

# Smoke and Particulate Resistant Structural Turnout Ensemble

## Reducing Firefighter Risk of Absorbing 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 and particulate matter 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 exposed to hazardous vapors and particulates when smoke penetrates interfaces in the turnout ensemble and deposits on the skin.

The firefighter community brought this critical safety issue to the attention of the Department of Homeland Security (DHS) Science and Technology Directorate (S&T). S&T responded by developing requirements for a project to address this issue and working with the research and development community and industry to create a solution.

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

S&T collaborated with North Carolina State University's (NC State) Textile Protection and Comfort Center (TPACC) and LION First Responder PPE, Inc. (LION) to develop a structural turnout ensemble with enhanced protection from smoke and soot infiltration at the ensemble interfaces. Input and feedback from S&T's First Responder Resource Group was used to support and guide the design and implementation of the new ensemble.

Two different approaches were used 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 gear.



Firefighter in overhaul environment with skin exposed to toxic combustion products (Photo: CalFire)

In this approach, specific emphasis was placed on improving the smoke resistance of the turnout gear with smoke impermeable fabrics at the wrists, ankles and in an internal skirt structure in the coat that prevents smoke from entering. These improvements can be retrofitted into any manufacturers' existing turnout gear.

The second approach, while also using the enhanced interface designs, incorporates a removable bib onto the turnout pants to prevent smoke from reaching the firefighter's skin. The ensemble in this approach includes the improved wristlet and calf protection, but no internal particulate skirt is included in the turnout coat.

Laboratory tests, including tests to determine vapor infiltration and fluorescent particle tests, were critical to demonstrating that both approaches prevent smoke and particulates from reaching the firefighter's skin, protecting them from hazardous vapors and materials. In addition, testing using TPACC's PyroMan® and physiological manikins proved the new approaches offer improved flashfire protection and similar comfort level when compared to standard turnout gear. The final prototypes have been NFPA 1971 certified.

## Improving the Well-Being of Firefighters

This project ended in late 2017. The resulting turnout ensemble features inherent resistance to smoke and other particulates without the need to don additional equipment. These turnouts are now available for agencies to purchase via LION PPE.

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

