



PROTECTIVE CLOTHING OF DUPONT NOMEX® AND HEAT STRESS

What You Should Know

It's a fact that for maximum protection against fires, your body must be covered as completely as possible with flame-resistant protective clothing. This requires long pants and long sleeves, and can lead to hot work in warm and humid climates. Understandably, there is some concern among industrial workers about potential heat stress when wearing protective apparel.

Comfort Factors

In general, we think of temperature as the main factor in determining our comfort. However, there are actually three factors that affect thermal comfort:

1. External conditions, which include temperature, humidity and wind
2. Weight of garment and type of clothing
3. Type and level of activity

Work, Heat and Comfort

Any activity causes our bodies to generate heat. This heat must be lost or dissipated through our skin and clothing for the body to maintain its proper temperature balance. If the body cannot lose all the heat it is building up, then heat stress will occur. There are two primary ways our bodies lose heat:

1. Dry heat transfer— when the surrounding temperature is lower than that of our skin. Since our internal body temperature is over 90°, dry heat transfer takes place most of the time.

2. Evaporative heat transfer—sweating and sweat evaporation. Sweating leaves a layer of moisture on our skin surface; when this water evaporates, our body is cooled. The balance between the heat our bodies create by activity and the heat that is lost through dry and evaporative heat transfer determines how hot or cool we feel. Figure 1 demonstrates this relationship. Note that we will feel warm or hot long before heat stress occurs. Heat stress occurs only when the body is unable to lose all of the heat it is generating.

Testing NOMEX® III and Other Materials*

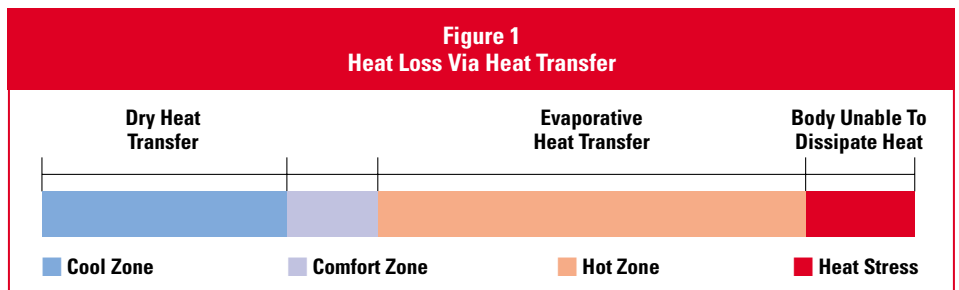
Various everyday and flame-resistant protective fabrics were evaluated for their ability to dissipate heat using the sweating hot plate test in an environmentally controlled chamber at an independent laboratory.** This is the state-of-the-art laboratory test for simulating how our bodies lose heat through dry and evaporative heat transfer. The test indicates the levels of activity that would produce feelings of comfort, discomfort and heat stress for each material. Different weights of NOMEX® III fabrics were compared to

various weights of other everyday and protective clothing materials.

Figure 2 shows the results of this test under moderate conditions (70° F at 65% relative humidity). Figure 3 shows the same test under severe conditions (90° F at 90% relative humidity). Note that these conditions are a simulation and are too severe to be encountered in most work situations. For example, on the Gulf Coast of the U.S., summer temperatures are typically in the mid-90s, but humidity seldom exceeds 65% at those temperatures.

Test Results

Figure 2 indicates that all fabrics tested are likely to be comfortable at moderate to heavy activity levels under standard temperature and humidity conditions. In addition, heat stress is very unlikely



with any of the fabrics tested here, due to the extremely high metabolic activity level required to induce heat stress under these conditions.

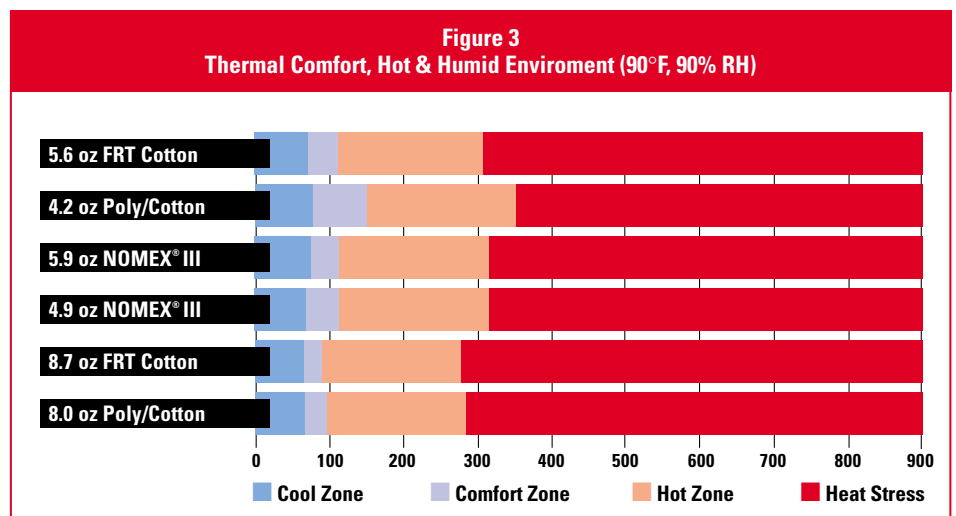
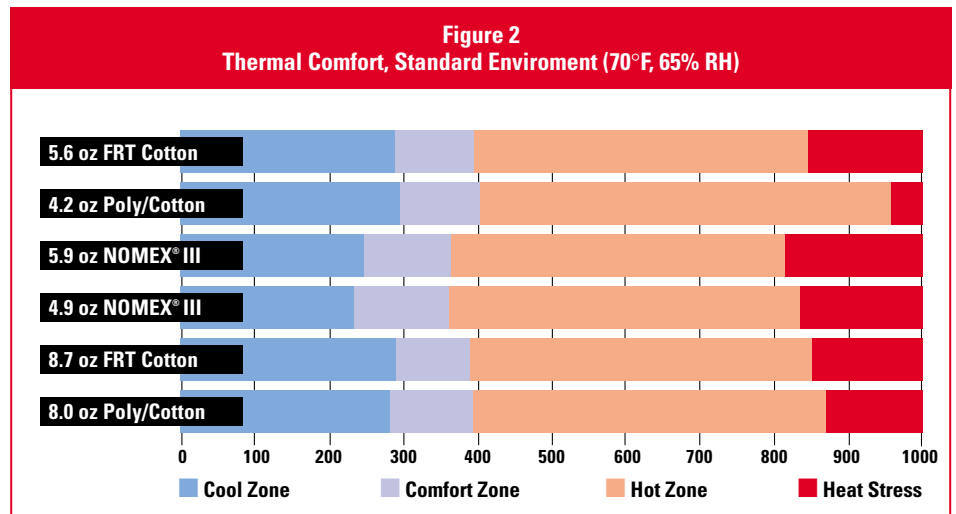
Figure 3 shows that all of the fabrics tested will feel hot once the wearer exceeds light activity levels in a hot, humid environment. But even at moderate activity levels, all of these fabrics still permit sufficient heat transfer to prevent heat stress.

At heavy activity levels under severe weather conditions, the amount of heat generated can exceed the total heat loss through all of the fabrics tested. Extended work under these conditions can cause heat stress, regardless of the type of fabric worn. These test results show, however, that heavier fabrics make heat stress more likely. Therefore, as shown in Figure 3, a garment of flame-retardant-treated (FRT) cotton or a polyester/cotton blend that weighs eight to nine ounces per square yard would cause heat stress sooner than a NOMEX® III garment that weighs only 5.9 ounces per square yard.

Conclusion

These laboratory test conditions predict that garments of NOMEX® III have no more, and sometimes less, potential to cause heat stress than other everyday or protective fabrics. This is because fabrics of NOMEX® III generally weigh less than other everyday or protective fabrics. Heat, humidity and activity level are the primary factors contributing to comfort and heat stress, rather than the type of fabric worn. Fabric weight has more influence than fabric type in determining when and if heat stress occurs in hot, humid environments.

This research indicates that you can enjoy the superior protection and long wear life of protective clothing made of NOMEX® III without undue



Fabric weights listed are actual measured weights of commercial fabrics.

The following activities provide examples of various metabolic rates in Watts/M²: standing: 70, walking at 3 MPH:

180, tennis: 260, heavy labor: 320/440, wrestling: 500.

Data from Fanger, P.O., "Thermal Comfort"; McGraw Hill, New York, 24026, (1970)

concern about the effects of heat and heat stress.

The lighter weight of NOMEX® III fabrics makes them less likely to cause heat stress in hot, humid environments than other heavier fabrics.

*In general, the comfort limits measured by this type of testing should be used only for relative comparisons between fabrics and not as absolute predictors. In actual garments on humans, dry and evaporative heat losses are likely to be lower due to the presence of air layers between the body and the garment, and the presence of additional layers of clothing such as underwear.

**Fabric characterization was done at North Carolina State University.

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