# Shelter Technology, Engineering, Fabrication Directorate

## Fabric Structures Team Technology Update

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Army Natick Soldier RD&E Center
November 2011

US ARMY RDECOM

# Report Documentation Page

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# Fabric Structures Team Overview

***FST Goal:*** **Mature technologies for fabric shelter systems providing increased protection, improved habitability, and reduced logistics burden.**

***The Team:***

- **Jean Hampel - Team Leader, Mechanical Engineer**
- **Tom Larkham - Equipment Specialist**
- **Kristian Donahue - Chemical Engineer**
- **Robin Szczuka – Chemical Engineer**
- **Julia McAdams – Chemical Engineer**
- **Liz Swisher – Electrical Engineer**
- **Chris Aall – Mechanical Engineer**
- **Clinton McAdams – Mechanical Engineer**
- **Allyson Stoyle – Chemical Engineer**
- **Stephanie Enos - Admin support**

***Technologies:***

**Advanced Fabric Structures including Airbeam Shelters :**

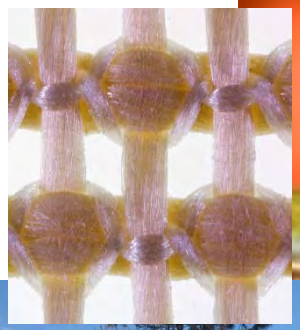
- **Maintenance Shelters**
- **Mobile Warehouses**
- **Large Command Posts**
- **CB Medical**
- **Backpackable**

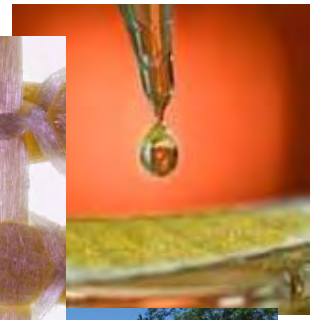
**Insulation & energy**

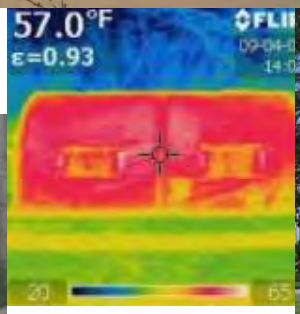
- **Insulation**
- **Radiant Floor Heating**

**Collective Protection – CB Defense:**

- **Overpressure/Negative Pressure Shelters**
- **CB Fabrics**
- **Reactive Airlocks**
- **Self-Decontaminating Fabrics**








# Airbeam Technology

- **Provides Rapid, Lightweight, Durable Deployment**
- **Technology transitioned to Force Provider (HDT-Vertigo, Inc.) and Chemically and Biologically Protected Shelter (Federal Fabrics-Fibers, Inc.)**
- **Airbeam backpackable shelters – Nemo, Inc.**

# 40 Foot Wide Airbeam Shelter
# DLA Distribution Warehouse

- **Six, 44” wide,100’ long shelters completed in March for Defense Logistics Agency (DLA) customer**
- **10-man DLA crew trained at in deployment and operation of shelter**
- **DLA deployed shelters overseas**

# Aviation Inflatable Maintenance Shelter

# Single Skin Chem/Bio Protected Airbeam Shelter with Inflatable Bump-Thru Airlock

•Based off the air-supported TEMPER design originally built for AMED through Force Provider (640 sq ft with a 20 ft long airlock)

• The entire airlock is made of textiles and can be completely deflated and rolled up into the shelter for storage/transport. All rigid frame and door components have been replaced with inflatable technologies (small-scale airbeams/inflatable bump-thru door)

•Can be deployed and operating as a ColPro Shelter in less than 30 minutes with 4 personnel

• Shelter fabric is a certified ColPro material made by Bondcoat

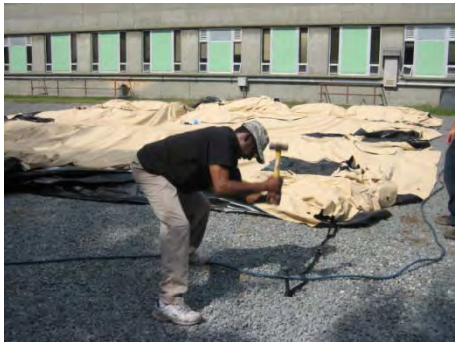
• All connections sealed using 2 Track MaxiGrip, creating an air tight seal for over pressuring and allowing for compatibility with current A2S col pro liners

• Sponsor:  Army Medical Materiel Development Activity (USAMMDA)

# Large Command Post Airbeam Shelter
# NSRDEC Deployment – Sept 2011











# Airbeam & Frame Backpackable Tents

- Primary Objective - high performance backpackable tents with reduced weight and cube
- Congressionally directed program with Nemo, Inc., Nashua, NH
- Designs include novel inflatable airbeam technology and tensioned fabric/pole configurations

# NEMO Tent Evaluation at FOB Kunduz, Afghanistan, 10th Mountain Division

NOTE: Pic Below from MC SERDP Brief

# New Nemo Tents

## 10-Man Isopod

**MAGBAG – connects to vehicle undercarriage**

## 8-Man Astro

# Condensation Test Procedure Developed for Marine Corps

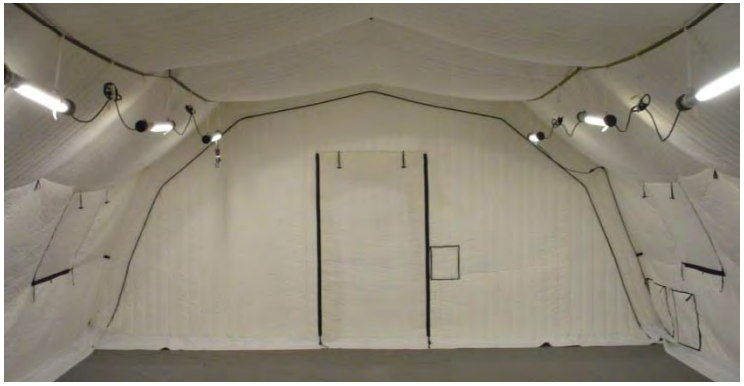
**Goal:** In collaboration with the Marine Corps, develop a test standard by which condensation build-up or mitigation can be quantified in small combat shelters

• Several 4- and 10-man shelters were deployed in the NSRDEC climatic chamber under a variety of temperature and humidity conditions.

• Warm, moist water vapor was introduced into the shelters to simulate human water-vapor exhalation at rest. Heaters were placed into the shelters to mimic body heat.

• Based on results, modifications and retesting, a new Test Standard was written: TOP 10-2-176 Condensation Testing

# MANTECH: Energy Efficient Expedient Shelters with Non-woven Composite Insulation Liners



Airbeam Shelter with a Prototype Non-woven Insulation Liner

Non-Woven Composite Fibrous Batting

Manufacturing Quilt Lines of Current Prototype Liner System

## Purpose:

- To develop an improved manufacturing process for a non-woven composite, insulation liner to be used in expedient soft wall shelters. Manufacturing improvements will increase thermal performance and likelihood of transition while decreasing product cost and weight.

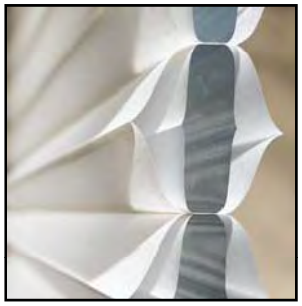
## Product(s):

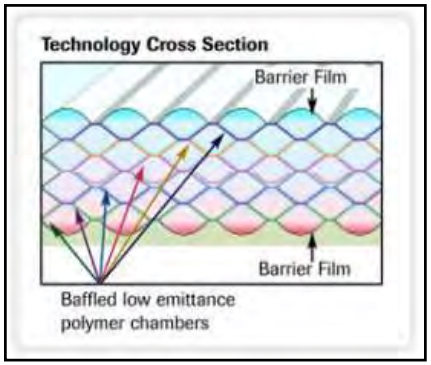
- An improved manufacturing process for non-woven insulation tent liners shown through prototyping and pilot demonstration.
- Three or more 12” x 12” hand samples of non-woven composite liner fabricated with improved manufacturing techniques. These samples will be used for evaluation towards a new manufacturing process.
- Hand sample test results regarding thermal performance, weight, tear strength, flame resistance, etc.
- Demonstration of enhanced manufacturing capability through two full-scale prototype tent liners – one for a standard 32’ TEMPER and one for an air-supported tent.
- System level test results providing weights, pack volume, overall system R value (thermal performance).
- A final test report documenting the efforts under this project, test methods used, and overall benefits achieved.

## Payoff:

- Enhanced non-woven composite tent liners will provide improved thermal performance in highly-agile soft wall shelters resulting in less fuel consumption for expeditionary operations
- Soldiers will experience an higher quality of life due to better climate control, and enhanced ease of insulated shelter set-up

# Cellular Insulation






***Purpose:***

- *To reduce energy and fuel usage of Army base camps by providing an expeditionary, light-weight, and durable shelter insulation system based off multi-layer, cellular insulation technology. Ideally, the resulting system will transport flat and expand into a robust, flame resistant, honeycomb construction that maximizes thermal efficiency when deployed.*

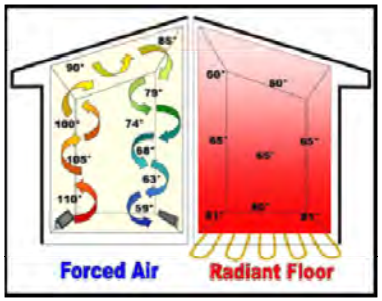
***Product:***

- *Highly energy efficient shelters with minimal impact on pack size and weight*
- *Two full-scale prototypes suitable for installation in existing military shelters (Air-supported TEMPER, and framed TEMPER), potentially containing manifold inflation systems for quick deployment*
- *Affordable manufacturing processes to deliver large width insulation panels for shelter use*
- *Test data indicating energy saving benefits as well as performance with regard standard military specifications such as durability and flame resistance*

***Payoff:***

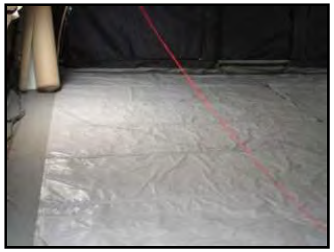
- *Lessening fuel requirements results in a reduction of fuel convoys directly reducing associated soldier casualties*
- *Reduced Convoy Protection missions increase Warfighter availability for Counter Insurgency Operations.*
- *Reduced fuel use will increase funding available for Warfighter protective and offensive equipment*
- *Soldiers will experience a higher quality of life due to better climate control improving cognitive performance.*
- *Planned transition to PM Force Projection, PM Force Sustainment Systems, Force Provider*

# Radiant Floor Heating

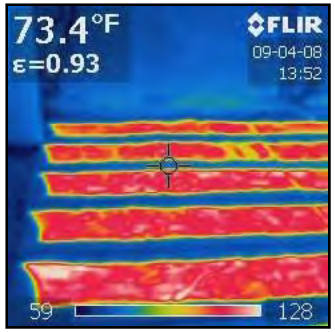



Heat Distribution Comparison
Forced Hot Air vs. Radiant Floor Heating

Electric and Hydronic Radiant Floor Heating Systems



Radiant Floor Heating Prototype




Thermal Imaging of Radiant Floor Heating Prototype

**Purpose:** To reduce the energy required to power shelter heating systems which would reduce the logistical burden of fuel supply. The effort focuses on the design and development of a radiant floor heating system that would efficiently heat an airbeam shelter in cold weather climates, either replacing or in addition to current Environmental Control Units. Background research and technology downselect comparing electric or hydronic (liquid) systems.

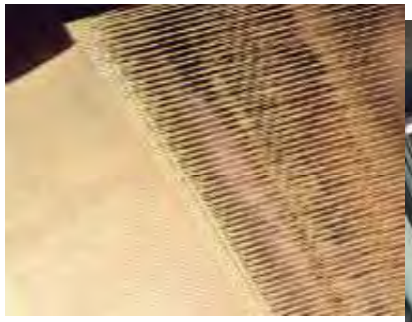
**Results/Products:**

- Design and manufacturing process that is financially feasible and proficient.
- Energy Efficient radiant floor heating system prototype(s) that are lightweight, deployable, portable and durable.
- Possible continued testing of previously tested electric radiant floor heating prototype.

**Payoff:**

- Reduced fuel transport requirements due to 25% energy reduction.
- 100% silent heating system.
- Increased soldier comfort levels by eliminating hot spots created by forced hot air heating systems.
- Transition capabilities to multiple areas of the military; potential for transition to Product Manager – Force Sustainment Systems (PM-FSS) and Force Provider, Future Medical Shelter System and Joint Expeditionary Collective Protection

# MANTECH: High Performance Chemical/Biological Agent Resistant Shelter Fabric



***Purpose:***

- ***Provide Chemical, Biological, Radiological and Nuclear (CBRN) protection at a low mass, low cost in high volume for shelter & airlock applications***

***Results:***

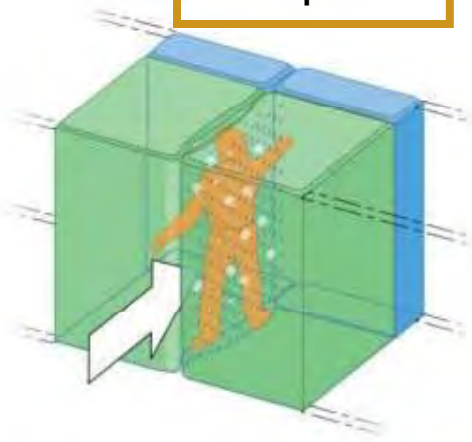
- ***High volume CBRN laminate production demonstration at target cost and mass***
- ***Multiple 600 sq ft structures with airlock meeting Joint Expeditionary Collective Protection (JECP) requirements***

***Payoff:***

- ***Lower cost and reduce logistics burden to achieve CBRN collective protection; warfighter protection & agility improved***
- ***Transition to procurement at lower mass for JECP in FY11 for JPO at TRL6***
- ***Transitions at lower mass and lower cost FY12 at Aberdeen Proving Ground for TOP-10-2-175 at TRL7***

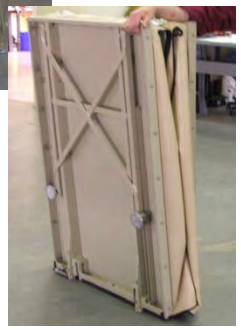
# Next Generation Airlocks for Col Pro Applications

**"Zero Volume" Concept**



- New airlock technology concepts that are lightweight, compact, easily deployed, reduced volume and incorporate self-decontaminating textiles.
- Full-scale bio-simulant test apparatus and procedure developed
- Testing of prototypes ongoing

**Inflatable Airbeam Concept**



# Self-Decontaminating and Biocidal Textiles

**Goal**: Reduce nosocomial infections in fabric shelters through the incorporation of reactive fabrics into shelter interiors.

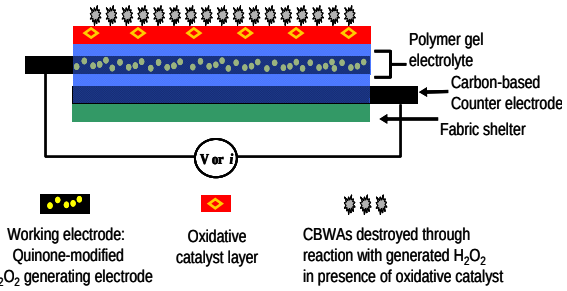
**New emerging textiles with the capability to neutralize common battlefield microbes in addition to chemical/biological warfare agents :**

***Warwick Mills, Inc:***

- Chloramine based chemistry with hydantoin/siloxane attachment
- Advancements in textiles allow up to a 6000ppm load
- 3-log kill time in <1 hour on Bacillis Subtilis (Anthrax surrogate)
- Demonstrated reactive textile in developmental airlock

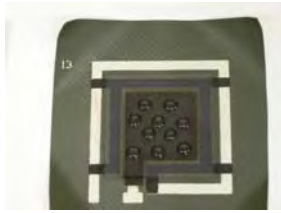
***Crosslink, Inc:***

- A reactive, electrochemical polymer coating system capable
- of generating $H_2O_2$ to detoxify chemical and biological warfare
- agents was developed and tested.
- Two configurations of this system were fabricated by
- screen-printing method on general purpose shelter fabric, as well as on tent liner fabrics.
- Demonstrated efficacy with numerous biological and chemical agents




***Ventana Reseach Corp.***

- Light-activated, reactive photocatalytic coatings that *generate & reversibly store* singlet oxygen ($^1O_2$ ), a mild oxidant
  - *Rapidly disinfects* surfaces exposed to *microbiological pathogens & toxic industrial chemicals*
  - *Demonstrated technology with shelter prototype*



# NSRDEC Participation in NASA's Desert Research and Technology Studies (D-RaTS)

- **On 8 August 2011, an Interagency Agreement (IA) was established between the National Aeronautics and Space Adminstration's Johnson Space Center (NASA-JSC) and the Army Natick Soldier Research Development and Engineering Center (NSRDEC)**

- **The IA enables NSRDEC and NASA to leverage and collaborate on advancing technologies related to life support and remote basing.**

- **From 22 August – 14 September 2011, NSRDEC and industry partner HDT, Inc. participated in NASA's Desert Research and Technology Studies (D-RaTS) in Arizona providing three airbeam shelters, a rigid/fabric hybrid shelter and energy saving accessories such as solar shades and new shelter insulations.**

**•NASA used these shelters for their test command center and to house their space exploration vehicles. NSRDEC instrumented two airbeam shelters and conduct testing of three new shelter insulations to establish energy savings.**

**•The next step is to broaden the IA to establish an RDECOM-NASA IA**