

Flame-Resistant Garments: Certification, Availability, and Limitations



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Presentation at
NFPA Dust Explosion Symposium
September 20-21, 2011

NFPA 2112 Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire

- **Scope.** The standard shall specify the minimum performance requirements and test methods for flame-resistant fabrics and components and the design and certification requirements for garments for use in areas at risk from flash fires.
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NFPA 2113 Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire

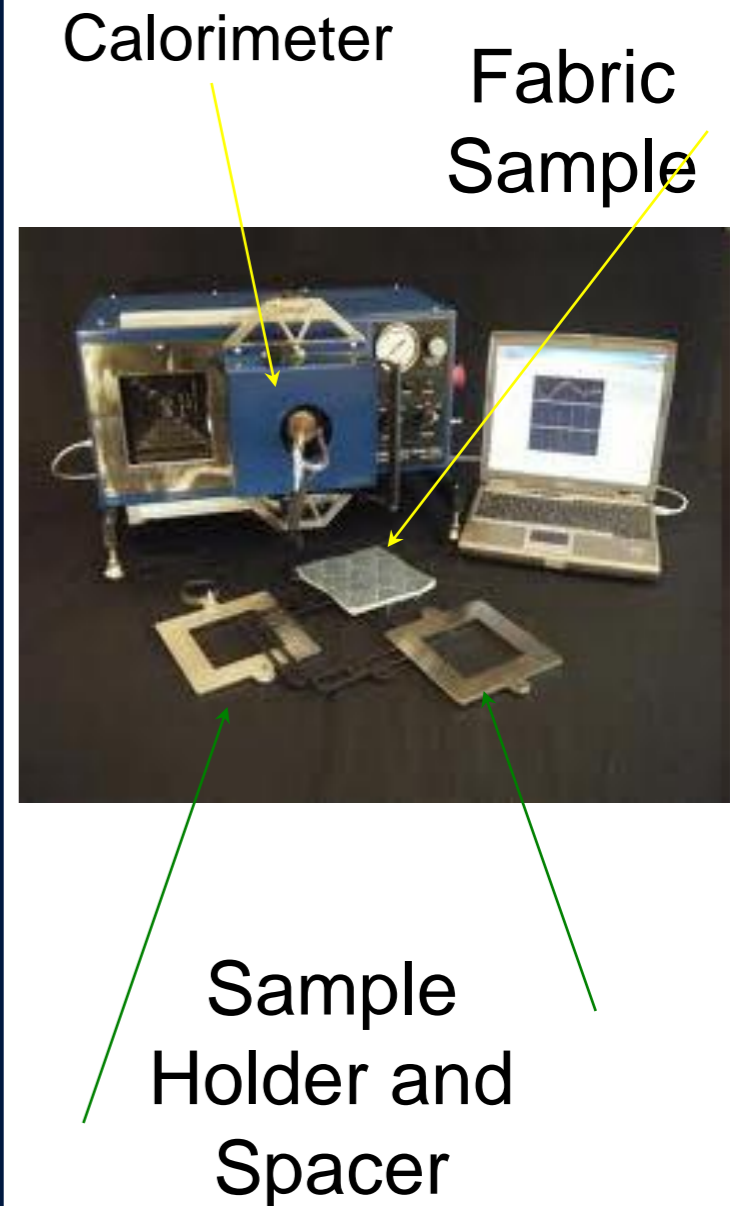
Scope: specify the minimum selection, care, use, and maintenance requirements for flame-resistant garments that are compliant with NFPA 2112

NFPA 2112 Requirements for Flame Resistant Garments

- Thermal Protective Performance Test on Fabric Sample including multiple Layers
- Flame Resistance Test on Fabric Layer Samples
- Manikin Simulated Flash Fire Exposure Test on Garment

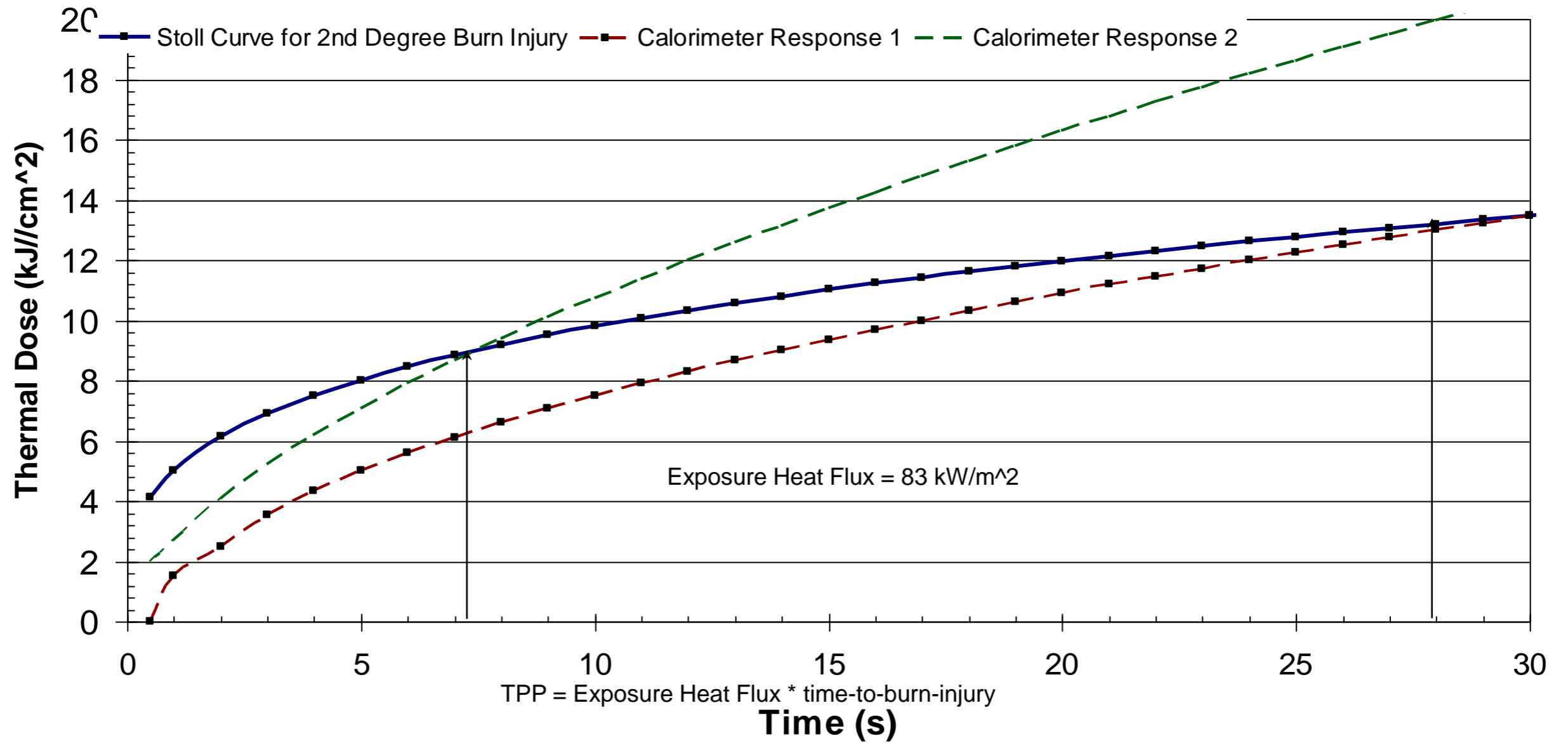
Thermal Protective Performance Test

- Objective: Determine exposure time and thermal dose (TPP rating) for a heat flux of 83kW/m^2 applied to the outer surface of the fabric to cause second degree burn injury. During exposure a data collection sensor, positioned above the innermost surface of the test sample, measures the heat energy transmitted through the fabric.
- Test method requires a combination of convective and radiative heat flux be applied for 30 seconds and thermal dose (transmitted energy per unit area) at skin location be measured
- Pass criterion is a maximum thermal dose of 25 kJ/m^2 (6 cal/cm^2) for spacing of $\frac{1}{4}$ inch and 12 kJ/m^2 (3 cal/cm^2) at contact surface



NFPA 2112 TPP Rating Determination

Thermal Dose versus Time



ASTM D 6413

Test Method for Flame Resistance of Textiles (Vertical Test)



7.6 cm wide x 30.5 cm high (3 in. x 12 in.) rectangle samples tested before and after 100 cycles of washing and drying

- Pass criteria: max char length of 10 cm
- After-flame of not more than 2 seconds
- Fabric shall not melt and drip

ASTM F 1930

Test Method for Evaluation of Flame Resistant Clothing for Protective Garments Flash Fire Simulation Using an Instrumented Manikin



Requires
manikin
instrumented
with numerous
thermocouples
on various
parts of body

The manikin shall be dressed in 150 g/m^2 (4.5 oz/yd^2) (± 5 percent), jersey knit, 100 percent cotton underwear briefs and short-sleeve crew-neck T-shirts before the garment specimen is placed on the manikin.

ASTM F 1930 Exposure Fire in Manikin Test

- Uses an exposure fire heat flux of 84 kW/m^2 ($2.02 \text{ cal/cm}^2\text{-sec}$) with an exposure time of 3 seconds.

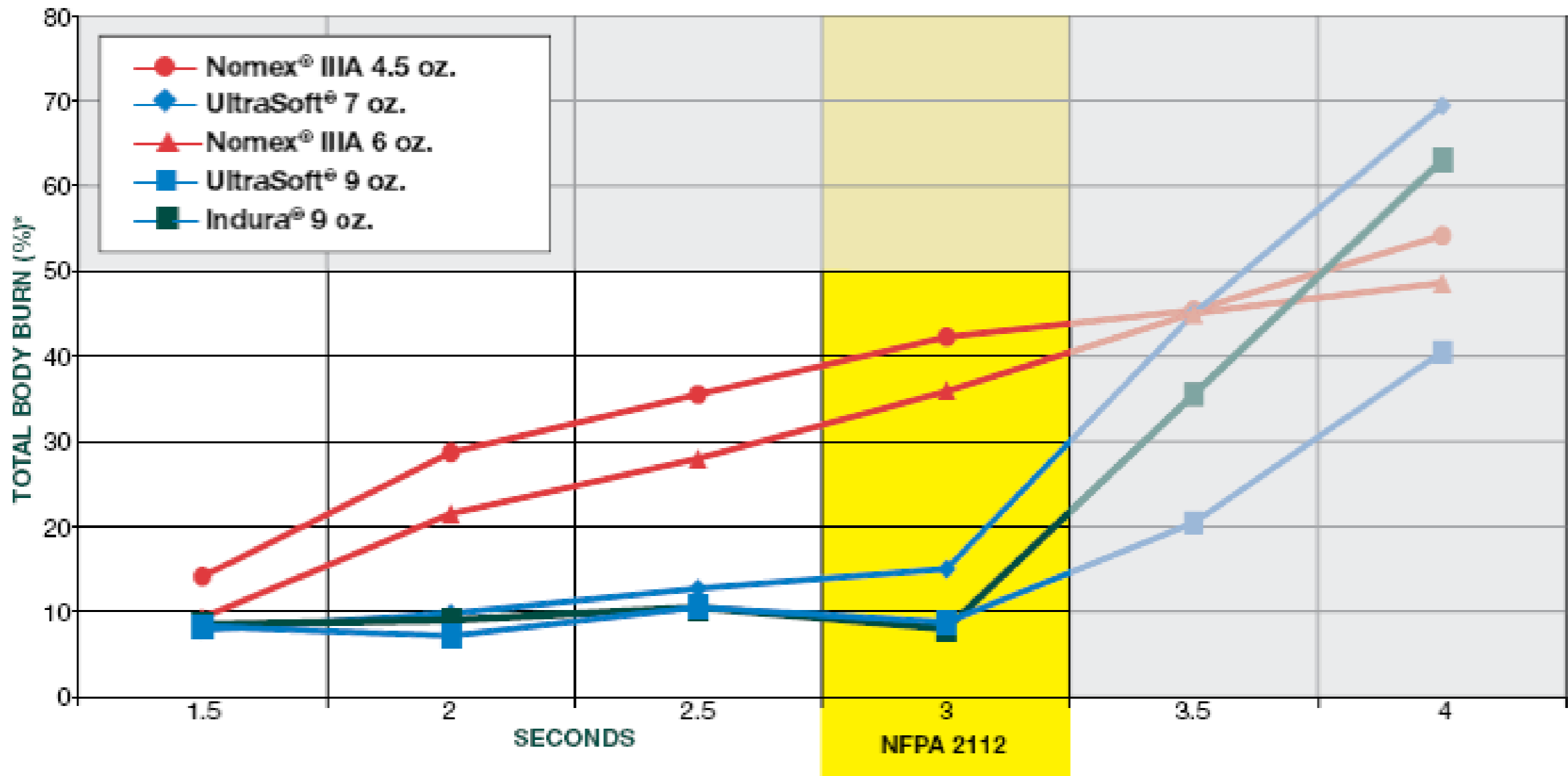


F 1930 Manikin Test Results Required by NFPA 2112

- **8.5.5.1** The percent total body burn for each of 3 specimens shall be reported as the body burn rating.
- **8.5.5.2** The average predicted body burn rating of all specimens shall be calculated and reported.
- Specimen garments shall be tested for overall flash fire exposure shall have an average predicted body burn rating of not more than 50. (for 3 second exposure)

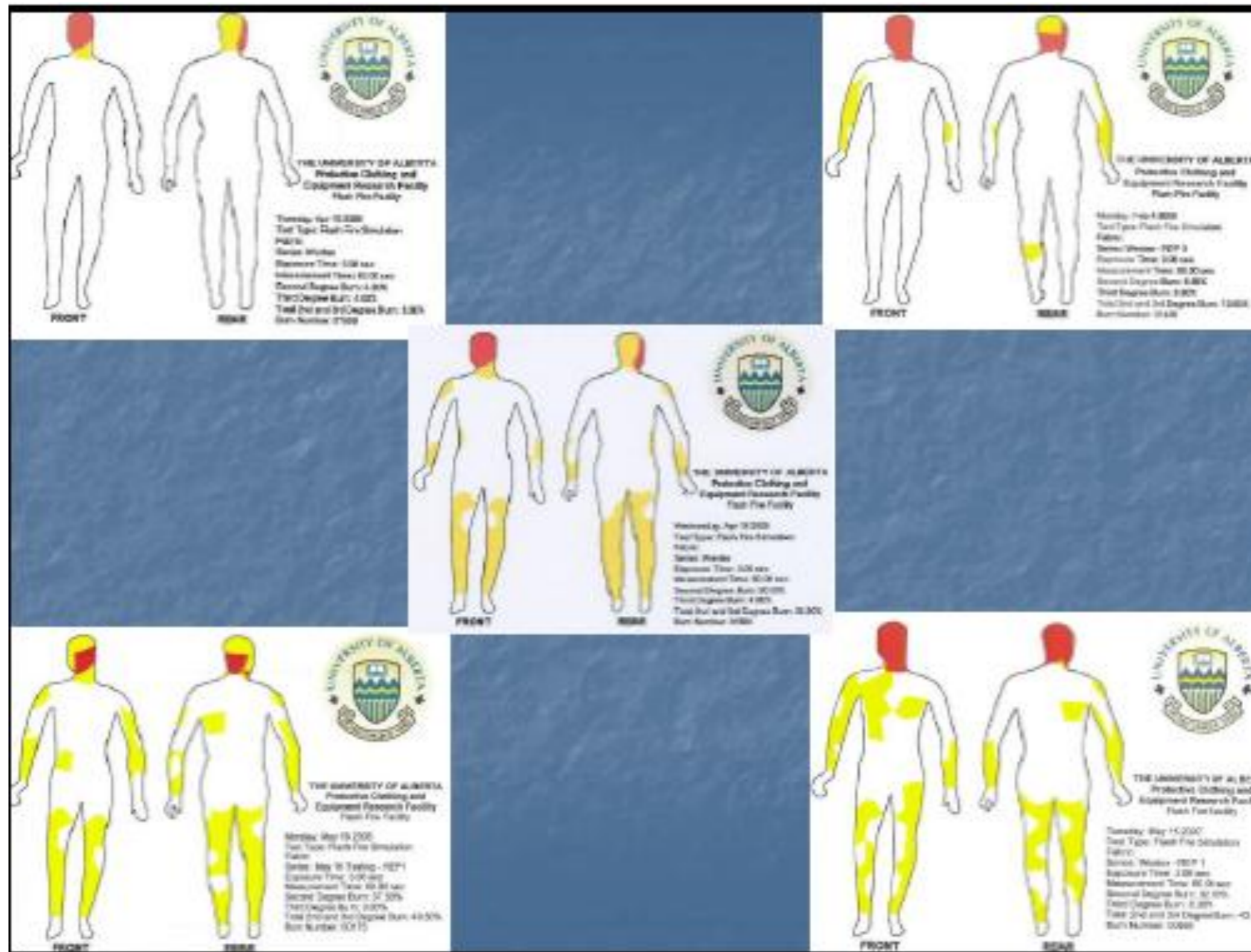
Example of NFPA 2112 Manikin Flash Fire Test Results for Different Single Layer Fabrics

From Westex Web Site



*Note: 88% is the maximum possible since the hands and feet are excluded. All figures include 7% for the head.

Illustrated Examples of Manikin 2nd and 3rd Degree Burn Injury Measurements with Flame Resistant Garments



Limitations of NFPA 2112

- Allows second degree burn injury on as much as 50% of body from 3 second duration flash fire
- Does not account for longer duration dust flash fires or secondary fires
- Does not account for possibly higher heat fluxes associated with combustible metal flash fires
- Does not account for combustible dust deposited on garment since last cleaning and inspection

NFPA 2113: Examples of Requirements

- Conduct workplace flash fire hazard assessment
- Consider thermal protective characteristics of the fabric over a range of thermal exposures (e.g., to evaluate the effect of delayed egress)
- Garments shall be selected that offer minimal interference and minimal hindrance to perform the work task required in the fire hazard zone.
- **5.1.2** Organizations shall instruct workers in the limitations, use, care, and maintenance of flame-resistant garments.
- **6.1.4** Flame-resistant garments shall be laundered or dry-cleaned with such frequency so as to prevent buildup of contaminants that reduce flame resistance.
- Flame-resistant garments contaminated by flammable substances,...shall be cleaned and decontaminated in accordance with manufacturer instructions.

Other combustible dust flash fire PPE issues

- Need for head and hand thermal protection
- Do respirators provide any protection for burning dust?
- Dust cloud obscures visibility and makes egress extremely difficult
- Cold climate unheated and outdoor facilities create need for non flame resistant outer garments

NFPA 2112 and 2113 Committee currently seeking new members in the *user* category. Can you contribute by discussing these issues with the Committee?