

Stored Thermal Energy

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Project Background

- Protective clothing or turnout gear is designed to insulate a fire fighter from the thermal environment.
- Protective layers and air gaps prevent the energy of the fire environment from being transferred to the fire fighter.
- Burn injuries occur when stored thermal energy (STE) within the garment layers are quickly transferred to the skin through compression of the layers.
- Current standards and testing methods do not adequately evaluate the risk caused by STE.



Photos courtesy of IAFF

Burn Injury History

- Fire fighters have referred to these burns as stored energy burns, steam burns, and compression burns
 - Little to no visual damage to the outershell material
 - Occurs more frequently in areas of the body covered with dense reinforcement materials



Photos courtesy of NCSU

Project Objectives



- Development of an apparatus and a procedure to measure the stored thermal energy (STE) in material composites



- Conduct variability studies between test labs using the STE method and apparatus

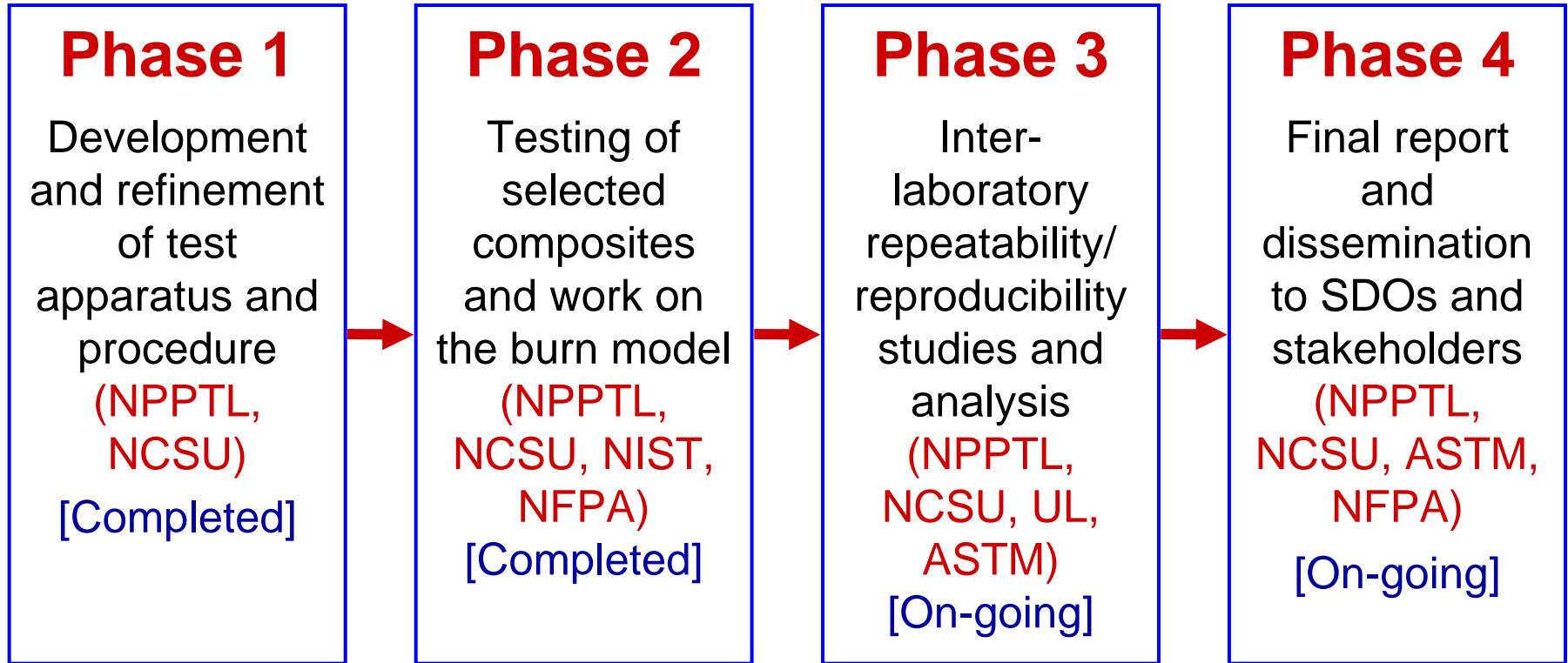


- Creation of ASTM standard entitled “Standard Test Method for Measuring the Transmitted and Stored Energy of Firefighter Protective Clothing Material Systems”

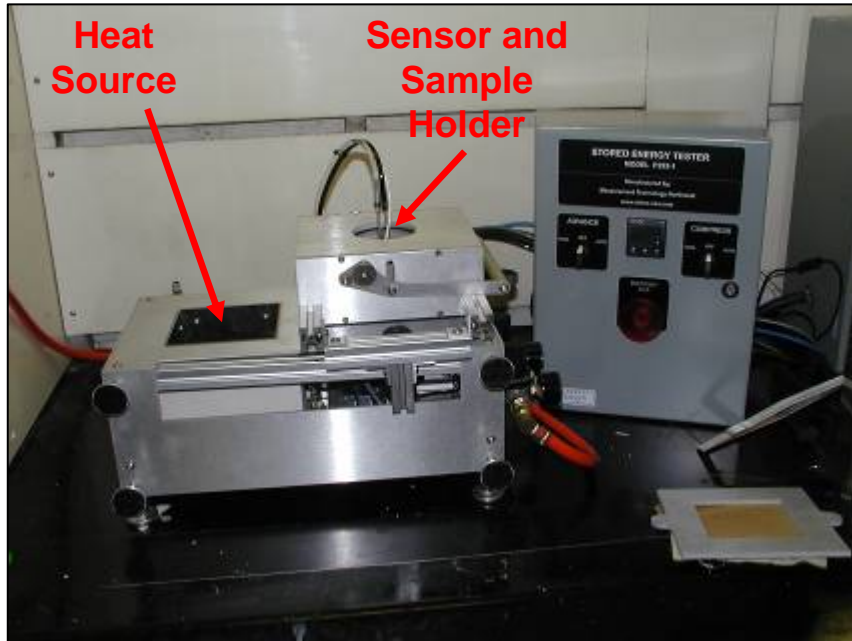


- Recommend method, parameters, and criteria to the NFPA Technical Committee on Structural and Proximity Fire Fighting

Project Approach



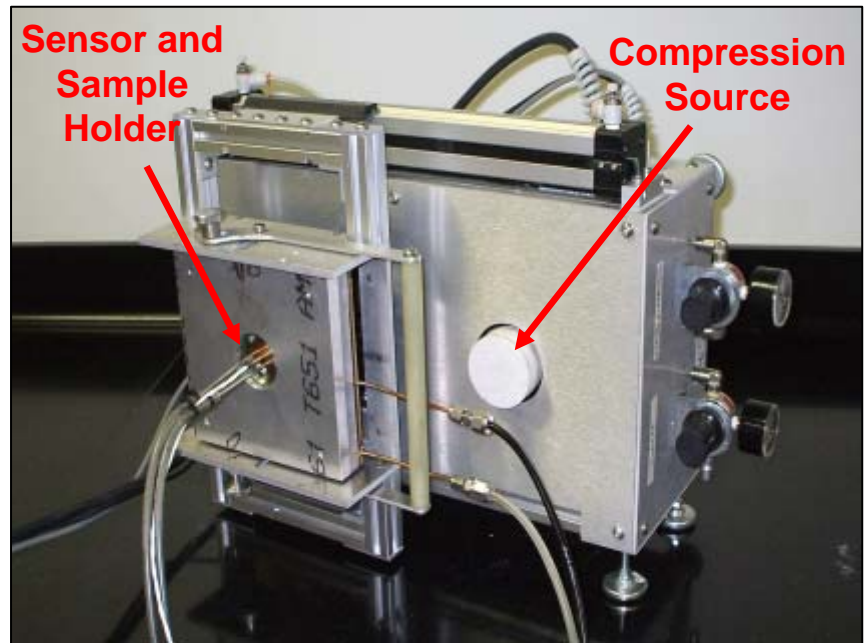
STE Test Apparatus



Initial Design - Horizontal

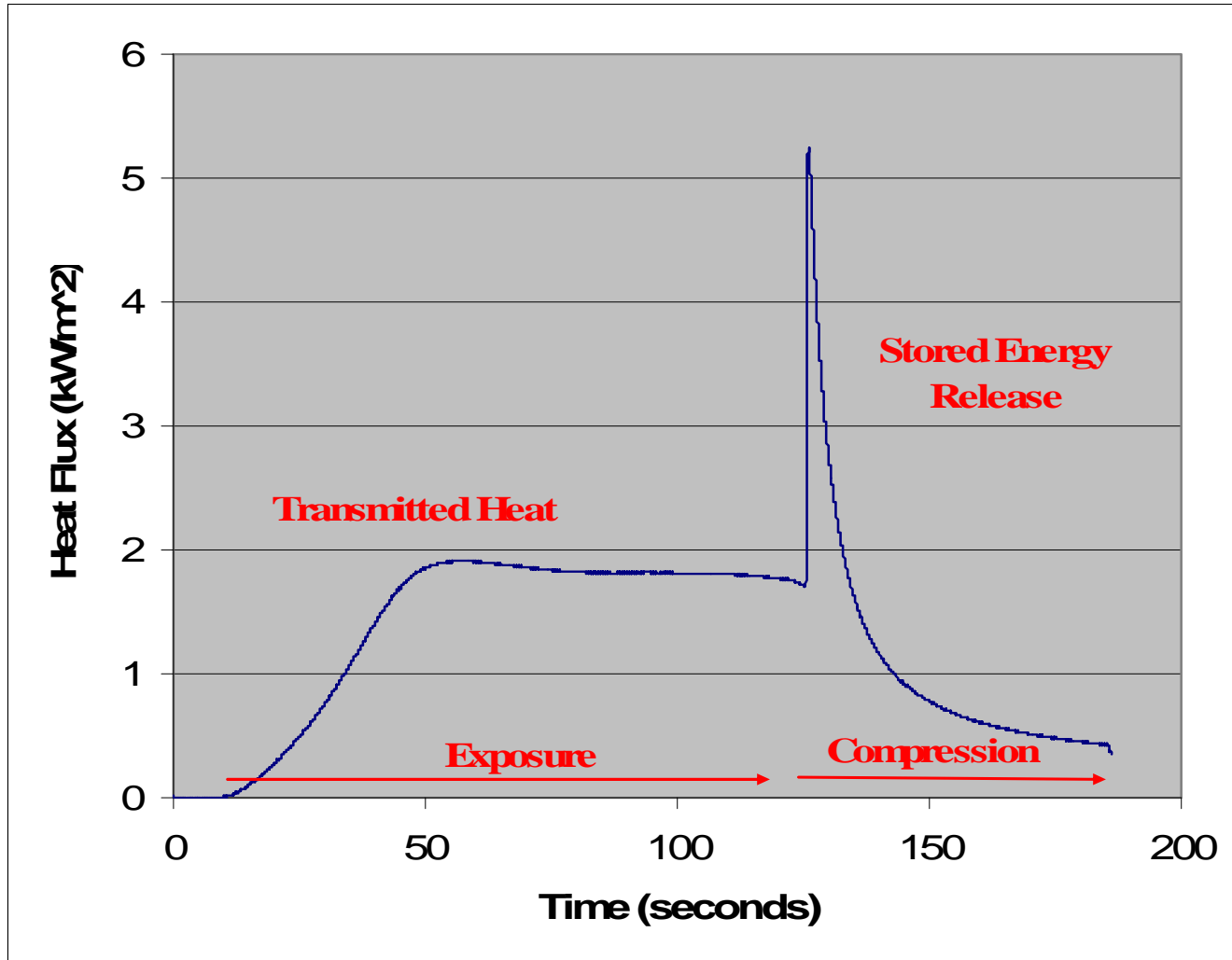


Sample Composite with Reinforcement



Current Design - Vertical with Water Cooled Sensor

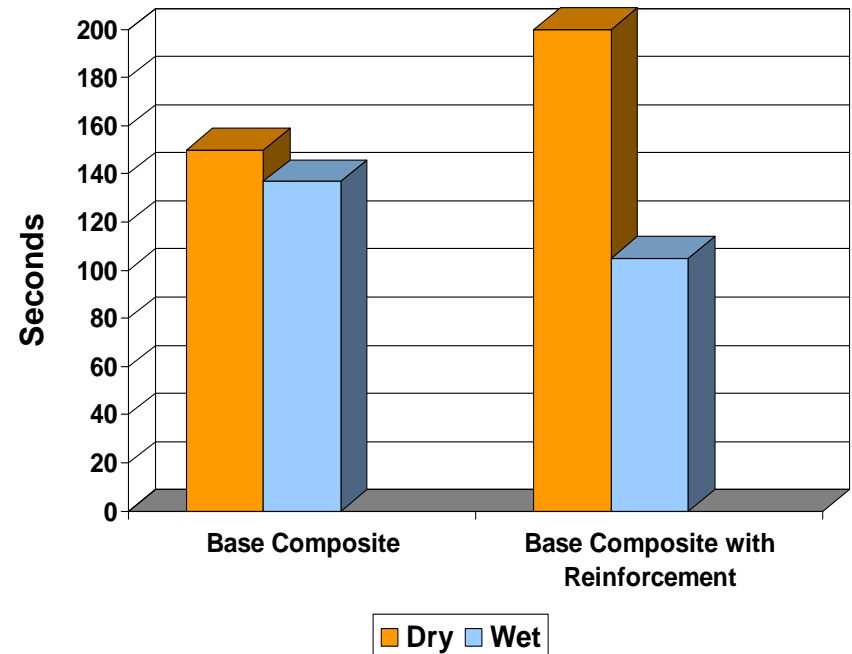
Example STE Results



Moisture and Material Effects

- No Moisture Preconditioning
 - Similar to other thermal tests (TPP, RPP)
 - Reinforced samples have higher times to 2nd degree burn
- With Moisture Preconditioning
 - Time to burn drops with all samples
 - Composites with dense impermeable reinforcements have lower times to 2nd degree burn

Predicted Time to 2nd Degree Burn
Wet and Dry Condition



Project Outputs

- ASTM Draft Standard, WK10531 - Measuring the Transmitted and Stored Energy of Firefighter Protective Clothing Systems
- Phase 1 Final Report titled, “Development of a Test Method for Measuring Transmitted Heat and Stored Thermal Energy in Firefighter Turnouts”
- Phase 2 Final Report titled, “Thermal Capacity of Fire Fighter Protective Clothing” - Available on the web:
http://nfpa.org/assets/files/PDF/Research/PPE_Thermal_Energy.pdf

PPT Program Impact

- PPT Program Objective – Improve emergency responder protective clothing to reduce exposure to thermal, biological and chemical dermal hazards
- Incorporation of the method into nationally recognized standards is expected to reduce the number of burn injuries sustained by fire fighters due to stored thermal energy transfer
- Additional surveillance outside this project is needed to acquire anything more substantial than anecdotal information

Quality Partnerships Enhance Worker Safety & Health

Acknowledgements

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International Association of Fire Fighters

www.cdc.gov/niosh/npptl/default.html

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