



# RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

## Enhanced Cleaning to Reduce Firefighter Exposure to Carcinogens

### PROJECT SUMMARY

Last Updated: 16 July 2019



#### **Background:**

Current NFPA 1851 advanced washing procedures remove 40% or less of potentially carcinogenic contaminants found in turnout gear after firefighting smoke exposure. After wash contaminants can migrate from turnout suits & transfer to skin; semi-volatile compounds can off-gas, exposing firefighters to low-level sustained doses of toxic vapors. Better cleaning methods, to extract residual smoke & fire ground contaminants, at reasonable cost & with less damage to gear, will reduce firefighter cancer risks.

#### **Implementation and Schedule:**

This project is led by North Carolina State University (NCSU) with collaborative support from the Fire Protection Research Foundation (FPRF). Funding for this project is through a three-year DHS/FEMA Assistance to Firefighters Grant (AFG) with a targeted completion date of September 2021. The Principal Investigator (PI) for this project is: Don Thompson, email: [dtomps1@ncsu.edu](mailto:dtomps1@ncsu.edu)



#### **Project Goal:**

This research will develop deep-cleaning methods to remove residual smoke and vapor carcinogens present in turnout material components after conventional washing.

#### **Project Methodology:**

This study involves the following tasks:

##### Task 1: Evaluation of Retired Gear for Accumulated Contaminants

Ten sets of retired structural turnout suits will be obtained from at least five fire departments around the U.S. The suits will be inspected for condition and wear, and they will be tested for residual contamination. Testing will include: Wiping shells and inner surface to identify potential transfer of contaminants; Assessment of off-gassing of swatches (3/uniform) at warm (32°C) and hot (80°C) temperature using modified permeation cells to sweep and recover semi-volatile organic compounds (PAHs, phthalates and phenols); Extraction of shell, moisture barrier and thermal liner swatches for analysis of contaminants; Extraction and chemical analysis will be performed using validated procedures

##### Task 2: Initial Evaluation of CO2 Dry Cleaning

Turnout suits will be repaired, and three suits from each department will be sent for CO2 cleaning and for advanced cleaning and decontamination at an Independent Service Provider (ISP). After cleaning,

*For more information, contact:*

Casey Grant, Fire Protection Research Foundation  
1 Batterymarch Park, Quincy, MA 02169-7471  
Telephone: +1.617.984.7284 Fax: +1.617.984.7010  
Email: [cgrant@nfpa.org](mailto:cgrant@nfpa.org)

the suits will be returned for extraction and analysis of areas adjacent to the swatches that were removed and repaired. The residual contaminants from each type of process will be compared.

Task 3: Laboratory Studies of Modified Advanced Cleaning and Decontamination

Procedures to achieve controlled, reproducible contamination of shell materials, moisture barrier, and thermal liners will be investigated. The best options identified for modifying advanced washing and decontamination will be selected for study. Other sets of contaminated materials will be sent for dry cleaning with CO<sub>2</sub>. Extraction and chemical analysis of specimens from contaminated swatches and contaminated/cleaned swatches will be used to determine the effectiveness of the cleaning procedures on a laboratory scale.

Task 4: Evaluation of Cleaning of Full Ensembles

Two types of turnout suits will be selected for contamination and cleaning experiments. Shells and composite moisture barrier/thermal liners will be dosed with the best procedure previously identified. Specimens will be removed from the contaminated elements and extracted for chemical analysis. Following repair, the suits will be sent for cleaning using current advanced cleaning and decontamination, by the best approach for modified advanced cleaning, and by CO<sub>2</sub> dry cleaning. Swatch samples taken from positions adjacent to the ones used for analyzing the contaminated gear will be extracted and chemically analyzed.

Task 5: Evaluation of Effects of Cleaning on the Turnout Clothing Materials

Advanced inspection methods called for by the NFPA 1851 Standard will be used to compare the effects of alternative washing and cleaning procedures with the current washing method. The focus will be on observing washing effects on visually observed physical damage (rips, tears, displacement of thermal liner insulation). A hydrostatic test will be used to qualify the impact of different laundering methods on the liquid integrity of the moisture barrier component of the turnout composite.

Task 6: Cost Analysis for Cleaning and Care

Develop a rough order of magnitude analysis of the capital and operational costs for modified advanced cleaning and decontamination and for CO<sub>2</sub> dry cleaning. Key considerations for each type of process will be documented and safety concerns will be identified.

Task 7: Project Technical Panel and Dissemination of Results

Final project deliverables will be reviewed with project advisory panel and broadly disseminated.

**Project Deliverables:**

The anticipated outcomes from this three-year effort are:

- 1) Provide fire service community with new hazard assessments for residual contaminants in smoke-exposed legacy gear
- 2) Identify next-generation cleaning procedures to remove more contaminants from turnout suits
- 3) Recommend procedures to relevant NFPA technical committees, fire departments, laundries, and ISPs