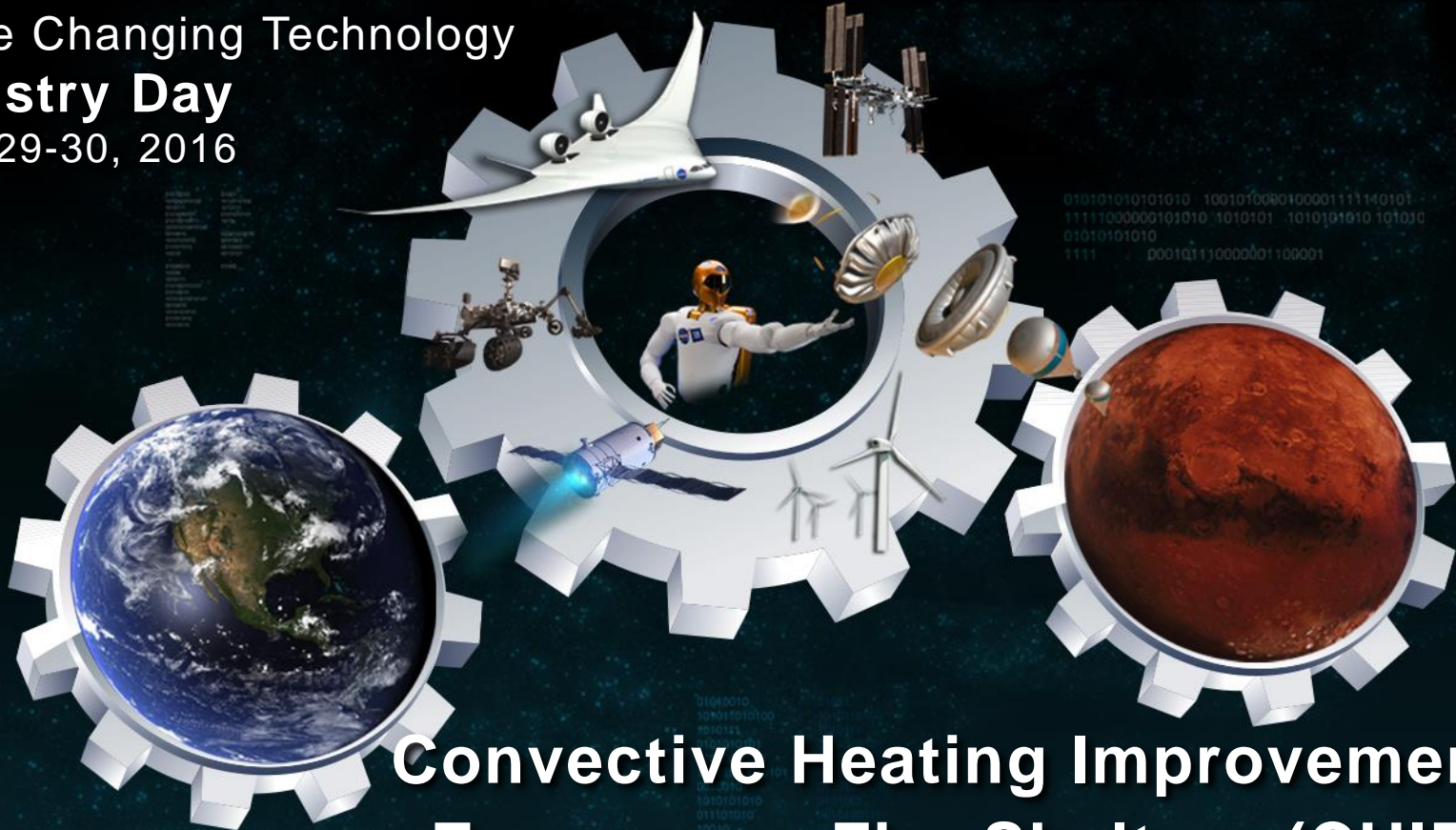




NASA's
Game Changing Technology
Industry Day
June 29-30, 2016



Convective Heating Improvement for Emergency Fire Shelters (CHIEFS)

Presented by
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NASA Langley Research Center

TECHNOLOGY DRIVES EXPLORATION



The Emergency Fire Shelter



Emergency fire shelter – last resort if entrapped
CHIEFS: Spin-off application of flexible heat shield tech

19 Lost: Yarnell Hill, AZ 2013

This was like a nuclear blast occurring right over you and you're lying in tinfoil.

Entrapment survivor

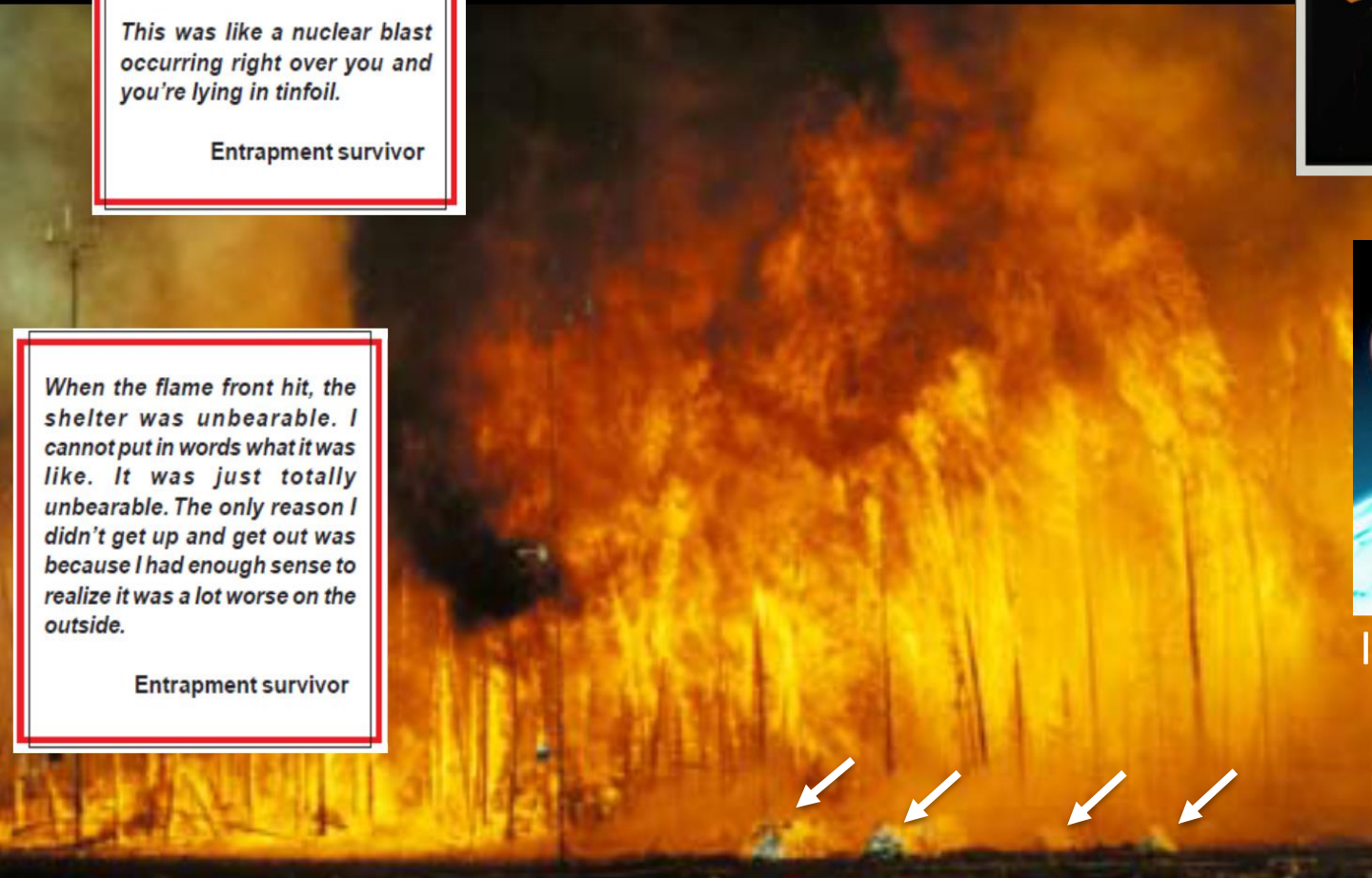


When the flame front hit, the shelter was unbearable. I cannot put in words what it was like. It was just totally unbearable. The only reason I didn't get up and get out was because I had enough sense to realize it was a lot worse on the outside.

Entrapment survivor



Inflatable Decelerator



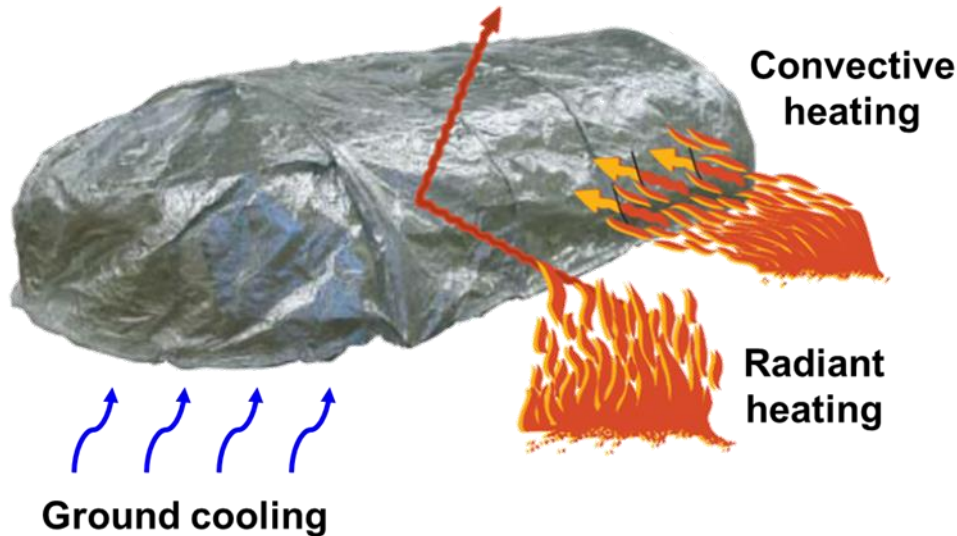


US Forest Service Fire Shelter



- Must avoid flame contact: clear site of fuels
- **Yarnell Hill (AZ 2013): insufficient time to clear dense brush**
 - **Shelters unable to sustain prolonged direct flame heating**
 - **19 firefighters lost**

Aluminum reflects 95%
radiant heating **if** $T < 1200^{\circ}\text{F}$



- CHIEFS: Target improved resistance to direct flame heating**
- Current fire shelter already considered “too big” by many
 - Need high “thermal efficiency” materials



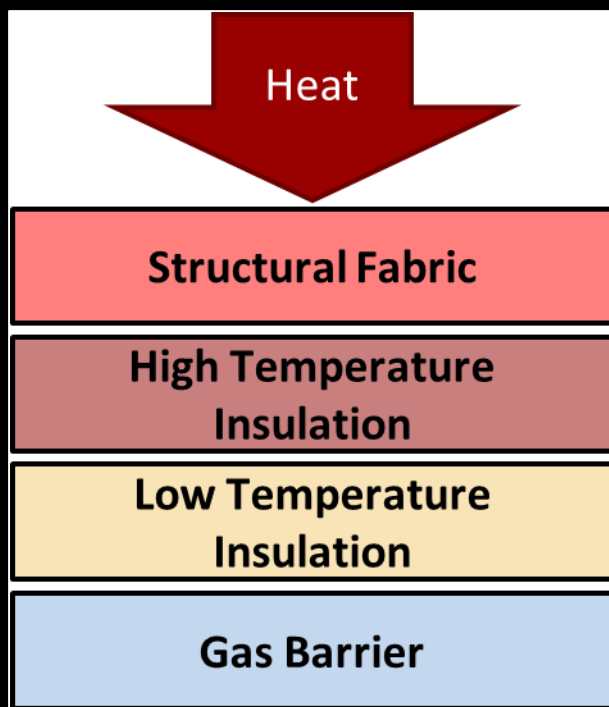
The “Layup”: NASA has expertise from inflatable heat shields



➤ “Layup” = stack of material layers

- Each material serves a function
- Order matters

Generic Layup Example:



Inflatable Heat Shield Layup



Example CHIEFS Layup



Heat shield vs. CHIEFS F-TPS

Notable Similarities:

- One time use
- Minimize packed volume & weight
- Short duration high intensity heat pulse
- Need to be flexible, foldable, durable

Biggest Difference:

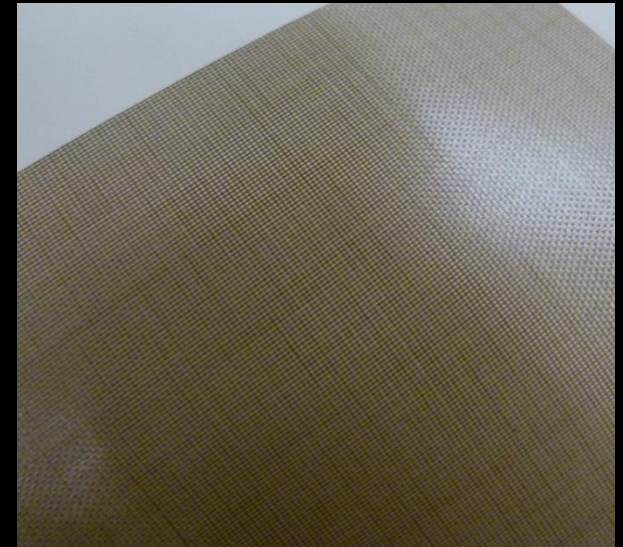
- Heat shield materials endure higher heat load
 - ***Heat shield layups are too big for CHIEFS***



Example Materials Investigated

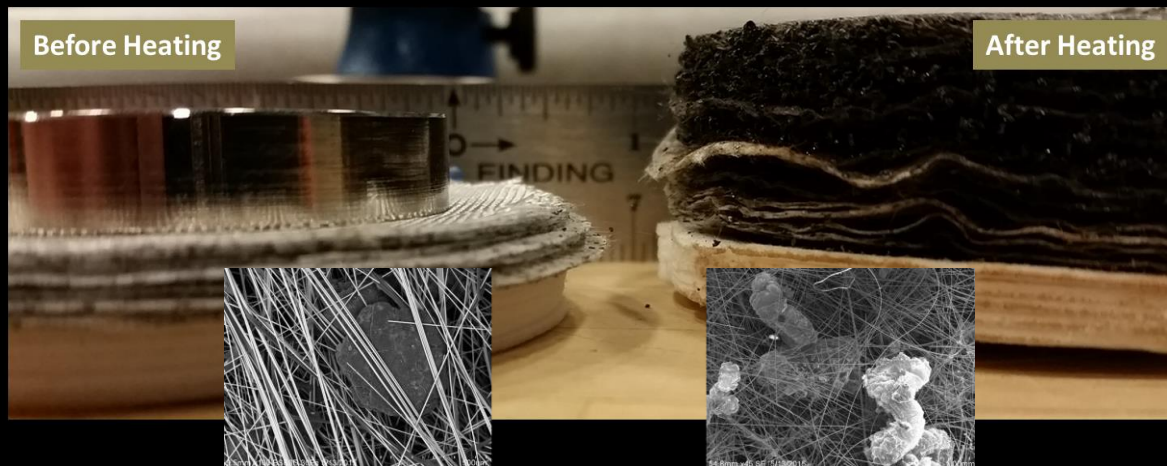


Low Density Fiberglass Batting



PTFE-Fiberglass Laminate

Intumescent Graphite



Before Heating

After Heating



CHIEFS Testing in Controlled Wildfire





CHIEFS Testing in U of Alberta Labs





Shelter Interior

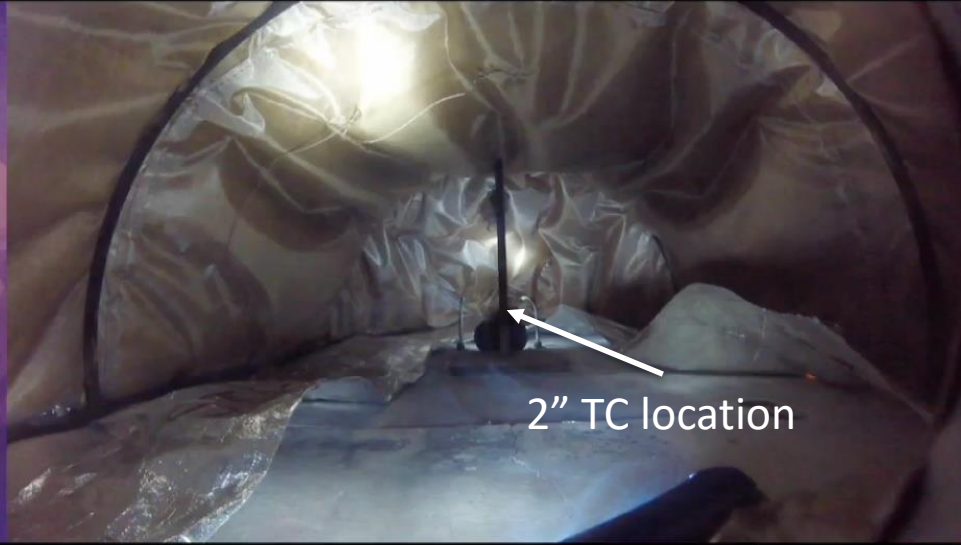


Current Shelter

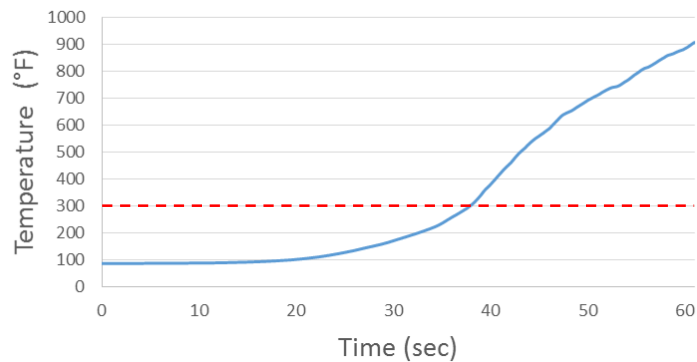
Test Time

00:01:01:00

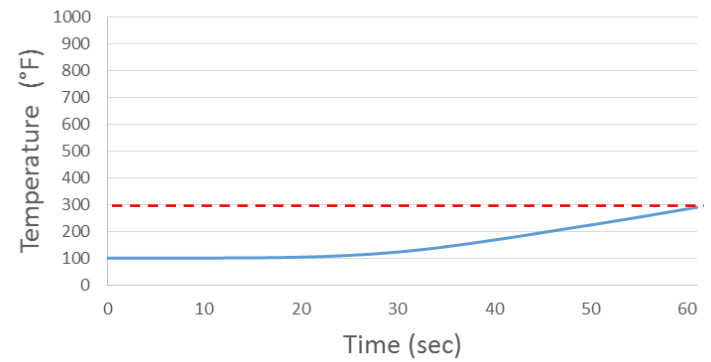
CHIEFS ST4 Shelter



M2002: Breathing Air Temperature



CHIEFS ST4-2: Breathing Air Temperature





Partnerships/Opportunities



1) Current partnerships:

- US Forest Service (MTDC)
- University of Alberta
- University of North Carolina
- Steve Miller and Associates Research Foundation
- Material vendors/laminators from private industry

2) Benefits for partners:

- This technology could save the lives of firefighters who protect us
- ~100,000 units in the field (USFS contracts)

3) Next steps/future work:

- Areas of opportunity to address:
 - Improved thermal performance/decreased packed volume materials
 - Durability and decomposition toxicity testing
 - Identify/test seam designs to mitigate gas ingress



Additional Applications



- 1) Fire protection blankets for equipment and vehicles
- 2) Fire resistant wraps for structures
- 3) General flame resistant PPE:
 - 1) First responders
 - 2) Race car drivers
 - 3) Foundries/industry
 - 4) Military
 - 5) Aviation and marine
 - 6) Oil rigs and mines





Contact Information



For more information about this technology or to discuss potential collaboration efforts:



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