CGSB 155.20

2017 Updates

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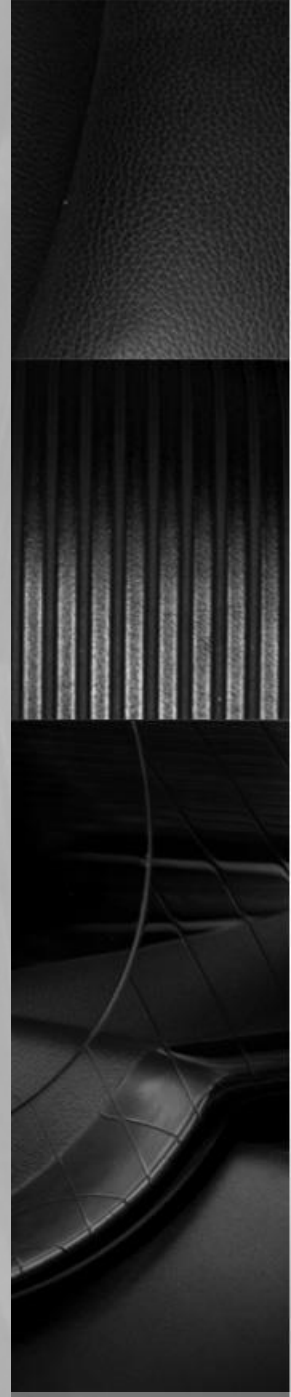


Introduction

1. Changes in requirements, test methods & classifications
2. Steam & hot fluid test methods & requirements

Classifications

2000

- Type 1
  - Single layer garments
- Type 2
  - Multilayer garments
- Type 3
  - Disposables

2017

- FR workwear
- FR rainwear
- FR limited use
- Hot fluid protection

Basic Tests

2000

- Flammability
- TPP
- Heat resistance & thermal shrinkage

2017

- Flammability
- TPP
- Heat resistance & thermal shrinkage
- Manikin
- Leak resistance/waterproofness
- Steam & hot fluid

Flammability

UNCHANGED

- 100 mm maximum damaged length remains the same
- 2 second maximum afterflame
- FR workwear tested as received and after 50 cycles of laundering

CHANGED

- CGSB 27.10 -> ASTM D6413
  - Concerns over consistency & infrequent updates
  - Consistency concerns backed up by round robin
- Insulated tested with shell fabric and folded edge
- Component testing clarified
  - Visibility trim, exterior garment components
- Laundering (NFPA 2112 method); can be tested after more than 50 cycles of laundering

TPP

UNCHANGED

- Test method
- Minimum average TPP of 6 cal/cm² for spaced test
- No individual TPP value less than 5.5 cal/cm²

CHANGED

- Contact test no longer required
- Test is now required for rainwear fabrics
- Not reported on label

Heat Resistance & Thermal Shrinkage

UNCHANGED

- Parameters – oven setup, oven temperature (260°C), test duration (5 minutes)

CHANGED

- Specimen size
- Maximum shrinkage 10% for all materials
- Thread requirements now in Heat Resistance section with updated test method (ASTM D7138)

Manikin Testing

- ASTM F1930
- Similar to NFPA 2112
- Maximum predicted burn injury of 40%
- All items tested on manikin – FR workwear (standard), FR rainwear (as sold and standard)

Waterproofness & Leak Resistance

- New test methods for rainwear
- Fabric tested to ASTM D3393 at 207 kPa
- Seams tested to AATCC 127 at 20.7 kPa
- Aligns with ASTM F2733

Labels

- Legibility requirements clarified
- Must remain legible after 50 cycles of laundering or one cycle of dry cleaning

Steam & Hot Fluid

- Small-scale steam test
  - No predicted burn injury within 60 seconds
  - Maximum 200 kJ/m² absorbed energy
- Small-scale hot fluid test
  - No predicted burn injury within 60 seconds
  - Maximum 100 kJ/m² absorbed energy
- Manikin steam & hot fluid tests
  - Maximum 20% body burn

Steam & Hot Fluid

- Four new tests to assess protection garments and fabrics offer from burns caused by hot water and steam
  - Small scale hot water splash
  - Small scale steam exposure
  - Manikin hot water test
  - Manikin steam test

Small Scale: Hot Water Splash

- Provides a basic measure of how well a material, or material system, can insulate against heat transfer from hot water
- Material, or material system, specimen placed between hot water stream and sensor to measure transferred energy
- Energy transfer used to predict burn injury using a computer model of human skin
  - The same manner in which burn injury is calculated in flash fire manikin tests
- Primary reported results are predicted time to 2nd degree burn and absorbed energy during test

Small Scale: Hot Water Splash

Exposure

- Water delivered from a simple spout consisting of a downward pointing tube with 12.7 mm outer diameter and 0.9 mm wall thickness
- Spout is positioned directly above a single heat flux sensor
  - Spout should be 75 mm above specimen
- Water supplied from a temperature controlled recirculating bath
- Water temperature in the bath is 85°C
- Flow rate set so that 1L of water is delivered over a 10 second exposure
  - Exposure duration selected for consistency with other test methods, and has been shown to provide differentiation between protective fabrics

Small Scale: Hot Water Splash

Specimens

- 200 mm x 200 mm (8 in. x 8in.) material or material system
- Placed directly on top of sensor and sensor holder
- Restraint used on top of the specimen and under the spout assembly
  - Also serves to ensure consistent spacing between the spout and the specimen
- Specimen, sensor, and sensor platform are inclined slightly (6°)
  - This provides more consistent pooling behaviour on the specimen

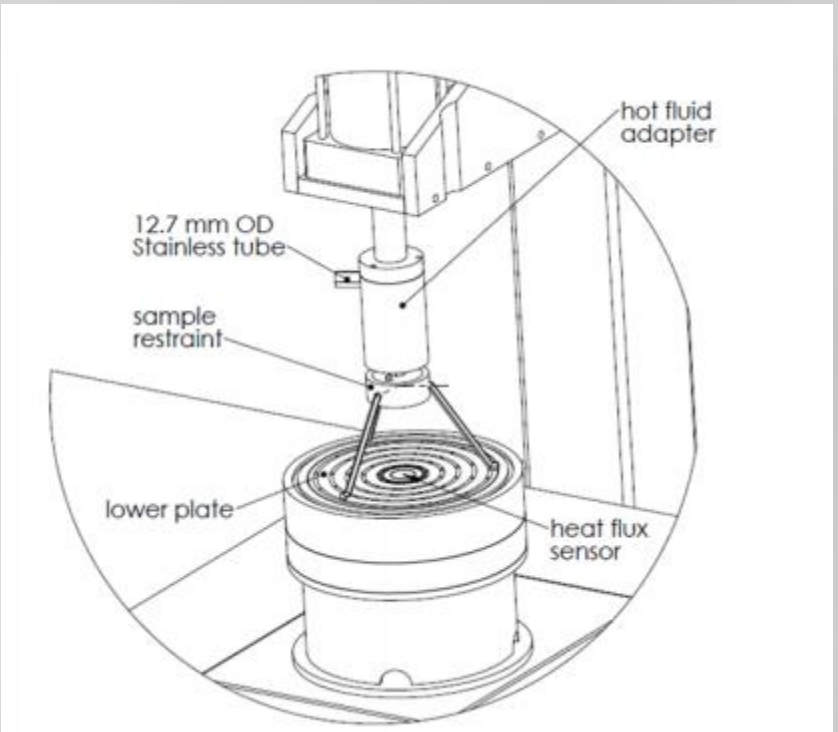
Small Scale: Hot Water Splash

Sensor

- Skin simulant sensor with thermal inertia of 2.2 $kJ^2/(m^4\ K^2\ s)$
  - Keeps surface temperature increase of sensor close to skin
- 20 mm diameter, at least 20 mm deep
- Starting temperature of 30°C

$$Q(t) = \sqrt{\frac{k\rho C}{\pi}}\left[\frac{1}{2}\int_{o}^{t}\frac{T_s(t)-T_s(\tau)}{(t-\tau)^{3/2}}\,d\tau + \frac{T_s(t)-T_i}{t^{(1/2)}}\right]$$

Small Scale: Hot Water Splash



Small Scale: Steam

- Provides a basic measure of how well a material, or material system, can insulate against heat transfer from steam
- Material, or material system, specimen placed between steam jet and sensor to measure transferred energy
- Energy transfer used to predict burn injury using a computer model of human skin
- Primary reported results are predicted time to 2^{nd} degree burn and absorbed energy during test

Small Scale: Steam

Exposure

- Delivered through a simple nozzle consisting of a downward pointing tube with 6.35 mm outside diameter and 4.6 mm inside diameter
- Nozzle positioned directly above heat flux sensor
  - Nozzle should be 50 mm above specimen
- Steam sourced from a generator and droplet separator
  - Maintains temperature to ensure steam is dry
- Steam stored in separator at 207 kPa (30 psi) and 150°C
- Exposure for 10 seconds directly from droplet separator
  - 30 psi and 10-second exposures provided best repeatability during method development

Small Scale: Steam

Specimens

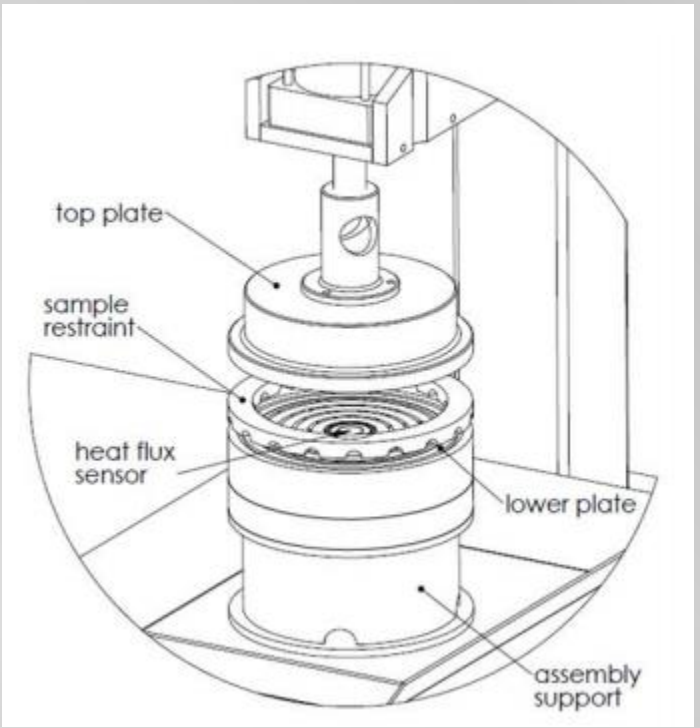
- 200 mm x 200 mm (8 in. x 8in.) material or material system
- Placed directly on top of sensor and sensor holder
- Restraining ring placed over specimen
- Lid attached to nozzle closed over restraining ring
  - Provides consistent post-exposure environment and nozzle potisitioning
- Specimen, sensor, and sensor platform are horizontal

Small Scale: Steam

Sensor

- Same sensor used in water test
- Skin simulant sensor with thermal inertia of 2.2 $kJ^2/(m^4\ K^2\ s)$
  - Keeps surface temperature increase of sensor close to skin
- 20 mm diameter, at least 20 mm deep
- Starting temperature of 30°C

Small Scale: Steam



Manikin: Hot Water

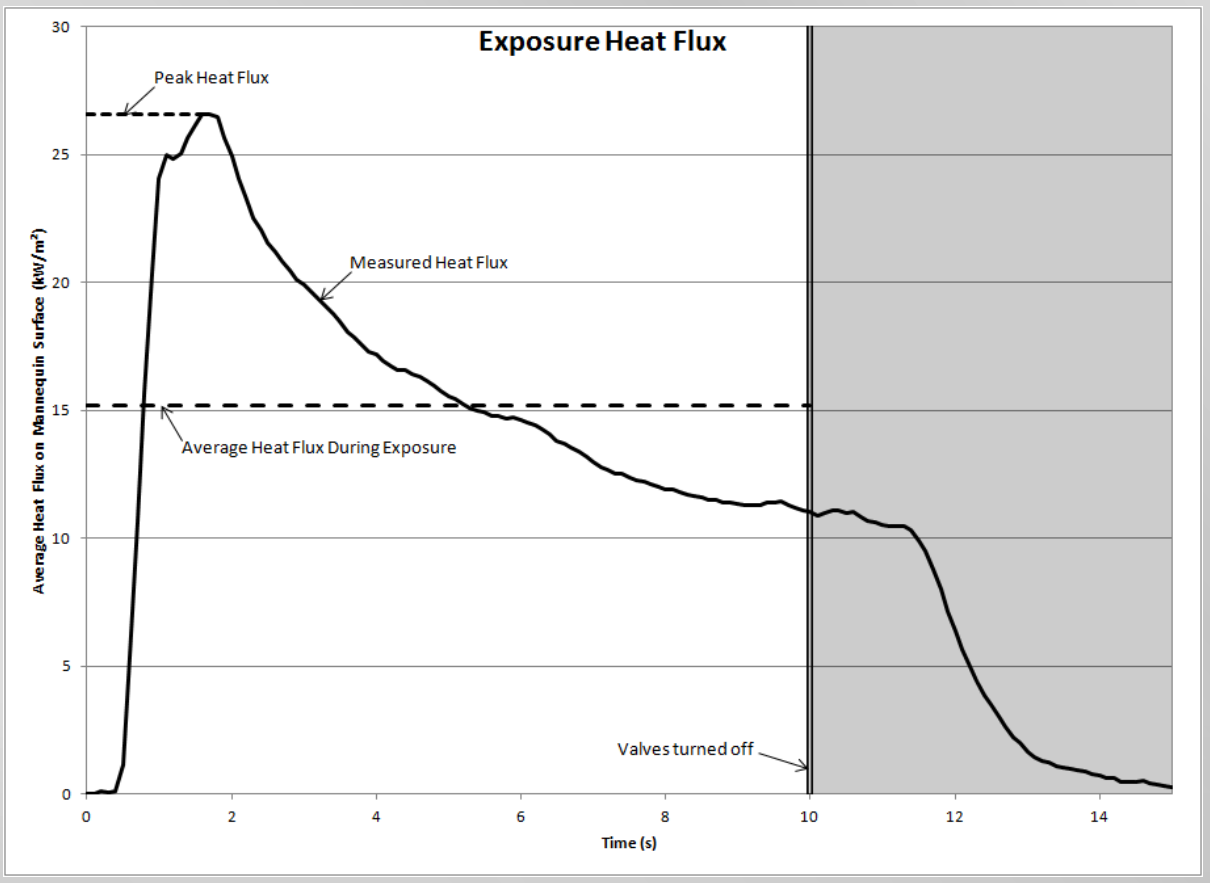
- Provides an evaluation of the effectiveness of material for protection from hot water hazards when used in construction of a particular garment
- Allows for assessment of performance of closures, seams, and interfaces
- A manikin is dressed garments to be tested and exposed to water jets from four angles
- Energy transfer to the surface of the manikin is used to determine the extent of predicted burn injury

Manikin: Hot Water

Exposure

- Water delivered through (at least) 12 nozzles with spray angle between 15° and 30°
- Nozzles aimed over the torso of the manikin to allow overlap of the spray areas and coverage over the manikin surface
- Water supplied to the nozzles at sufficient pressure to deliver 20L of water in a period of 10 seconds
- Average heat flux over the surface of the manikin during an exposure with no garment should be near 15 kW/m^2 with an initial peak near 27 kW/m^2

Manikin: Hot Water



Manikin: Hot Water

Specimens

- Hot water manikin tests are performed on “as sold” garments
- Size 42R or equivalent

Manikin: Hot Water

Sensors

- 110 skin simulant sensors, the same type used in small scale steam and hot water testing, are mounted over the surface of the manikin
- Each sensor is considered to represent a specific area of the manikin surface
- Burn injury prediction is done on each sensor and then summed to determine the burned area of the manikin

Manikin: Hot Water

Manikin: Steam

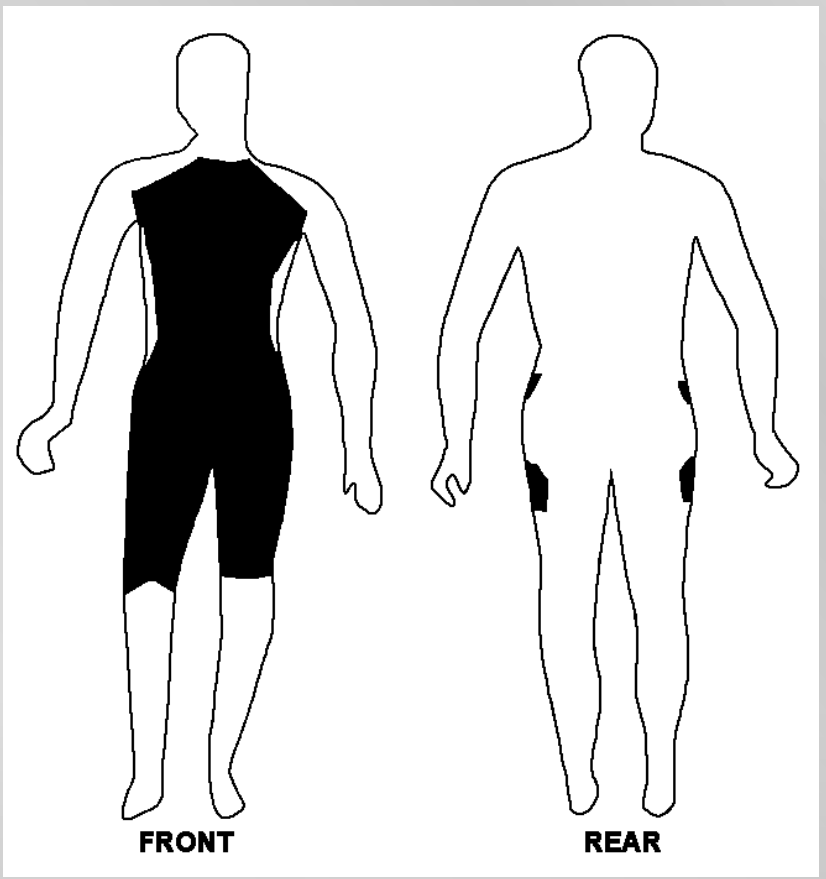
- Provides an evaluation of the effectiveness of material for protection from burns due to steam hazards when used in construction of a particular garment
- Allows for assessment of performance of closures, seams, and interfaces
- A manikin is dressed garments to be tested and exposed to steam jets from one side
- Energy transfer to the surface of the manikin is used to determine the extent of predicted burn injury

Manikin: Steam

Exposure

- Steam is delivered through at least two nozzles
- Steam source is 50 psi and 148°C (saturation temperature)
- Steam source has sufficient capacity to drop less than 10% during a 10-second exposure
- The direction nature of the steam exposures, and the small distance necessary between the manikin and the nozzles, results in only partial effective exposure of the manikin (unlike the flash fire and hot water manikin tests)

Manikin: Steam



Manikin: Steam

Specimens

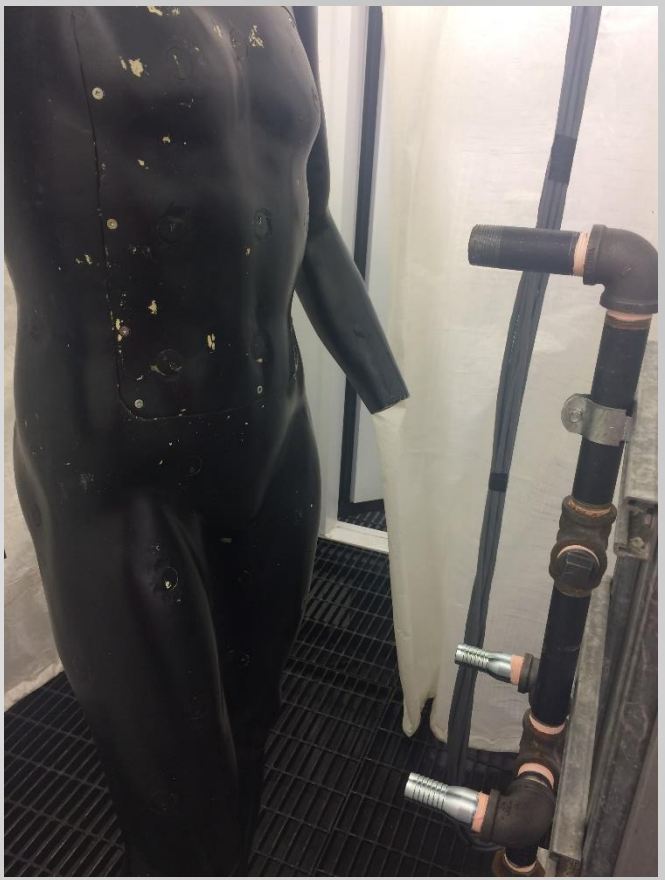
- Specimens requirements are the same as manikin hot water tests
- Hot water manikin tests are performed on “as sold” garments
- Size 42R or equivalent

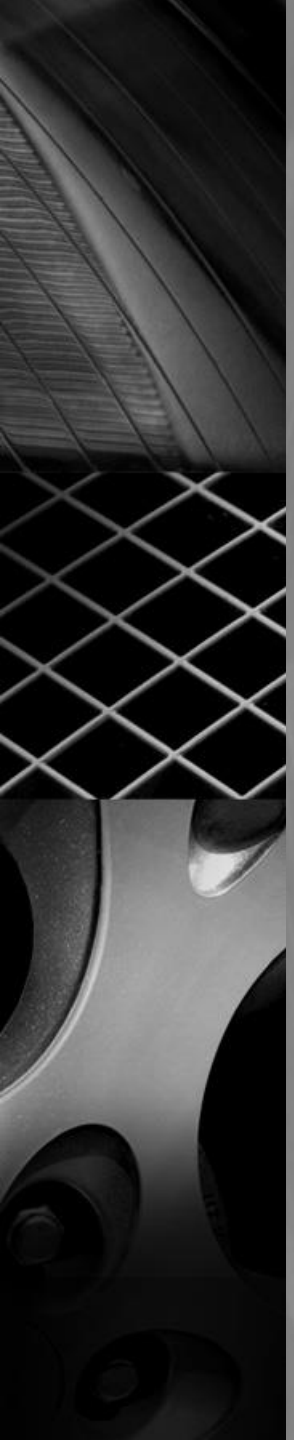
Manikin: Steam

Sensors

- Sensors are the same as flash fire and hot water manikin tests
- 110 skin simulant sensors, the same type used in small scale steam and hot water testing, are mounted over the surface of the manikin
- Each sensor is considered to represent a specific area of the manikin surface
- Burn injury prediction is done on each sensor and then summed to determine the burned area of the manikin

Manikin: Steam





Thanks