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Sandia – Power Surety Task Force Hawaii Foam Analysis Final Report

Annie McIntyre

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

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Sandia –Power Surety Task Force

Hawaii Foam Analysis

Final Report

Abstract

The Office of Secretary of Defense (OSD) Power Surety Task Force was officially created in early 2008, after nearly two years of work in demand reduction and renewable energy technologies to support the Warfighter in Theater. The OSD Power Surety Task Force is tasked with identifying efficient energy solutions that support mission requirements. Spray foam insulation demonstrations were recently expanded beyond field structures to include military housing at Ft. Belvoir. Initial results to using the foam in both applications are favorable. This project will address the remaining key questions: 1) Can this technology help to reduce utility costs for the Installation Commander? 2) Is the foam cost effective? 3) What application differences in housing affect those key metrics? The critical need for energy solutions in Hawaii and the existing relationships among Sandia, the Department of Defense (DOD), the Department of Energy (DOE), and Forest City, make this location a logical choice for a foam demonstration. This project includes application and analysis of foam to a residential duplex at the Waikulu military community on Oahu, Hawaii, as well as reference to spray foam applied to a PACOM facility and additional foamed units on Maui, conducted during this project phase. This report concludes the analysis and describes the utilization of foam insulation at military housing in Hawaii and the subsequent data gathering and analysis.

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I. Introduction

Work described in this report was conducted under the Hawaii Foam Analysis project, part of a two-fold activity funded by the Office of Secretary of Defense Power Surety Task Force (OSD PSTF) in 2008. Other research under this project included solar lighting analysis and was completed in 2009. This report concludes the Hawaii Foam Analysis activity and describes the utilization of foam insulation at military housing in Hawaii and the subsequent data gathering and analysis.

II. Purpose

The Office of Secretary of Defense (OSD) Power Surety Task Force was officially created in early 2008, after nearly two years of work in demand reduction and renewable energy technologies to support the Warfighter in Theater. The OSD Power Surety Task Force is tasked with identifying efficient energy solutions that support mission requirements. The task force has conducted demonstrations in power consumption reduction at Ft. Benning, Ft. Irwin, Kuwait, Iraq, and Afghanistan utilizing foam insulation to reduce demand. Sandia National Laboratories (Sandia) and Forest City Residential Group, Inc. (FCRG) are collaborating on this project to support the task force's overall mission: *"Current technologies help reduce Utility costs for DOD Installations using already programmed Utility dollars to implement."*

Spray foam insulation demonstrations were recently expanded beyond field structures to include military housing at Ft. Belvoir. Initial results to using the foam in both applications are favorable. This project will address the remaining key questions: 1) Can this technology help to reduce utility costs for the Installation Commander? 2) Is the foam cost effective? 3) What application differences in housing affect those key metrics? The critical need for energy solutions in Hawaii and the existing relationships among Sandia, the Department of Defense (DOD), the Department of Energy (DOE), and Forest City, make this location a logical choice for a foam demonstration. This project task statement outlines an approach for applying foam to a residential duplex at the Waikulu military community on Oahu, Hawaii.

Sandia has enduring relationships with the DOD and with Forest City, operator of military housing in Hawaii. DOD is the largest consumer of energy on the Islands with present rates ranging from 30-47 cents/Kwh. Sandia is also a strategic member of the Hawaii Clean Energy Initiative (HCEI). The vision within HCEI is twofold: 1) to engage all parties in Hawaii in creating a path to a sustainable, flexible, and economically vibrant State that uses clean energy resources to supply 70% or more of its energy needs by 2030, and 2) to serve as an integrated model for the U.S. and island communities globally.

III. Technical Approach

Technical activities in this project were divided into three main tasks, including application of the foam, monitoring and analysis, and foundation for further research and demonstration. The project team (OSD Power Surety Task Force, Sandia, and Forest City Hawaii) coordinated on these activities. Waikulu was considered the best location for the initial demo, and project timeframes align well with the neighborhood construction schedule. Critical environmental and consumption data was gathered over a set period of time, and analyzed for cost effectiveness of foam application.

Phase I: Foam Application

Foam was applied in attic space of a duplex home Waikulu. The unit is composed of two homes averaging approximately 2000 square feet per home. A commercial foam was applied through SprayFoamHawaii, a local contractor. This commercially available foam meets all safety and fire codes, and its chemical content has been evaluated for public use. The foamed units and controls of the same design and orientation (exposure to sun) were selected for maximum applicability of data.

During this phase, an exterior foam product was applied to the roof of a PACOM facility in Hawaii. This facility was not monitored for consumption changes; initial feedback from personnel in the facility indicated a dramatic reduction in temperatures within the building. The facility relies on window air conditioner units and prior to foaming, consisted of a metal roof. Approximately 3900 sq feet was foamed with exterior roof product during this phase.

Phase II: Monitoring and Analysis

Data collection was performed on the homes through a usage monitoring system operated by Forest City to determine demand and consumption rates. This system gathered daily meter readings, which were collated and sent to Sandia by Forest City. Forest City also collected demographic information and move-in/move-out data over the course of months. Analysis of this data considered the following:

- Demand
- Peak load times
- Cost and return on investment
- Life cycle and maintenance of foam
- Utilization in conjunction with other renewable energy technologies

Phase III: Foundation for Future Demonstration

Review of the foam data, along with insights gathered during application of the foam, provide a foundation for future work. Sandia, PSTF, and Forest City will discuss a path forward that considers the following:

- Sampling size of future foam applications
- Commercial and residential benefits and consideration of other structures
- Viability of future demonstration locations (such as Mesa del Sol in Albuquerque, NM, which is a planned sustainable community)
- Demonstrations that may include additional renewable energy technologies
- Additional or advanced metrics

- Reliability and life cycle issues

This path forward will assist in determining what additional safe, secure, sustainable, reliable and cost effective technologies could be installed in military housing to further drive down energy consumption.

Two foam products were applied in this assessment. An ER Systems 2.7 lb foam designed for roof application was applied on the PACOM facility. A Corbond 2 lb foam, designed for interior use, was applied in the attic space of the Forest City units. SprayFoamHawaii, the installation vendor, selected these products in accordance with objectives and ES&H guidelines. This analysis focuses on the overall applicability of foam in this environment, rather than a specific analysis of the foam products themselves. A variety of products exist that provide benefits in specific application environments.

IV. Technical Results and Findings

In June 2009, Phase I (Foam Installation) was completed in Waikulu. It was determined that foam insulation would be applied solely to the ceiling/attic space, rather than ceiling and walls. The data set, foamed and control units, were occupied starting in October 2009. Data was gathered that included occupant demographics, move-in date, daily consumption rates, and meter reading frequency.

Raw data can be found in the Appendices of this document:

- Appendix A: Map of Forest City community in Hawaii, Location of Foamed and Control Homes
- Appendix B: Photos of the Foam Installation
- Appendix C: Consumer Data and Demographics
- Appendix D: Spray Foam Vendor Statement of Work

A large control set is necessary given the various aspects the project team analyzed. The foamed units, Unit A1 and A2i, were compared to other control units, focusing mainly on consumption. Daily comparisons can be utilized to identify anomalies, but the project team focused its analysis over the course of months for a more accurate view. For example, we can compare a foamed and control unit directly given similarities in occupant demographics. This is described for each foamed unit:

Unit A1, occupied on October 22, 2009 by 4 people (2 adults, 2 children).

Consumption from November 11, 2009 through July 31, 2010: 10,943 Kwh. Foamed Unit.

Compared to Like Unit B1, occupied on October 5, 2009 by 2 people (2 adults).

Consumption from November 11, 2009 through March 31, 2010: 12,795 Kwh. Non-foamed Unit.

This comparison indicates an impact by the foam insulation. However, comparison with other units produces varying results. There are numerous factors to consider. In a real-world study such as this one, human behavior, weather unpredictability, etc., all impact the final result. A laboratory experiment would include two identical units without these factors, but in this study, these realities actually help the team identify factors in using energy saving measures that apply in an “operational” environment. Such factors include:

- Geographic obstacles (trees, structures)
- Directional facing (sunlight and shadows)
- Detailed demographics (age of children, “ indoor comfort temperatures”)
- Occupant behavior (conservation awareness, windows, lifestyle, time at home)
- Foam location (ceiling vs ceiling and walls)
- Stud materials (heat conduction in metal studs vs wood)

For example, we review comparison of the second unit.

Unit A2, occupied on October 5, 2009 by 2 people (1 adult, 1 child).

Consumption from November 11, 2009 through July 31, 2010: 3,907 Kwh. Foamed Unit.

Compared to Like Unit B2, occupied on October 28, 2009 by 2 people (2 adults).

Consumption from November 11, 2009 through March 31, 2010: 7,601 Kwh. Non-foamed Unit.

Compared to Like Unit B3, occupied on October 5, 2009 by 2 people (2 adults).

Consumption from November 11, 2009 through March 31, 2010: 8,632 Kwh. Non-foamed Unit.

The analysis of the foamed unit, Unit A2 shows particularly significant data changes from the non-foamed units. Above, we compare an additional like unit. It may be important to consider the demographic in this analysis. The foamed unit housed one adult and one child, whereas the comparative units housed two adults. This stresses the behavioral factors to consider. We may assume that for a period of 8-9 hours per day, the foamed unit is unoccupied.

Perhaps more useful than the consumption numbers themselves, are identifications of these factors, which are relevant to future installations of foam and should be considered when applying foam or employing energy saving mechanisms with other energy systems such as renewable.

Occupant behavior and lifestyle may be a particularly important factor when considering application of foam insulation in specific communities. For example, awareness of cost per Kwh, choice in appliances, and work schedules outside the home, could vary if comparing a military community, common suburb, or sustainable community. Likewise, renewable energy systems and home automation systems could

help to identify these factors and behaviors, and compensate for variances in demand. It is the opinion of the project team that an energy saving component, such as foam insulation, would provide maximum benefit if used in conjunction with other energy saving technologies.

In Hawaii, cost benefit is more easily justified given the high cost per Kwh. In many cases, even a small reduction in consumption can provide a reasonable cost benefit. For example, if a single home could save just 100Kwh per month over the course of 30 years, at an average of \$.50 (over 30 years), a savings of \$18,000 could be realized. At present rates in Hawaii over \$.30-40 per Kwh, that amount of savings could be greatly increased with more accurate forecasted pricing. As many more homes are available with net-zero energy packages available, foam insulation may be a viable component in a total package. It is recommended that foam insulation be further studied in unique energy environments for viability. Hawaii provides unique aspects for investigation, such as islanding effects, a tropical environment, and cost/rate considerations. Other unique environments, military and civilian, may benefit from the consideration of foam insulation for cost saving, life span, and ease-of-use characteristics.

From an installation perspective, ceiling foam was installed by SprayFoamHawaii, a local contractor near the Waikulu community. Interaction with the contractor began just weeks prior to the installation. The product was obtained quickly and installation was completed during a specific construction phase identified by the Construction Management (CM) Team. A number of foam products are available commercially, with different lifespans, specific performance capabilities and uses, and cost. Foam samples from SprayFoamHawaii are on display at Sandia's Mesa del Sol facility.

The CM Team has provided feedback from a construction standpoint on the use of foam insulation compared to traditional insulation.

- Spray foam application involves a few more days over traditional batt insulation installation. During this time, no other trades can work in the unit due to mist generated by the spray application. Typically, other trades can work in the unit while insulation is being installed.
- Additional time may be required to apply a fire retardant over the foam.
- Items, such as the gypsum drywall, are typically stocked inside the building before insulation to minimize down time between trades. A clear unit is required, or at minimum, any items stocked inside the unit must be covered.
- Extra cleanup may be required for over spray.
- The foam performed well from a constructability standpoint.

No consumption monitoring system was employed at the PACOM facility, a large metal unit serving as a training facility, however results gathered by an onsite PSTF representative indicate a significant reduction in air temperature. For example, the facility utilized multiple room-sized units, rather than a central air conditioning unit. Feedback the next day by personnel indicated a significant drop in temperature in the facility. Given the ability to maintain cooler room temperatures, many of the AC units were set to higher temperatures to reduce consumption.

The scope of this analysis did not include additional housing units other than the Forest City units. However, the vendor, SprayFoamHawaii, did conduct an independent analysis at newer homes on Maui

that included a more controlled environment. The data was provided to Sandia for consideration and comparison with data obtained at the Forest City units. The experiment on Maui included two homes, unoccupied and for sale, with controlled access, no fluctuation in air conditioning requirements, and both of the same structure and design. This data is compelling, and it underscores the need to control occupant behavior for a more accurate analysis. The Maui homes are both elevated off the ground, so under-floor foaming is included in the spray foam envelope. The vendor utilized an electronic monitoring system to collect the data in three phases. A sample is illustrated below; complete data for the three phases are included in Appendix E. This experiment considers humidity, a variable that DOD may want to continue evaluating in more detail for use in unique energy environments.

Hot Humid Climate Performance

- Two identical houses with no occupants
 - One house was build-to-code with glass fiber insulation
 - Was built to code with CORBOND Performance Insulation in the walls and roof
- Thermostats set to 74°F
- Temperature and humidity readings taken every 5 minutes
- Data readings from July 23rd-July 31st 2009

V. Benefits to DOE and the Nation

This project focused on analysis of a commercially available product utilized to reduce energy demand in a unique energy environment. Previously analyzed in DOD field tests, spray foam insulation dramatically reduced consumption of hard-to-obtain and expensive fuel. The analysis in Hawaii provided an opportunity to consider a common residential unit in a tropical environment. Most importantly, DOD is the largest consumer of energy in Hawaii, and given the cost per Kwh, savings on residential units have the potential for a significant cost impact. Demand reduction and cost analyses benefit the DOD, Hawaii, and residential consumers in all states with rising energy costs.

DOE is interested in not only demand reduction and cost benefit, but long term grid stability and integration issues. Coupling commercially available, tested technologies can provide a sustainable solution meeting long-term energy goals. Given long-term national energy objectives, as well as short-term guidelines for demand reduction in government buildings, all federal and state agencies, particularly those in unique energy environments, benefit from performance analyses of products such as spray foam insulation. Lastly, consumers benefit from analysis of a product/technology that is commercially available, low cost, and easily obtained. Simple, easily installed solutions, that can have impact in environment with energy challenges, provide options for consumers. This data facilitates informed decision making by consumers in all areas, not just those with transmission and cost issues.

VI. Summary

This analysis, albeit limited, provided foundational information regarding the use of spray foam insulation in residential applications for unique energy environments. Initial data suggests and impact of spray foam in demand reduction and cost benefit. An additional assessment in a controlled experiment environment is recommended. This study also identified a number of factors in the impact level,

primarily location of spray foam in the unit and resident behavior. It is anticipated that a cost benefit could be realized by spray foam insulation, and calculated accurately with data from unoccupied homes in a closed environment. In Hawaii, this cost benefit may be realized more quickly, given present and forecasted energy costs. Likewise, no significant impacts to construction are created by spray foam. Scheduled accordingly, it can be considered as part of a series of steps to complete the home. Additional elements for study in the use of spray foam insulation have been suggested. Life-cycle and study in other environments, including harsh or aging infrastructure environments, remote sites, and additional residential studies, would be beneficial to DOE, DOD, and the consumer. The vendor has also produced data that indicates spray foam may stabilize aging structures, an added capability that DOD may want to investigate. While demand reduction may not be as visible in residential units as it is at field sites, spray foam may be a viable solution for many energy environments and an easily obtainable solution for government seeking low cost solutions.

Appendix A: Map of Forest City Community, Foamed and Control Homes

Appendix B: Photos of the Foam Installation

Appendix C: Consumer Data and Demographics

House Size Demographics

New Address	House Plan Type	# of Bedrooms	Net Square Feet	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10
Other Unit	115	4	1,967	1248	1500	1222	924	1027	990	1150	1255	1306
Unit B3	115	4	1,967	822	784	848	746	946	984	1161	1186	1491
Unit A1	115	4	1,967	1370	1467	1263	1056	1183	1069	1282	1413	1329
Unit A2	115	4	1,967	512	521	406	330	404	431	544	472	480
Other Unit	115	4	1,967	1126	1145	962	846	942	929	902	708	919
Other Unit	114	4	1,950	1017	1029	1011	697	939	867	1086	1096	1163
Other Unit	115	4	1,967			1158	1076	1114	846	971	771	998
Other Unit	114	4	1,950			1268	1085	1376	1197	1346	1296	1060
Unit B2	115	4	1,967			873	748	805	750	979	919	983
Other Unit	115	4	1,967			1051	784	789	846	1265	1262	1356
Other Unit	115	4	1,967			968	779	894	814	935	963	915
Unit B1	114	4	1,950			1392	1360	1399	1407	1639	1509	1670
Other Unit	118	4ADA	1,992			1050	889	975	1114	1208	1162	1210
Other Unit	115	4	1,967			660	609	792	651	727	751	423
Other Unit	115	4	1,967			1138	918	1064	1173	1204	998	1245
Other Unit	115	4	1,967			1009	848	1027	315	1290	1350	1340

Sample Daily Consumption Data

Daily Consumption	Other Unit	Other Unit	Unit A1	Unit A2	Other Unit	Other Unit	Other Unit	Unit B3	Unit B2	Other Unit	Other Unit	Unit B1	Other Unit	Other Unit	Other Unit	Other Unit
kWh																
1-Jul	23	48	34	35	32	35	30	44	20	32	33	42	38	28	23	33
2-Jul	23	48	34	4	32	35	35	44	20	32	33	42	38	28	23	33
3-Jul	60	58	53	4	20	36	34	34	58	40	32	45	46	25	26	34
4-Jul	60	63	71	16	19	36	52	63	14	45	37	53	46	27	25	35
5-Jul	43	54	50	19	33	31	40	49	23	40	40	59	34	26	23	34
6-Jul	43	43	42	16	36	43	49	25	41	42	30	58	36	32	26	66
7-Jul	44	49	44	14	50	25	26	26	29	53	24	51	37	9	34	43
8-Jul	51	43	39	14	22	40	21	26	34	44	30	42	33	9	41	47
9-Jul	41	46	45	15	22	36	35	26	33	44	28	44	46	9	39	38
10-Jul	41	46	45	15	22	36	35	26	33	44	28	44	46	9	39	38
11-Jul	41	46	45	15	22	36	35	26	33	44	28	44	46	9	39	38
12-Jul	55	48	51	18	33	29	27	26	32	52	32	46	32	10	33	42
13-Jul	49	42	37	15	32	52	22	28	29	39	35	47	37	10	44	49
14-Jul	44	49	21	15	21	24	24	26	29	37	27	62	34	10	49	39
15-Jul	49	47	41	15	33	43	25	17	33	44	24	46	38	11	38	40
16-Jul	46	46	34	14	51	35	27	28	31	38	29	51	35	12	52	44
17-Jul	45	49	33	8	20	47	23	29	36	28	33	64	41	11	45	31
18-Jul	33	50	36	15	39	38	58	26	41	37	27	56	39	9	43	44
19-Jul	50	65	62	18	18	35	48	26	31	38	23	57	66	10	47	38
20-Jul	38	54	40	18	34	41	27	26	28	40	39	51	38	9	19	48
21-Jul	40	37	35	18	38	43	26	28	31	39	26	59	37	11	49	73
22-Jul	35	54	30	15	45	37	35	29	30	53	24	63	19	11	45	23
23-Jul	20	54	35	13	13	37	27	26	30	55	26	59	36	10	49	57
24-Jul	41	52	46	13	21	34	32	28	31	17	28	54	34	10	42	40
25-Jul	36	48	53	20	26	44	23	36	39	52	19	53	54	11	49	49
26-Jul	44	45	61	17	38	47	33	51	32	53	29	51	38	10	42	47
27-Jul	44	45	61	17	38	47	33	51	32	53	29	51	38	10	42	47
28-Jul	38	24	22	15	31	35	20	40	32	48	25	51	33	11	41	42
29-Jul	40	47	35	15	32	31	23	45	33	56	35	62	33	7	53	43
30-Jul	41	39	34	15	53	21	29	50	29	51	34	69	34	11	57	46
31-Jul	40	56	39	14	14	43	44	48	32	55	33	69	37	23	38	37

Sample Tracking of Residents per Unit

# of Residents per Unit	Other Unit	Unit B3	Unit A1	Unit A2	Other Unit	Other Unit	Other Unit	Other Unit	Unit B2	Other Unit	Other Unit	Unit B1	Other Unit	Other Unit	Other Unit	Other Unit
1-Oct																
2-Oct																
3-Oct																
4-Oct																
5-Oct	4	2		2				4		4	5	4	3		3	3
6-Oct														4		
7-Oct							5									
8-Oct					4	5										
9-Oct																

Detailed Demographics

Address	# of families that moved in	# of families that moved out	Date family moved in	# occupants in family that moved in	# of men	# of women	# of children
Other Unit	1	none	10/5/2009	4	1	1	2
Other Unit	1	none	10/5/2009	2	1	1	0
Unit A1	1	none	10/22/2009	4	1	1	2
Unit A2	1	none	10/5/2009	2	0	1	1
Other Unit	1	none	10/8/2009	4	1	1	2
* Other Unit	2	1	6/15/2010	5	1	1	3
Other Unit	1	none	10/8/2009	5	1	1	3
Other Unit	1	none	10/7/2009	5	1	1	3
Unit B3	1	none	10/5/2009	4	1	1	2
Unit B2	1	none	10/28/2009	2	1	1	0
Other Unit	1	none	10/5/2009	4	1	1	2
Other Unit	1	none	10/5/2009	5	1	1	3
Unit B1	1	none	10/5/2009	4	1	1	2
Other Unit	1	none	10/5/2009	3	1	1	1
Other Unit	1	none	10/6/2009	4	1	1	2
Other Unit	1	none	10/5/2009	3	1	1	1
* Other Unit	2	1	7/6/2010	3	1	1	1
Other Unit	1	none	10/5/2009	3	1	1	1
* Other Unit	2	1	4/28/2010	4	1	1	2
* There has been a change of occupancy							

Sample Consumption Data

Unit A1 – Foamed Unit

#	Date	Days	Read	Usage
120	2/21/2010	1	6401	36
121	2/22/2010	1	6460	59
122	2/23/2010	1	6493	33
123	2/24/2010	1	6524	31
124	2/25/2010	1	6557	33
125	2/26/2010	1	6599	42
126	2/27/2010	1	6635	36
127	2/28/2010	1	6688	53
128	3/1/2010	1	6740	52
129	3/2/2010	1	6768	28
130	3/3/2010	1	6796	28
131	3/4/2010	1	6836	40
132	3/5/2010	1	6855	19
133	3/6/2010	1	6883	28
134	3/7/2010	1	6936	53
135	3/8/2010	1	6981	45
136	3/9/2010	1	7018	37
137	3/10/2010	1	7049	31
138	3/11/2010	1	7091	42
139	3/12/2010	1	7121	30
140	3/13/2010	1	7156	35
141	3/14/2010	1	7207	51

Unit A2 – Foamed Unit

#	Date	Days	Read	Usage
119	2/21/2010	1	3410	14
120	2/22/2010	1	3421	11
121	2/23/2010	1	3438	17
122	2/24/2010	1	3450	12
123	2/25/2010	1	3461	11
124	2/26/2010	1	3473	12
125	2/27/2010	1	3485	12
126	2/28/2010	1	3500	15
127	3/1/2010	1	3512	12
128	3/2/2010	1	3522	10
129	3/3/2010	1	3533	11
130	3/4/2010	1	3542	9
131	3/5/2010	1	3559	17
132	3/6/2010	1	3578	19
133	3/7/2010	1	3588	10
134	3/8/2010	1	3594	6
135	3/9/2010	1	3612	18
136	3/10/2010	1	3623	11
137	3/11/2010	1	3633	10
138	3/12/2010	1	3649	16
139	3/13/2010	1	3664	15
140	3/14/2010	1	3675	11

Unit B3 - Non-foamed Unit

#	Date	Days	Read	Usage
85	2/21/2010	1	6193	41
86	2/22/2010	1	6227	34
87	2/23/2010	1	6274	47
88	2/24/2010	1	6322	48
89	2/25/2010	1	6364	42
90	2/26/2010	1	6415	51
91	2/27/2010	1	6457	42
92	2/28/2010	1	6505	48
93	3/1/2010	1	6535	30
94	3/2/2010	1	6588	53
95	3/3/2010	1	6613	25
96	3/4/2010	1	6647	34
97	3/5/2010	1	6694	47
98	3/6/2010	1	6737	43
99	3/7/2010	1	6787	50
100	3/8/2010	1	6830	43
101	3/9/2010	1	6878	48
102	3/10/2010	1	6926	48
103	3/11/2010	1	6970	44
104	3/12/2010	1	7014	44
105	3/13/2010	1	7056	42
106	3/14/2010	1	7076	20

Appendix D: Spray Foam Contractor Statement of Work

STATEMENT OF WORK FOR

Military Housing Foam Application

OSD Power Surety Task Force

- 1 Introduction.** The OSD Power Surety Task Force was officially created in early 2008, after nearly two years of work in demand reduction and renewable energy technologies to support the Warfighter in Theater. The Power Surety Task Force is tasked with identifying efficient energy solutions that support mission requirements. This is the guiding premise of the Power Surety Task Force: provide for transparent demand reduction, and then reduce the traditional power generation based upon reduced requirement and the provision of alternative and renewable energy sources. They have conducted reduction in power consumption demonstrations at Ft. Benning, Ft. Irwin, Kuwait, Iraq, and Afghanistan utilizing foam to reduce demand. Foam demonstrations were recently expanded beyond field structures to include military housing at Ft. Belvoir. Initial results to using the foam in both applications are favorable. Key questions remain; can this technology help to reduce utility costs for the Installation Commander? Is the foam cost effective? What application differences in housing affect those key metrics?

Sandia National Laboratories is a leader in research of energy systems and renewable energy technologies. Sandia has enduring relationships with the Department of Defense and with Forest City, operator of military housing in Hawaii. Sandia is a strategic member of the Hawaii Clean Energy Initiative (HCEI). The vision within HCEI is to engage all parties in Hawaii in creating a path to a sustainable, flexible, and economically vibrant State that uses clean energy resources to supply 70% or more of its energy needs by 2030, and to serve as an integrated model for the United States and island communities globally. DOD is the largest consumer of energy on the Islands and present rates range from 30-47 cents/kwh.

The critical need for energy solutions in Hawaii and the existing relationships between Sandia, DOD, DOE, and Forest City, make this location a logical choice for foam demonstration. This proposal outlines an approach for applying foam to one each residential housing unit at the Marine Corps Base's Waikulu community and one each government building at Hickam AFB.

Critical consumption data will be gathered over a set period of time. This data will be analyzed and initial metrics established for cost effectiveness of foam application. A report will be drafted that details this analysis, and will provide a foundation for further analysis and demonstration needs.

- 2 Scope of Work.** The objective of this effort is to deliver to the Government a technical report generated through three phases; application of the foam, analysis of foamed areas, and a foundation for further research/demonstration. This report will be derived and written by Sandia personnel in conjunction with close coordination of the Power Surety Task Force and Forest City Hawaii. The foaming will be conducted by the contractor in coordination with Forest City Hawaii for the housing unit and PACOM for the government facility.

2.1 General Requirements. The vendor/contractor shall foam the attic space (underside of roof) on a sample duplex house and the outside roof of a government office building. The house roof dimensions are approximately 2,300 sq. ft. and the office roof is approximately 3,900 sq.ft. Additional information on the duplex home is provided in Annex A, information on the government building is available upon request. This commercially available foam must meet all safety and fire codes, ATEC testing standards (to be provided by OSD) and its contents must have been evaluated for public use. Power Surety Task Force PACOM PM and foam installers will meet with Forest City Hawaii engineers at an initial site visit to ensure an application plan and timeframe are properly coordinated. Any other energy technology applications will be considered when analyzing data and establishing metrics, to provide a clear view of return on investment.

2.2 Site Description. The Contractor shall foam the duplex house at civil lot # 68 & 69 in Waikulu. This location includes both the baseline house and test house; decision on which lot # will be used for which purpose will be made by all interested parties during the site visit.

2.3 Site Access. The Contractor shall follow the following site access:

2.3.1 All Contractor personnel working at the construction site are subject to Forest City Hawaii construction regulations and military rules while on site.

2.3.2 The Contractor shall not drive or set material and equipment off of designated roads, access areas, right-of-ways, staging, or laying down areas, etc.. In addition no excavation, grading, leveling, grubbing, backfilling, etc. shall be performed beyond the area designated on the plans unless pre-approved by Government POC.

- 3 Conceptual Designs.** See Annex A

4 Foam Application & Assessment.

4.1 Spray Foaming - The Contractor shall conduct the following “work sets” required for the spraying of foam.

- 4.1.1** Site Survey
- 4.1.2** Site Prep
- 4.1.3** Foam Application
- 4.1.4** Post Application Inspection of Site

4.2 Monitoring and Analysis (performed by Sandia). Data collection will be performed on the home and government facility through a monitoring system, to determine demand and consumption rates. Analysis will be performed on this data that considers:

- 4.2.1** Demand
- 4.2.2** Peak load times
- 4.2.3** Cost and return on investment
- 4.2.4** Life cycle and maintenance of foam
- 4.2.5** Utilization in conjunction with other renewable energy technologies

An initial review of the data at 6 months will be performed, and an interim report will be drafted. A final report will be drafted at 12 months, updated with the remaining data.

4.3 Foundation for Future Demonstration (will be performed by Sandia). Review of the analysis and reports drafted, along with insights gathered during application of the foam, will provide a foundation for potential future work. A path forward will be determined that considers:

- 4.3.1** Sampling size of future foam applications
- 4.3.2** Commercial and residential benefits and consideration of other structures
- 4.3.3** Visibility of future demonstration locations
- 4.3.4** Demonstrations that may include additional renewable energy technologies

4.3.5 Additional / Advanced metrics

4.3.6 Reliability and life cycle issues

This path forward will assist in determining what additional safe, secure, sustainable, reliable and cost effective technologies could be installed in military housing to further drive down energy consumption.

4.4 Service Product and Equipment. The contractor shall provide all necessary equipment and foaming product to ensure adequate covering of said facilities in order to ensure proper analysis of energy savings capabilities. The contractor is responsible for all equipment while on site and responsibility for ensuring proper clean-up of said product upon completion of the project.

5 Schedule & Planning Requirement. The Contractor shall submit for approval an initial master project schedule (*As Planned Schedule*) addressing the targeted milestones and work breakdown structure (WBS). This master schedule will determine the planned start and finish dates for project activities. Once approved, master project schedule will serve as the baseline against which progress can be tracked. A duplicate master schedule (*As Built Schedule*) will contain all work progress, delays and other anticipated or new risk events.

5.1 As Planned Schedule.

5.2 Project & Construction Plans. The Contractor shall submit two (2) copies of the project and construction plans to the PSTF PACOM PM as required.

5.3 Daily Status Report. The contractor is responsible to provide information on schedule performance, such as which planned dates have been met and which have not. This report will communicate issues that are critical to the project completion. This report will be provided to the PSTF PACOM PM on a daily basis while the foaming is being performed.

6 Miscellaneous Construction Services.

6.1 Inspections. Contractor will make site available for the following inspections by the government.

6.1.1 Site Assessment

6.1.2 Construction Inspection

6.1.3 Walk through and Punch list

6.1.4 Final Inspection

6.2 Delivery.

6.2.1 Duplex House Foaming. In accordance with this SOW, the duplex house foaming is installed within **3** weeks from the date of the contact award. This deliverable is to include a **365**-day warranty, in accordance with the contractor's obligations, for the foam and its components effective upon installation to the Government at the Government's selected location.

6.2.2 Government building Foaming. In accordance with this SOW, the government building foaming is installed within **3** weeks from the date of the contact award. This deliverable is to include a 365-day warranty, in accordance with the contractor's obligations, for the foam and its components effective upon installation to the Government at the Government's selected location.

6.2.3 Warranty of Construction Components. The Contractor is responsible for submitting all warranty documents per component.

6.2.4 Reports (performed by Sandia) will be required as follows:

6.2.4.1 Foam application – Start + 6 months

6.2.4.2 Interim Foam Analysis & Report – Start + 6 months

6.2.4.3 Final Foam Analysis & Report – Start + 12 months

6.3 Maintenance & Repair Plan. Contractor to furnish with owners' manual (if applicable), information on structural maintenance and schedules. Also to include structural repair procedures.

7 Construction Demobilization.

7.1 Staging and Debris Disposal Areas. The Contractor shall conduct continual daily cleanup of the job site and the final cleanup when complete. Proper cleanup and disposal of all materials. Contractor is responsible for clean up of any and all construction debris generated by Contractor crew(s) or their subcontractors and vendors. Job site and staging areas should be contained at the end of each workday. Debris or spoils must be hauled away from job site by Contractor.

7.2 Final Inspections.

7.3 USACE EM385-1-1 regulations. The contractor is responsible to be in accordance with the latest USACE EM385-1-1 regulations.

7.4 Hazardous and Construction Waste Material Disposal. The Contractor shall properly disposed of all building material and byproducts from this construction site in accordance to Federal law.

8 Addresses for Deliverables.

Sandia Program Manager (PM):

ATTN: Juan Torres

Voice: (505) 844.0809

E-mail: jjtorre@sandia.gov

PSTF PACOM Program Manager (PM):

Address: 10236 Burbeck Rd (T-358), Ft Belvoir, VA 22060

ATTN: Richard Trundy

Voice: (253) 278.0098

Fax: (253) 649.0268

E-mail: rich.trundy@us.army.mil

Address: 10236 Burbeck Rd (T-358), Ft Belvoir, VA 22060

ATTN: Wade Jost

Voice: (253) 509.2013

Fax: (253) 649.0268

E-mail: wade.jost@us.army.mil

9 Distribution/Release Limitation Statements. All information provided to the contractor by the Government shall be protected from disclosure in accordance with the markings contained on the document and as described in the following text:

“Dissemination or public disclosure includes, but is not limited to: permitting access to such information by foreign nationals or by any other person or entity; publication of technical or scientific papers; advertising; or, any other proposed public release. The contractor shall provide adequate physical

protection to such information so as to preclude access by any person or entity not authorized such access by the Government.”

10 Security. This project is UNCLASSIFIED.

Appendix E: Maui Experiment Data Provided by SprayFoamHawaii

Hot Humid Climate Performance

Phase 1

- Two identical houses with no occupants
 - One house was build to code with glass fiber insulation
 - Was built to code with JM Corbond III™ Performance Insulation in the walls and roof
- Thermostats set to 74°F
- Temperature and humidity readings taken every 5 minutes
- Data readings from July 23rd-July 31st 2009
- Average exterior temperature in Hawaii 84°F
- Average relative humidity is in Hawaii 85%

Glass Fiber Insulation

Average Temp	75.1 °F	Average Humidity	52.9%
Maximum Temp	77.5	Maximum Hum.	65.0%
Low Temp	73.9	Low Hum.	44.0%
		Relative Humidity Ave	75%

SPRAYFOAM
HAWAII, LLC

Aug 25th-Sept 7th

Phase 2

- The house with JM Corbond III™ had the underside of the floor sprayed to create a full building envelope of JM Corbond III™
- Glass fiber insulated house stayed consistent
- Thermostats set to 74°F
- Temperature and humidity readings taken every 5 minutes
- Data readings from Aug 25th-Sept 7th 2009

August 25- September 7

Corbond Insulated House

Average Temperature 74.8°F
Average Humidity 32.4%
Power Usage 149 KWH

Power savings 46%

October 8th-25th

Average Temperature 75.1°F
Average Humidity 51.6%
Power Usage 274 kWh

October 8th-25th

Phase 3

- The glass fiber house had the underside of the floor sprayed JM Corbond III™ as a retrofit application.
- The JM Corbond III insulated house stayed consistent
- Thermostats set to 74°F
- Temperature and humidity readings taken every 5 minutes
- Data readings from Oct 8th-Oct 25th 2009

Oct. 8th- Oct 25th

JM Corbond III™

Average Temperature 75.8°F
Average Humidity 32.0%
Power Usage 172 kWh

Power savings 31%

Oct. 8th- Oct 25th

Average Temperature **74.8°F**
Average Humidity **39.0%**
Power Usage **225 Kwh**

Conclusion

- A full building envelope of JM Corbond III™ delivered a 46% saving for the same R-value as tradition insulation.
- By insulation the underside of the floor with JM Corbond III™ a ≈15% energy savings was realized
- Significant energy savings can be achieved in new construction by installing a full building envelope of JM Corbond III™ to the code stated R-value.
- For existing structures spraying the underside of the floor represents the opportunity to save 15% of cooling costs. This is an excellent retrofit application.

Distribution:

1 MS1108 Juan J Torres

1 MS0899 Technical Library, 9536 (electronic copy)