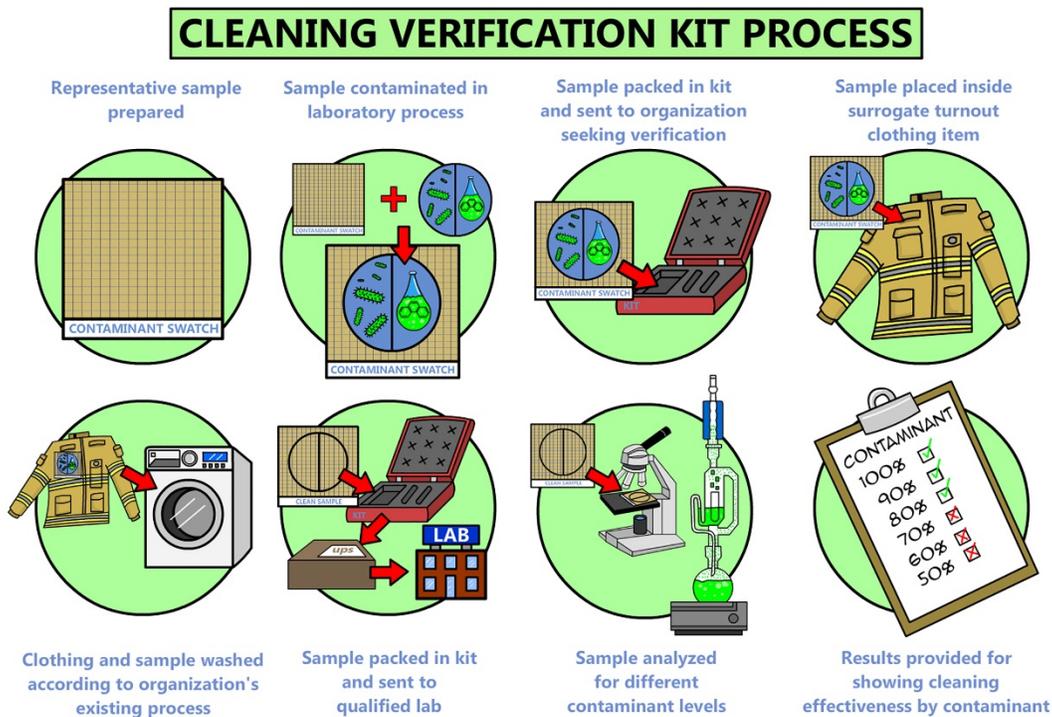
Project Phases and Tasks: This project involves the following four key phases of activity:

- 1) *Identify Contaminants:* Persistent chemical and biological contaminants present in fire fighter PPE are being identified, characterized, and confirmed using representative substances.
- 2) *Establish Soil and Chemical Contamination/Decontamination Procedures:* Specific procedures are being developed and validated to determine the effectiveness of laundering and other cleaning methods in removing specific soils and chemical contaminants.
- 3) *Establish Biological Contamination/Disinfection or Sanitization Procedures:* Similarly, related specific procedures are being defined and verified for assessing the effectiveness of laundering or disinfection/sanitization processes to remove/deactivate biologically-based contaminants.
- 4) *Draft Overall Fire Service Guidance:* Clear and definitive procedures are being prepared for the fire service industry (fire fighters, fire departments, clothing manufacturers, material suppliers, cleaning/care organizations, and cleaning agent or equipment manufacturers) to define appropriate and verified approaches for properly cleaning fire fighter protective clothing and equipment.

Key Project Output: One of the key outcomes of this project is the development of a portable, kit-like approach that enables the assessment of cleaning effectiveness for any type of cleaning or sanitizing process used to decontaminate turnout clothing (garments and hoods only).

The fundamental basis of the kit is turnout clothing samples that are contaminated in the laboratory in a manner replicating field exposure (surrogates). Using that basis, contaminated samples are placed in surrogate clothing (in pre-sewn pockets), then subjected to the cleaning or sanitizing process. The samples are returned to the kit and sent to a lab for analysis to determine the amount of contamination removed.

This approach, illustrated below, has been proposed as part of the cleaning verification process in NFPA 1851 with the recommendation that it be applied to Independent Service Providers (ISPs) to verify their cleaning procedures. This kit procedure is also expected to permit the assessment of different cleaning machine, agent, and process technologies.



The research team has now carried out research in a number of areas related to the assessment of contamination removal in turnout clothing. Highlights include:

- 1) Target contaminants have been defined that include various heavy metals, semi-volatile organic compounds, and bacteria that represent exposure threats to firefighters.
- 2) Specific procedures have been developed for contaminating turnout clothing samples in the laboratory that emulate levels of fireground chemical and biological exposures; these procedures have been shown to be repeatable and stable for use in the proposed cleaning verification kit process.
- 3) A number of cleaning verification kit process details have been established to promote a low cost evaluation approach using surrogate materials, clothing samples, and washing procedures to enable easy implementation.
- 4) A variety of experiments have been carried out providing initial findings for the effectiveness of certain wash conditions in removing both chemical and biological contaminants. The early emphasis has been on wash temperature and the type of detergent used in the wash process.

All research work for this project has been completed and the final project documentation will be available in 2019. This information will be made available to the NFPA 1851 Cleaning Task Group for consideration in the 2019 revision of the NFPA 1851 standard.

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