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Air Force Civil Engineer Center



Energy Efficient “Shelter in Shelter” Concept for Large Expeditionary Structures

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Battle Ready...Built Right!

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Energy Efficient "Shelter in Shelter" Overview

- ❑ **Joint Army/Air Force program**
 - ❑ **Energy saving, security, resiliency for expeditionary shelters**
 - ❑ **Particular emphasis on high energy/soft-wall shelters**
 - ❑ **Integration of technology options achieved goal of >50% increase in energy efficiency (Not linearly scalable to medium and large shelters)**

- ❑ **Most energy efficient option for large shelters is a "Shelter in Shelter" (SIS) concept**
 - ❑ **Confine environmental conditioning to a small area rather than conditioning the whole shelter**

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Energy Efficient "Shelter in Shelter" Concept

- Expeditionary shelters are primary power consumers and inherently inefficient for environmental heating and cooling
- Benefits of SIS:
 - Reconfigurable work areas within large structures
 - Localized environmental cooling or heating
- Will realize most cost benefits for large deployed military shelters;
 - Medium Shelters System (MSS), and Large Area Maintenance Shelters (LAMS)

MSS: 52'x30'x15' = ~23,000 ft³



LAMS: 192'x75'x31' = ~450,000 ft³



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Energy Efficient "Shelter in Shelter" Methodology



Prototype SIS:

- ❑ Small gable-style shelter (14'x14'x7') inside a Medium Shelter (MSS)
- ❑ Baseline: MSS running on a conventional ECU
- ❑ All testing completed at "Tent City" AFCEC test site at Tyndall AFB, FL



SIS Inside View



AFCEC Tent City Test Site
Tyndall AFB, FL

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Energy Efficient "Shelter in Shelter" Results

	Baseline	SIS
24 hour	91.5*	21.8
Early Morning (0000-0800)	12.3	4.8
Daytime (0600-1800)	71.9	13.1
Peak Hours (1100-1900)	52.6	9.6
Evening (1600-2400)	22.0	7.5

Energy demand (in KWH) Comparison throughout different time periods

*These results has an error range +/- 5%

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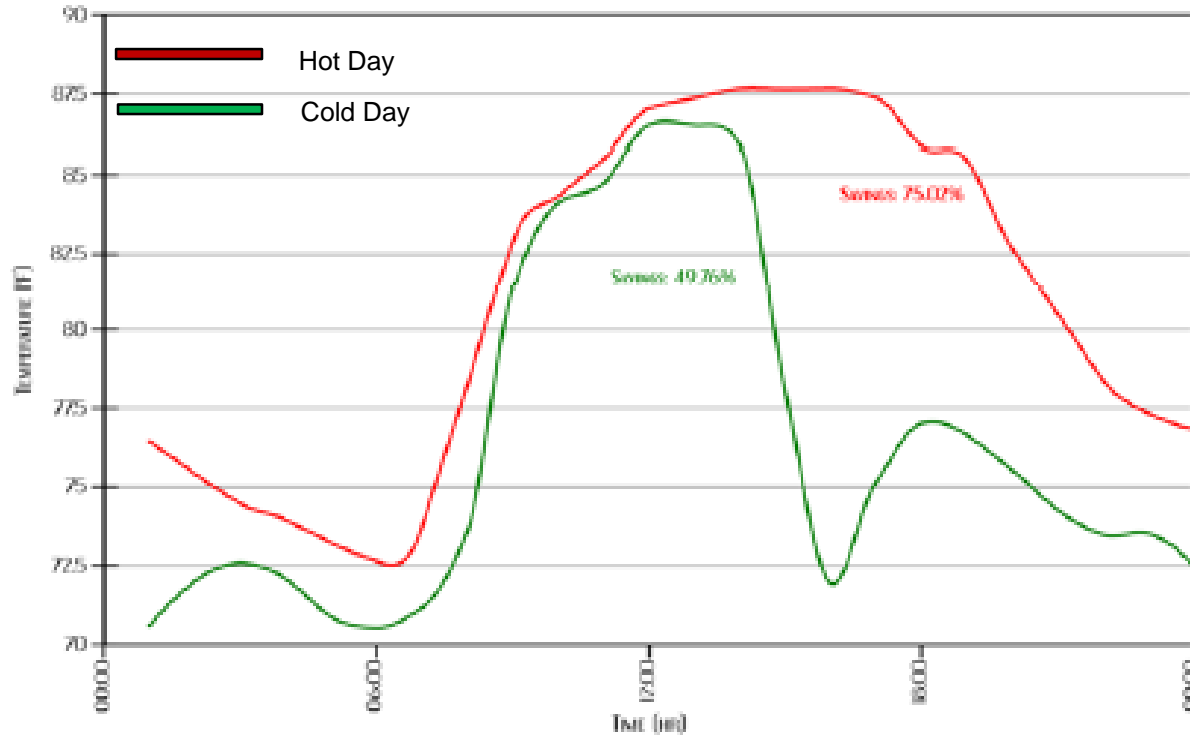
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Energy Efficient "Shelter in Shelter" Results (Continued)



Impact of Environmental Conditions on Energy savings for SIS

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Energy Efficient "Shelter in Shelter" Summary

- Energy savings of 49-75% were achieved by the SIS system compared to the baseline shelter,
 - Efficiency dependent upon ambient environmental conditions
 - High outdoor temperatures and high humidity require more power consumption from ECU
 - AC in the SIS remains constant; shaded by the exterior shelter
- Cumulative energy savings (1 month test) were ~65% over 24 hour period
 - Average daytime savings of 74% (ambient conditions of 85°F) = ΔT of 15°F
- Energy consumption, per sq. ft., is as follows:
 - 0.018 kwh/ft².....For SIS Shelter
 - 0.065 kwh/ft².....For Baseline Shelter

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Energy Efficient "Shelter in Shelter" CONCLUSION



- The SIS concept provides a workspace that is modular and configurable
- Designated heated/cooled environmental area
- Potential energy efficiency >50% is achievable
- Energy efficient solution for large expeditionary shelters
- Can incorporate additional functionality, i.e. blast resistance, fire resistance, controlled environments (clean room, mortuary, paint booth etc.)

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Energy Efficient "Shelter in Shelter" Military Applications



Small structures inside LAMS

Source: <https://www.bing.com/images/search?q=Lam%27s+Large+Area+Maintenance+Shelter&FORM=IDINTS>

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Energy Efficient "Shelter in Shelter" Real World Applications



Small shelter around Airbus Engine installation

Source:

https://airbus-h.assetsadobe2.com/is/image/content/dam/corporatetopics/innovation/Shelter_installation_03.JPG?wid=1196&fit=fit,1

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Energy Efficient "Shelter in Shelter"

Questions?

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