

Balancing protection and comfort



In the days of PVC leggings, cardboard helmets and wool jackets, not a great deal of consideration was given to comfort levels and their effect on firefighter efficiency. Huge investment has changed this, says **WL Gore & Associates**

DRAMATIC ADVANCES IN THE development of PPE for firefighters over the last 15 years have resulted in frontline staff being protected by clothing and equipment that is the result of heavy investment in research and technology.

Today's firefighter wears clothing that has been tested for flame protection in the lab, and designed for maximum comfort and efficiency. At WL Gore & Associates there is a real understanding of how structural fire kit has to deliver comfort and protection, taking into account all the situations the firefighter will encounter. Gore manufactures the famous waterproof, breathable Gore-Tex and Crosstech fabrics used in most firefighter assemblies worldwide. The company doesn't actually make the clothing, but its team is comprised of some of the best technical experts for troubleshooting issues around structural PPE.

Fire and Rescue services that buy PPE with a Gore membrane benefit from a support service that will work closely with them to solve any PPE issues, irrespective of the fact that it may not be related to the waterproof membrane.

HEAT BUILD-UP

One UK brigade recently implemented a major review of their PPE that resulted in a completely new 'top to toe' solution for its firefighters. However after a few months, some staff complained that the new PPE was not as comfortable as the previous assembly and that they were experiencing 'heat build-up'. Analysis of feedback showed that this occurred in non-firefighting activity such as drilling and training, with no perceivable difference when fighting a fire.

The brigade had changed its clothing to a shorter tunic with higher trousers. The new assembly incorporated lightweight fabrics and a waterproof membrane, although an additional layer of thermal insulation had been incorporated into the trousers.

After spending some time with the

brigade analysing feedback, Gore developed a programme to measure comfort levels and analyse the possible causes for the differences in the new kit.

The research was based on three levels. The first was a physical analysis of the fabrics using a skin model to ISO 11092 and EN 31092 standards. The second was a biophysical analysis using a moving mannequin. The third involved controlled wearer tests

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with the subject in a climatic chamber.

Dave Frodsham, fire product specialist for Gore in the UK led the project. He says: “What we wanted to do was characterise each garment style and establish how much of a difference garment characterisation would make in real life situations. The more breathable the garment, the less build up of heat should occur, so every facet of the garment design that would affect breathability, including reflective strips, pockets and neoprene cuffs, was examined and measured for its impact.

“Before we started the garment test it was clear that sizing of the new kit had a significant impact and was absolutely critical. In some cases firefighters were wearing the incorrect size of garment.”

In the first test using the skin model, which measured breathability and thermal resistance (insulation), the most significant difference

was in the overtrouser, where the new style incorporated a thermal barrier, reducing the ability for the system to lose body heat.

GARMENT VENTILATION

Once applied to a thermal mannequin, the tests were able to analyse the impact of the air layers between the fabrics as well as garment ventilation. At this stage a full garment breakdown was undertaken to analyse every textile layer covering the firefighter's body. This process took account of pockets, overlaps, non-breathable wicking barriers and reflective strips. The test showed that when compared to the previous kit, the new garments had a reduced non-breathable area, shorter jacket, increased overlap at the torso and less heat loss as a result of the increased insulation in the trouser.

The final stage of the process used human wearer trials to analyse the effects of ventilation on the subject. This identified considerable differences in ventilation depending on the activity being undertaken by the wearer. The old style longer tunic was found to create a 'bellows effect' when walking or running, which increased ventilation in a way not possible with the new shorter jacket. However, when fighting a fire with a belt or BA kit tied around the tunic this negated the bellows action.

“There are many factors that can affect comfort of firefighter PPE,” says Frodsham; “from the most obvious structural influences, such as extra layers of insulation, to the less obvious impact of design. In this case, what our research showed clearly was that there was a perceivable difference in two styles of PPE, but not on the fireground.

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