Smoke and Particulate Resistant Structural Turnout Ensemble

Reducing Firefighter Risk of Absorption of Fireground Toxicants and Carcinogens

In 2010, the World Health Organization's International Agency for Research on Cancer named the occupation of firefighting as possibly carcinogenic to humans. Their analyses of multiple studies concluded that firefighters experience a 50 percent increased risk of testicular cancer, a 30 percent elevated risk of prostate cancer and a 21 percent elevated risk of non-Hodgkin lymphoma, compared to the general population. Chronic exposures to toxic combustion products found in the fireground environment are believed to contribute significantly to the higher cancer occurrences in firefighters. When used during fire suppression and overhaul stages, the self-contained breathing apparatus (SCBA) protects the highly susceptible respiratory tract from toxic combustion products in smoke and soot. However, firefighters are still being exposed to hazardous vapors and particulates when smoke penetrates the interfaces in the turnout ensemble and deposits on the firefighter's skin.

Interfaces in Turnout Ensemble Designed to Limit Firefighter Exposure and Lessen Thermal Burden

North Carolina State University's (NC State) Textile Protection and Comfort Center (TPACC) and LION First Responder PPE, Inc., are collaborating to develop a structural turnout ensemble with enhanced protection from smoke and soot infiltration at the ensemble interfaces. Input and feedback from the Department of Homeland Security's First Responders Group will be used to support and guide the design and implementation of the new ensemble.

Two different approaches are being utilized in the development of this new system. The first approach focuses on using the existing moisture barrier with improved interfaces to provide the required level of protection with minimal change to the look or function of the existing turnout ensemble. In this approach, specific emphasis is placed upon improving the smoke resistance of the balaclava or hood.

The second approach, while also utilizing enhanced interface designs, will incorporate ventilation into the ensemble through staged protection configurations. The highest stage protection will have all vents sealed for fire suppression activities. The lower stage protection, intended for overhaul environments, will allow the firefighter to open vents in the ensemble to relieve thermal burden. Chemical and particulate filters to be placed in the vents are being developed to provide protection from the smoke and soot while the vents are in the open configuration.

Firefighter in overhaul environment with skin exposed to toxic combustion products (Photo: California Department of Forestry and Fire Protection [CalFire])

Prototypes developed from each approach will be evaluated as whole systems in the TPACC laboratories. The flashfire protection will be assessed using the PyroMan™ test manikin system and an instrumented physiological manikin will be used to determine the level of thermal burden for each prototype. TPACC's Man-In-Simulant-Test (MIST) facility will be critical to identifying which interfaces allow the most inward leakage as well as showing which prototype provides the best vapor/particulate protection overall. The final prototype will be submitted for certification to the NFPA 1971 requirements and appropriate requirements from NFPA 1994.

Daily Impacting the Well-Being of Firefighters

This project will be complete in early 2017 with the goal of providing firefighters with a turnout ensemble with inherent resistance to smoke and other particulates without the need to don additional equipment. Following NFPA certification, the prototype will be transitioned into a commercial product available from LION First Responder PPE, Inc.

By reducing the potential for chronic dermal exposures to toxic fireground compounds, this ensemble and the technologies developed during this research will help to improve the well-being and safety of firefighters.

To learn more about the Smoke and Particulate Resistant Structural Turnout Ensemble, contact SandTFRG@hq.dhs.gov.

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