Finnish Institute of Occupational Health

Heat load while using firefighter protective garments in forest fires

Sirkka Rissanen, Chief Researcher

Emergency Services Academy Finland: Juha Laitinen, Marko Hassinen

Introduction

- Wildland firefighters are exposed to high temperatures (air and fire), strenuous work and hazardous chemicals and dust
- Traditionally fire garments designed for structural fires are used by firefighters during forest fires in Finland
- Heavier garment may increase the risk of heat and physiological strain
- Fire garments for forest fires are lighter and may decrease the risk of over strain

Aims

- To study
- heat and physiological strain while wearing
  - light forest fire garment with long underwear and
  - heavy structural fire garment
- during work simulations and forest fires

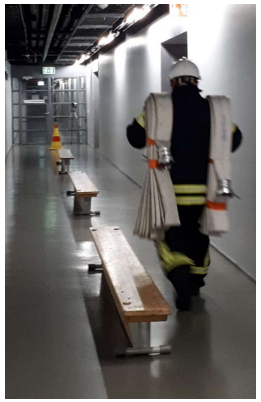
Garments

1. Forest fire garment (FFS)
   - underwear: long-sleeved and legged underwear (PP)
   - weights; suit 2050 g, whole garment 2287 g
2. Fire garment designed for structural fires (SFS)
   - underwear: t-shirt (CO)
   - weights; suit 3805 g, garment 3893 g
   - during forest management burning NO jacket

Methods – measurement setups

1. Work simulation, n=4, garments= 1 SFS and 3 FFS
   - Indoor Ta 22 °C, test track with 9 tasks, duration 1 h
2. Forest management burning, n=4, garments= 1 SFS and 3 FFS
   - Ta 6 – 25 °C, duration 4-5 h
3. Forest fire training track, n=8, garments=2 (FFS, SFS)
   - Ta 6 – 14 °C, duration 2 h


Forest fire training track



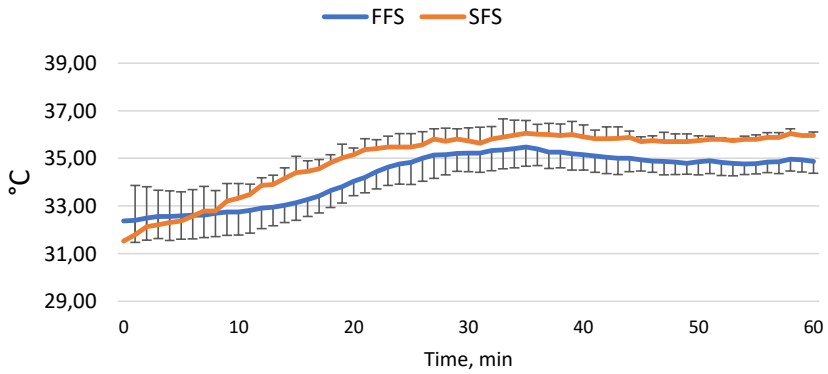
Methods

- Heat load measurements:
  - Skin (iButton) and core temperature (ingestible pill)
  - Heart rate
  - Weight loss and moisture absorbed to clothing layers
  - Thermal sensation, RPE and wear comfort of the garments

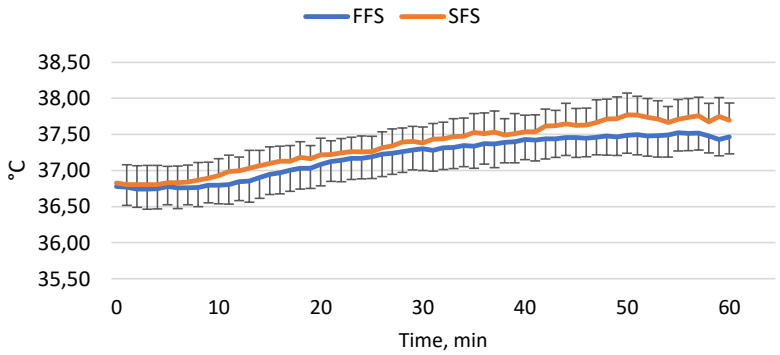
Subjects
- 1) Four male firefighters: 38.3±3 yrs, 174±5 cm, 82.9±11.8 kg
- 2) Four male firefighers: 42.7±5 yrs,177±4 cm, 76.5±3.1 kg
- 3) Eight male firefighter students: 23.5±2 yrs, 175±4 cm, 85.5±8.2 kg

Results - heat strain

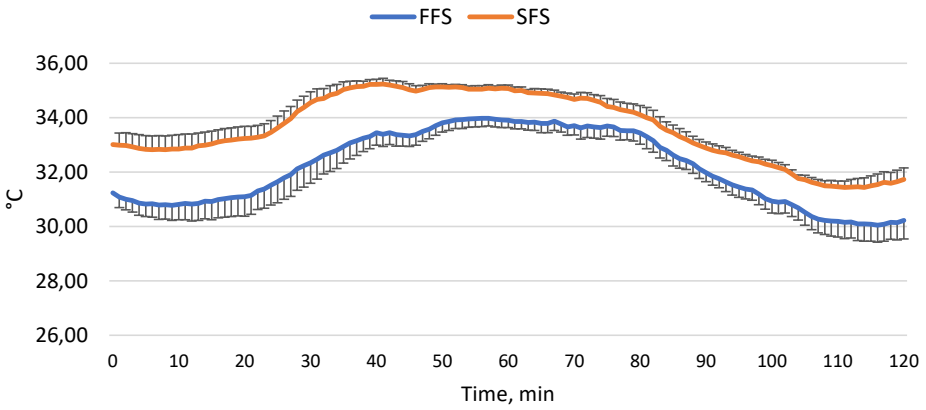
Mean skin temperature, simulation, n = 4



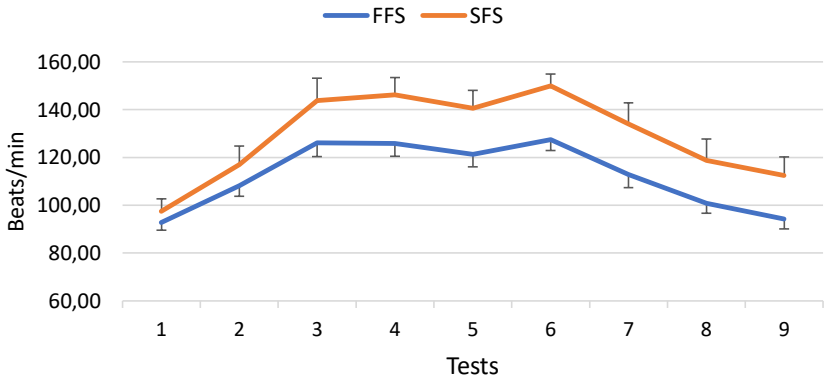
Core temperature, simulation, n = 4



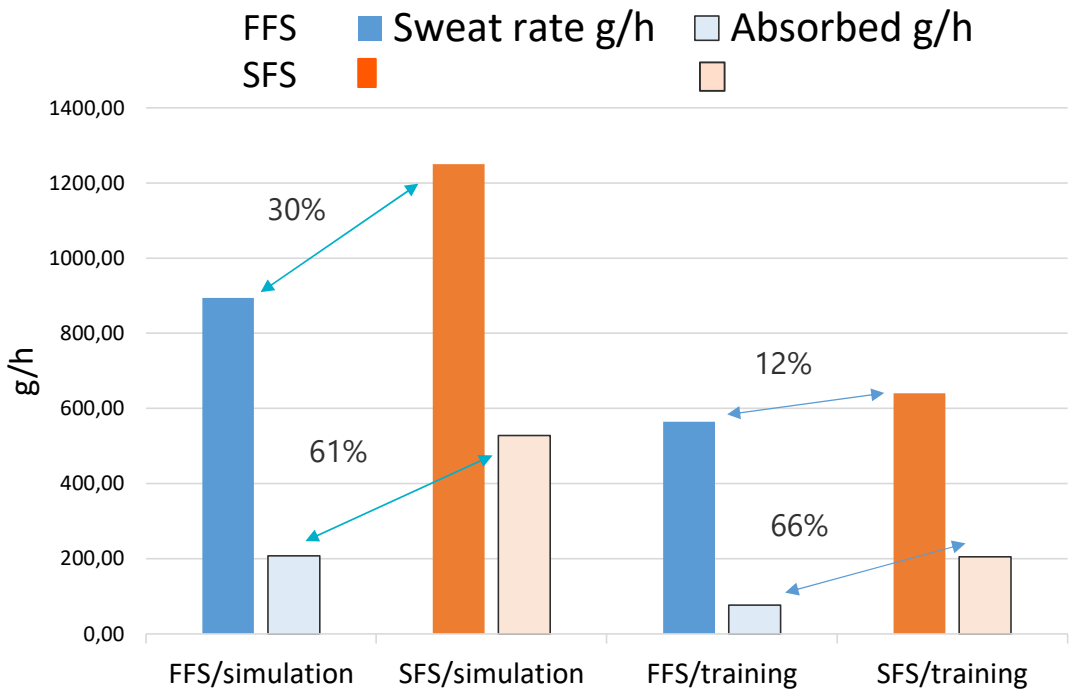
Mean skin temperature, training track, n = 8



Heart rate, simulation, n=4



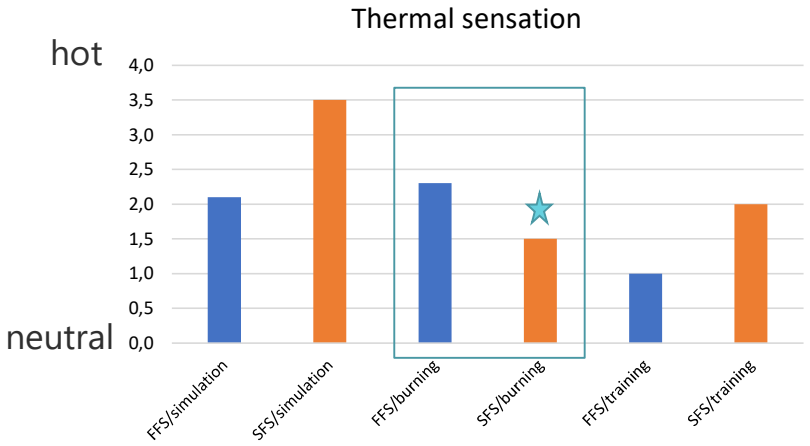
Sweating and absorbed moisture in the clothing

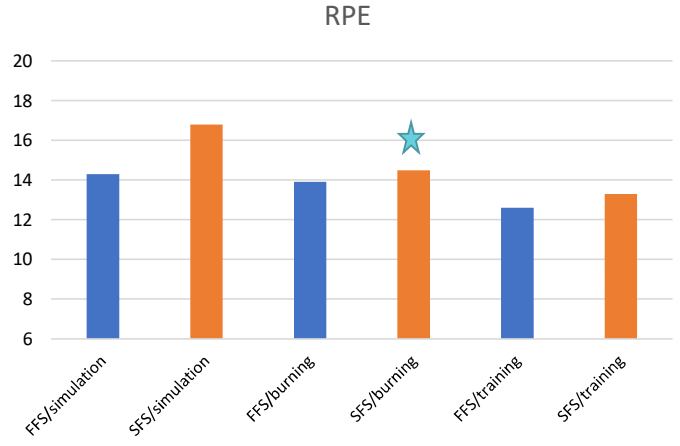


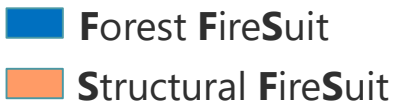
Forest **F**ire**S**uit

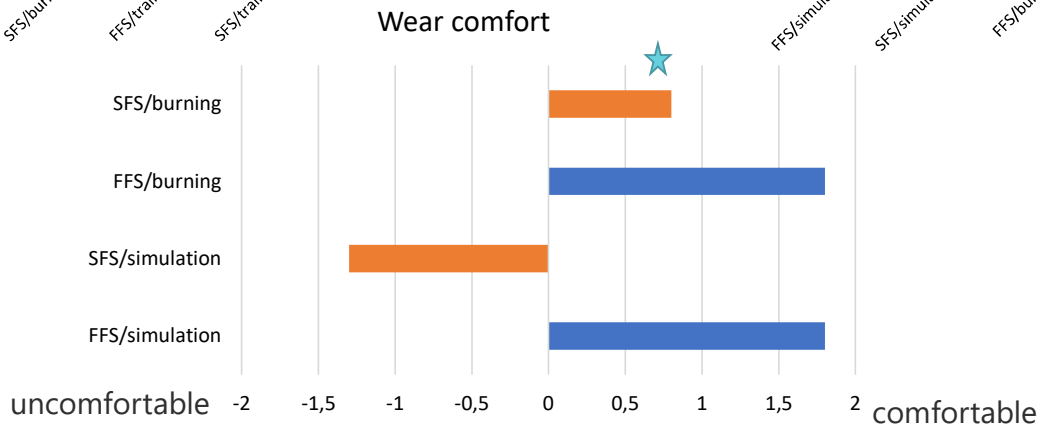
Structural **F**ire**S**uit

Perceptions of thermal sensation, RPE, wear comfort









Conclusions

Light forest fire garments with long sleeved and legged underwear

- reduced the risk of heat and physiological strain
- provided greater moisture evaporation from skin and clothing layers

Structural fire garment without extra protection of skin

- increased the risk of heat strain (greater sweat rate, heart rate, skin temperature)
- increased risk of dermal chemical exposure due to increased sweat rate and cutaneous circulation

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@SirkkaRissanen

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