Researchers develop new test method to measure stored heat in firefighter suits

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For decades, researchers have evaluated the thermal performance of protective clothing worn by firefighters. A particular area of current interest is how to address the burns received by firefighters when they are not directly in contact with fire - called stored heat burns. Researchers at North Carolina State University have developed a testing apparatus and measurement protocol that allow firefighter suits to be evaluated for their ability to prevent and minimize stored heat burns.

"You can compare the burn to when you sit close to a fireplace, and then press down on your jeans and you can feel the heat," says Dr. Roger Barker, professor of textile engineering chemistry and science, and director of the Textile Protection and Comfort Center (T-PACC). "Firefighters are getting burns without ever coming in direct contact with the flames. It is a serious issue."

Barker and his colleagues were contacted to develop and evaluate this new test method for stored heat measurement in a two-phase study. During the first phase, sponsored by the National Institute for Occupational Safety and Health, Barker and his team developed a laboratory testing apparatus to conduct the "stored energy test" which measures transferred and discharged heat in turnout suit materials. The second phase, sponsored by the National Fire Protection Research Foundation, involved using that apparatus to test a variety of firefighter suits and develop a database that will facilitate a new national standard that firefighter suits are measured against and certified.

All firefighter turnout suits are made of three layers - an outer shell, moisture barrier and thermal liner. There are many different combinations of fabrics and barriers used, and reinforcements and reflective trim are attached to the outer shell. Regardless of the combination of materials used, suits must go through a battery of tests to meet the standard set by the National Fire Protection Association, or NFPA.

"One of the major objectives of our study was to better understand the role moisture - mostly the sweat from firefighters - plays in transferred and stored heat burns," Barker says. "When moisture accumulates in the turnout suit materials, it has a big effect on the thermal properties of those materials and changes its heat capacity and thermal conductivity. These changes affect its thermal protective insulation and ability to store thermal energy.

"The stored energy test protocol we developed includes having suit test materials pre-conditioned with moisture - similar to the sweat of a firefighter - in order to determine the effect on transferred and stored heat," Barker adds.

Throughout the development process, various stakeholders - including firefighters, suit manufacturers and members of the NFPA - provided feedback and input to NC State's researchers in order to develop a protocol that met the needs of the firefighters, while understanding the challenges and limitations of the manufacturing process. The NFPA is currently reviewing the protocol supplied by NC State's College of Textiles, and will consider adopting this test method as part of the requirements that manufacturers will need their suits to meet in order to have their suits certified as complying with the NFPA standard.

"We know there is no lab test that measures with absolute accuracy what a firefighter encounters, because every fire is a different set of

conditions and thermal threats," Barker says. "However, we now have a better understanding of the general causes and mechanisms behind transferred and stored heat, and a test method to measure these effects. This research and recommended testing protocol is a major development that could significantly improve the health and safety for firefighters everywhere."

Source: North Carolina State University (news : web)