Building America Gate 3 Report
40% Efficiency in Hot-Humid Climate
Forest City Military Communities LLC – NC TAMS
Wahiawa, HI

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Forest City Military Communities LLC –NC TAMS
Wahiawa, HI

Executive Summary

Title: Building America 40% Hot-Humid Community
Forest City Military Communities LLC – NC TAMS, Wahiawa, HI

Overview

This report presents the evaluation results of the Forest City Military Communities LLC (known herein as Forest City) – Naval Computer and Telecommunications Area Master Station (NCTAMS) Community in Wahiawa, Hawaii to determine if it meets the Building America (BA) 40% whole house energy savings (WHES) goal when compared to the BA Benchmark in the Hot-Humid Climate Zone. The community evaluation was based on the Building America's Stage Gate 3 "Must Meet" and "Should Meet" criteria for Initial Community Scale Evaluations. The key research partner in this endeavor is Will Boudra, Development Manager of Forest City.

Key Results

It has been determined that the NCTAMS community qualifies as a Building America 40% Community in the Hot-Humid Climate Zone. This assessment is based on an energy analysis performed using Energy Gauge™ 2.8.01, incremental costs based on builder estimates, and additional information gained first hand from Forest City.

Gate Status

To date, Forest City has built 46 homes and expects 37 more homes to be complete in the NCTAMS community by September. The NCTAMS community includes two floor plan models. An energy analysis performed on the two building models show whole house energy savings of 47.6% and 48.9%, resulting in a 48.3% average compared to the Building America Benchmark. As the worst case, the floor plan model which provided the least whole house energy savings was selected for reporting purposes. Based on the energy savings from Energy Gauge™ and incremental costs from Forest City, it has been determined that the expected energy cost savings is approximately $1,496 per year when compared to the Building America Benchmark.

As a developer for military-subsidized personnel housing, Forest City has been able to occupy the NCTAMS community within a week of final inspections. The NCTAMS community is helping to strengthen the sustainable home market by demonstrating the benefits and cost effectiveness of energy efficient homes to young service men and women. Forest City has committed significant time and resources to educate their staff, subcontractors, and customers about the benefits of high performance homes. Their commitment to energy efficiency is evident by the amount of building science training that Forest City staff has received from the BIRA team.

Conclusions

Forest City is one of the best examples of a Building America builder in the Hot-Humid Climate Zone. Their continued dedication to improving their designs will most certainly create an opportunity for them to build a community that displays 50% whole house energy savings in the future. If Forest City continues to keep their costs low while closing the gaps mentioned above, energy savings, comfort, and quality will continue to improve.

Community Overview

Forest City is a large progressive developer and property management company working with the U.S Navy and Marines to deliver comfortable, cost effective, energy efficient homes. Forest City builds and manages single family detached and attached homes, townhomes and non-residential projects. As developers of Military housing, Forest City understands the importance of building energy efficient and eco-friendly units, so as to minimize the cost impact on tax payers, who fund construction, operating and maintenance costs for military housing, while providing comfortable, quality housing to the servicemen of our country. They are constructing energy efficient housing in a climate zone that is largely struggling to meet code, and as such they are a prime example of a Building America builder/developer partner in the Hot-Humid Climate Zone. The NCTAMS community, currently at least 47.6% more efficient than the Building America Benchmark, is an example of their proactive building strategy. Their continuing dedication to improved designs will most certainly create an opportunity for them to build a community that achieves substantially greater than 40% whole house energy savings in the future.

The NCTAMS community is in Wahiawa (near Honolulu), on the island of Oahu, Hawaii, and is located in Building America's Hot-Humid Climate Zone. This city experiences an average annual precipitation of 22.0 inches, zero annual heating degree days and 4474 annual cooling degree days[1]. These weather patterns provide the opportunity for energy savings from reduction in space cooling loads. Hawaii leads the nation with the most expensive average, state-wide utility rate. The average electric rate is 23 cents/kWh, and due to the high cost of natural gas, $4.28/therm, all building features and appliances are electric.

This case study will demonstrate that the NCTAMS Community will meet Building America's 40% initial community's goal for the Hot-Humid Climate Zone while addressing all of Stage Gate's "Must Meet" and "Should Meet" criteria.

"Must Meet" Gate Criteria

Source Energy Savings

Using Energy Gauge™ 2.8.01, an energy analysis was performed on the only two floor plan models in Forest City's NCTAM community. The models include 1,720 and 1,984 square feet of finished floor area (respectively), three bedrooms, two bathrooms, and identical building features. As the worst case, the floor plan model which provided the least whole house energy savings was selected for reporting purposes and hereon represented in all analysis shown. Figure 1 shows the Energy Gauge™ source energy use graph with the BA Benchmark as the reference house. Table 1 summarizes the findings of the energy simulation. The energy savings are averaged over all four orientations and grouped into five main end use categories.

[1] http://www.climate-zone.com/climate/united-states/hawaii/honolulu/

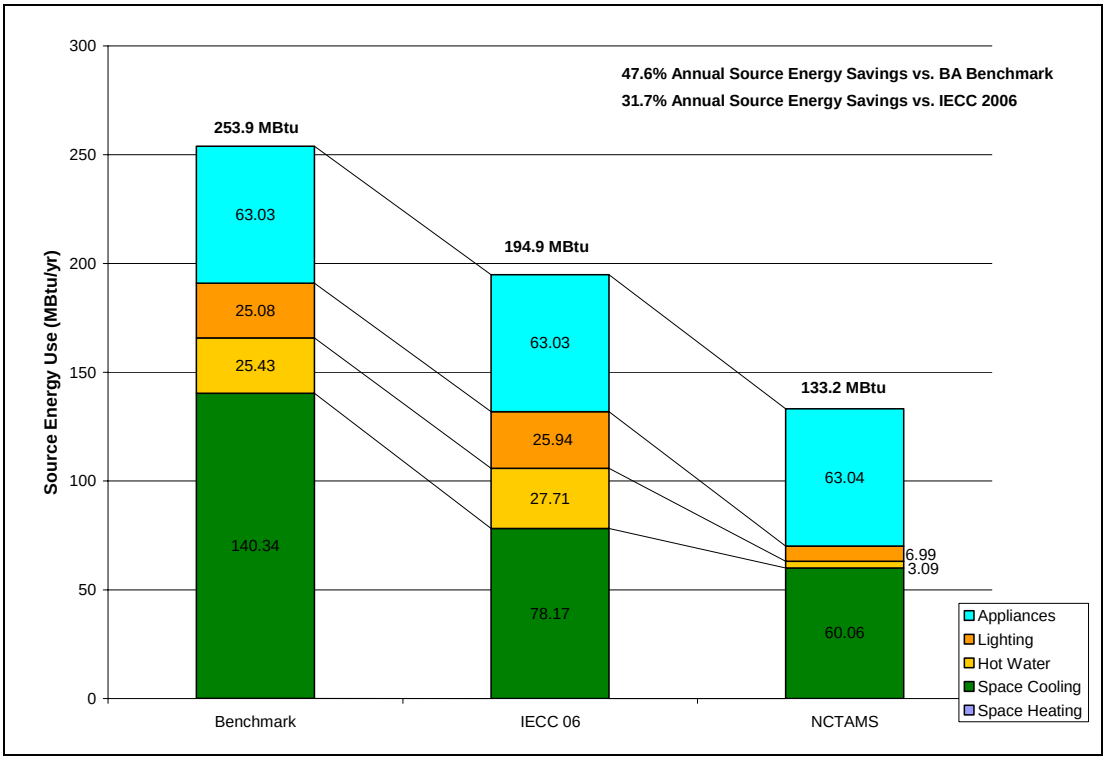


Figure 1. Energy Gauge Source Energy Use

Description	Annual Source Energy			Estimated Source Energy Savings				Annual Utility Bill Savings
	Benchmark	Builder Standard Practice (IECC 2006)	NCTAMS	Percent of End Use		Percent of Total		
End Use	(MBtu/yr)	(MBtu/yr)	(MBtu/yr)	vs. Benchmark	vs. Code	vs. Benchmark	vs. Code	vs. Benchmark
Space Heating	0.1	0.0	0.0	80.7%	67.6%	0.0%	0.0%	$1
Space Cooling	140.3	78.2	60.1	57.2%	23.2%	31.6%	9.3%	$1,618
DHW	25.4	27.7	3.1	87.9%	88.9%	8.8%	12.6%	$362
Lighting	25.1	25.9	7.0	72.1%	73.1%	7.1%	9.7%	$283
Appliances and MELs	63.0	63.0	63.0	0.0%	0.0%	0.0%	0.0%	-$11
PV	0.0	0.0	0.0	n/a	n/a	0.0%	0.0%	$0
Total Usage/ Savings	**253.9**	**194.9**	**133.2**	**47.6%**	**31.7%**	**47.6%**	**31.7%**	**$2,253**

Table 1. Source Energy Savings

As shown in Table 1, a worse case NCTAMS house meets the Building America goal of 40% energy savings in the Hot-Humid Climate Zone with respect to the BA Benchmark. The critical energy reduction features implemented in order to reach this goal are as follows:

- R25 attic insulation
- R13 exterior wall insulation
- 5.0 ACH_{50} infiltration
- 0.35 U-value/0.40 SHCG windows
- R6 Ducts in Attic
- SEER 16 A/C
- 90% EF electric water heater
- 32 ft^2 closed loop solar thermal water heater
- 100% hardwired CFL lighting
- ENERGY STAR refrigerator, dishwasher, and clothes washer

Market Coverage

The NCTAMS community will consist of 83 homes when complete. Currently, 46 homes have been constructed. Based on this information, Forest City's NCTAMS community passes the Market Coverage "Must Meet" criteria.

Neutral Cost Target

Forest City has been able to keep its costs marketable while implementing energy efficiency features. Costs are naturally higher in Hawaii due to the building material importation; however their large production scale has allowed them to work with vendors to quickly receive mature-market costs. The worst case floor plan model from the NCTAMS community met the neutral cost target. When financed as part of a 30 year mortgage, the incremental annual cost of energy improvements is much less than the annual utility bill savings resulting in an approximate $1,496 net annual cash flow to the homeowner, as illustrated in Figure 2.

Figure 3 shows the Energy Gauge™ end-use source energy cost with the BA Benchmark as the reference house. It should be noted that this does not include fluctuations in utility rates or inflation. These costs are based on the utility rates in Honolulu, Hawaii and include only electric energy sources.

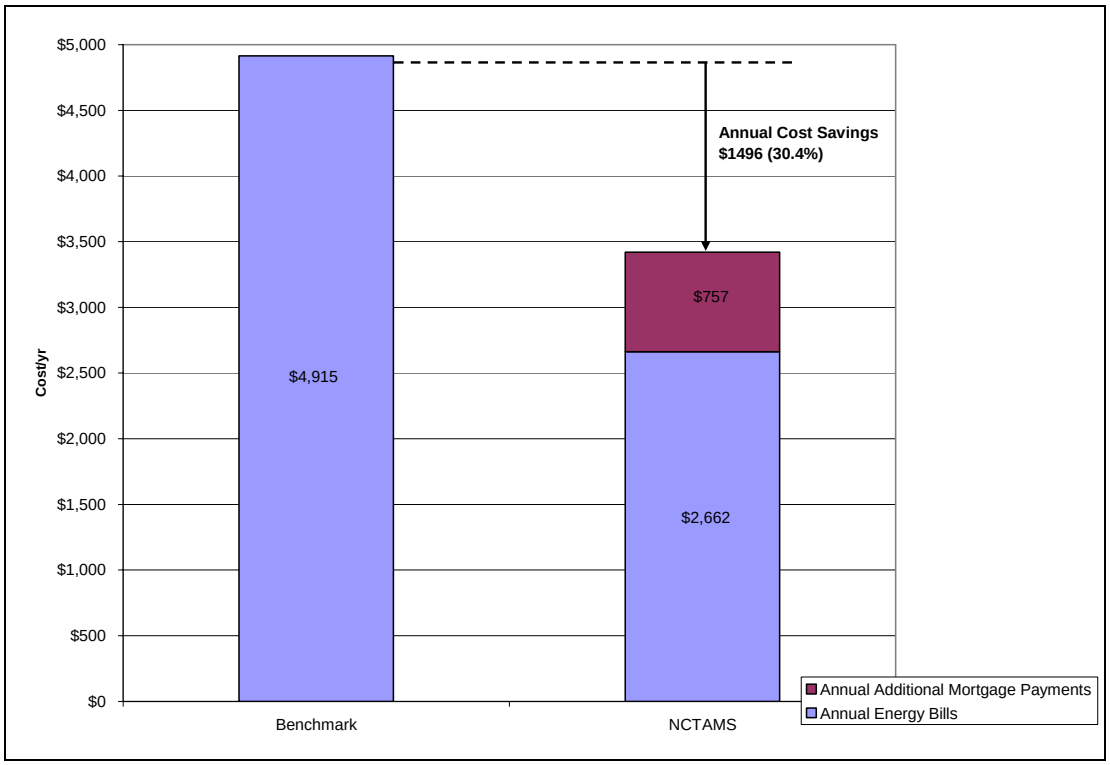


Figure 2. Neutral Cost Graph

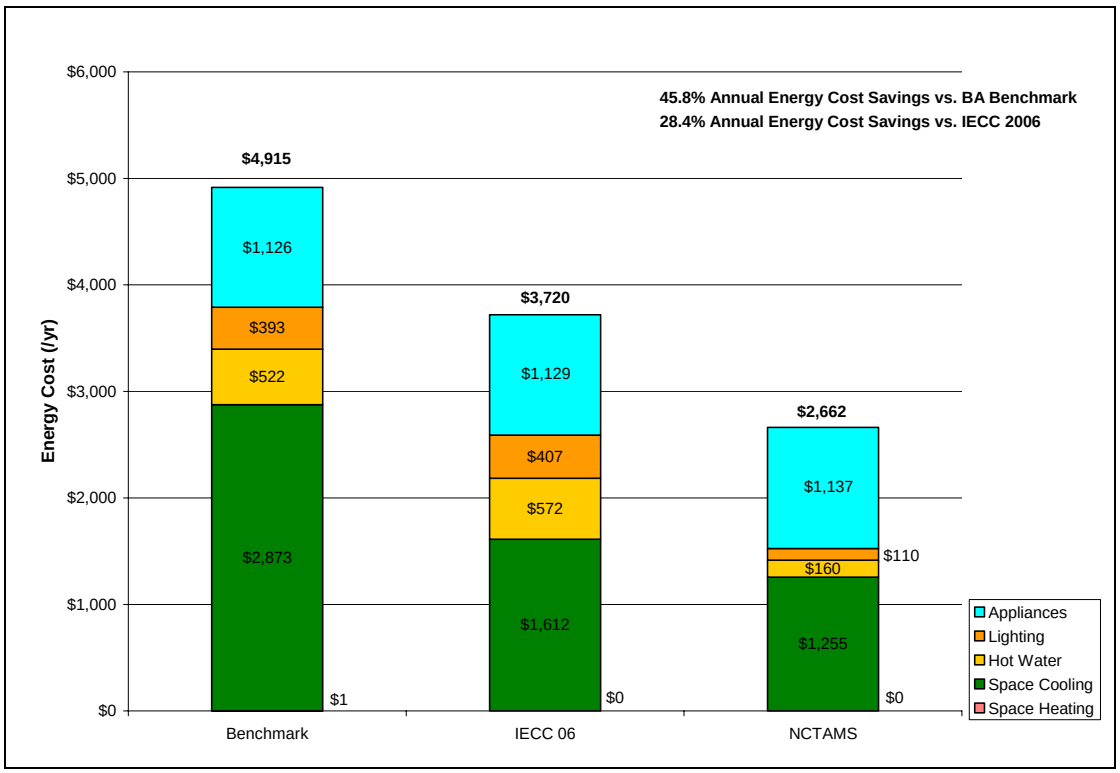


Figure 3. End-use Site Energy Costs

As shown below in Table 2, the net annual cash flow to the homeowner is approximately $1,496. Based on this information, it is clear that the incremental annual cost of energy improvements is much less than the annual reduction in utility bill costs and Forest City's NCTAMS community meets the Neutral Cost Target "Must Meet" criteria.

The top half of Table 2 adds a column to Table 1 that details the annual utility bill savings of each of the five main end use categories in comparison to the BA Benchmark. The bottom half of Table 2 is derived from the builder's first cost for each of the energy efficiency features listed. A 10% markup is assumed and the cost is converted into an annuity assuming a 7% loan over 30 years.

Description	Annual Source Energy			Estimated Source Energy Savings				Annual Utility Bill Savings
	Benchmark	Builder Standard Practice (IECC 2006)	NCTAMS	Percent of End Use		Percent of Total		
End Use	(MBtu/yr)	(MBtu/yr)	(MBtu/yr)	vs. Benchmark	vs. Code	vs. Benchmark	vs. Code	vs. Benchmark
Space Heating	0.1	0.0	0.0	80.7%	67.6%	0.0%	0.0%	$1
Space Cooling	140.3	78.2	60.1	57.2%	23.2%	31.6%	9.3%	$1,618
DHW	25.4	27.7	3.1	87.9%	88.9%	8.8%	12.6%	$362
Lighting	25.1	25.9	7.0	72.1%	73.1%	7.1%	9.7%	$283
Appliances and MELs	63.0	63.0	63.0	0.0%	0.0%	0.0%	0.0%	-$11
PV	0.0	0.0	0.0	n/a	n/a	0.0%	0.0%	$0
Total Usage/ Savings	**253.9**	**194.9**	**133.2**	**47.6%**	**31.7%**	**47.6%**	**31.7%**	**$2,253**

Energy Efficiency Feature	Total Cost	Annual Mortgage Cost
		vs. Code
R13 Exterior Walls	$147	$13
R25 Ceiling (Under Attic)	$0	$0
Highly Efficient Windows	$599	$53
16 SEER A/C unit	$592	$52
Improved Duct Sealing, Envelope Sealing, and Testing	$663	$58
120 gal Water Heater 0.9 EF	$1,570	$138
Pipe Insulation Water Distribution	$150	$13
32 sq ft solar collector	$4,800	$422
100% CFL Lighting	$100	$9
Total Annual Mortgage Cost	$3,721	**$757**
Net Annual Cash Flow to Consumer		**$1,496**

Table 2. Neutral Cost Analysis

"Should Meet" Gate Criteria

Marketability

As a developer for military-subsidized personnel, Forest City has been able to occupy the NCTAMS community within a week of final inspections. The homes are being constructed as a plan to replace older, less efficient homes, while increasing the number of units to maximize the use of land. The NCTAMS community is helping to strengthen the sustainable home market by demonstrating the benefits and cost effectiveness of energy efficient homes to young service men and women.

Based on current sales and marketing information, Forest City's NCTAMS community passes the Marketability "Should Meet" criteria.

Builder Commitment

Forest City has made a commitment to only build energy efficient homes. In 2007, they began construction of homes at the 35% BA benchmark. Since then, they have further upgraded features and construction practices to reach up-to the 40% plus WHES level, and are committed to building their homes beyond both Energy Star and Builders Challenge program benchmarks.

Forest City has committed significant time and resources to educate their staff, subcontractors, and customers about the benefits of high performance homes. Their commitment to energy efficiency is evident by the amount of building science training that Forest City staff has received from the BIRA team. In 2009, BIRA traveled to Forest City's numerous communities to test and inspect at rough homes, and to train the field staff. This has resulted in improved insulation installation, tighter homes and improved ducting to maximize the home's efficiency. This team commitment helps differentiate Forest City from other production builders.

Based on these proactive energy efficiency practices at the NCTAMS community, Forest City passes the Builder Commitment "Should Meet" criteria.

Gaps Analysis

Forest City had a few problems with proper sealing of the home, installation of insulation and ducting. Construction practices in Hawaii are not as rigorous as in other parts of the nation, and even though Forest City was committed to more efficient homes, their subcontractors were not up to par with the required installation techniques, or QA/QC.

An additional barrier for Forest City's NCTAMS community has to do with occupant driven loads. As a military-subsidized personnel housing community, the occupants do not pay for their utility bills, and as such are not as conscientious about the amount of their energy consumption. To combat this issue, Forest City is taking a two step approach: Home Energy Management (HEM) systems and utility allowances.

Regarding use of HEM systems, Forest City will be prototyping the Verve Living System to test the feasibility, constructability and energy savings produced by the system. The HEM system will reduce lighting and cooling loads through a whole house control switch, as well as occupant, door and window sensors. If a door or window is left open, the HVAC system will automatically shut down.

Additionally, Forest City is putting more responsibility on the occupants to properly manage their energy use, by imposing a utility bill allowance on each unit. Occupant training in energy efficiency practices will be especially important if Forest City switches to a monthly allowance type billing system for utility usage. This system is similar to a Tiered energy rate structure, except Tier 1 would be covered, and Tier 2 would have to be paid for by the current occupants. This approach, coupled with a HEM system and educational material should reduce the energy consumption of the occupants.

In the future, Forest City plans on working with Building America to continue to develop increasingly efficient homes that further reduce heating and cooling loads.

Quality Assurance

Forest City has demonstrated a strong commitment to quality assurance. They have aggressive inspection and third-party verification protocols to ensure that the building features are properly installed and functional, including but not limited to Energy Star® Thermal Bypass Inspection Checklist and RESNET HERS inspections.

BIRA has worked with the developer's superintendents and construction managers to ensure that their construction protocols are up-to-date and compliance measures are met. By addressing the issues found during testing and inspection and by implementing BIRA's recommendations (based on Building America's Hot-Humid Best Practices Series), Forest City was able to make energy-efficient changes to their construction techniques and produce homes which provide at least 40% WHES (Appendix D).

Based on this information, Forest City's NCTAMS community passes the Quality Assurance "Should Meet" criteria.

Conclusions

As a result of the collaborative efforts by Forest City and BIRA, the NCTAMS community has become a high performance, cost efficient development. Simulation results indicate that a house in the NCTAMS community saves at least approximately 47.6% more energy than the BA Benchmark. The technology pathway exceeded cost neutrality with an approximate $1,496 annual net cost savings. By incorporating a smart design, improved construction practice, and high efficiency, "off-the-shelf" equipment, the 40% WHES target was achieved in the Hot-Humid Climate Zone.

Appendix A : Stage Gate 3 – Community Evaluation Criteria

Gate 3 Research Objective
Evaluate performance of final production building designs using energy simulations and targeted field tests, if needed.

"Must Meet" Gate Criteria

Source Energy Savings

1. Final production home designs must provide targeted whole house source energy efficiency savings based on BA performance analysis procedures and prior stage energy performance measurements.

Market Coverage (including projects from all teams)

2. Must have a minimum of 10 homes per project.
At least five homes must be completed by March/April to be used as a case study in the annual Joule* report.

Neutral Cost Target

3. The incremental annual cost** of energy improvements, when financed as part of a 30 year mortgage, must be less than or equal to the annual reduction in utility bill costs relative to the BA benchmark house.

* Five completed G3 project reports and case studies, including reports from all teams, are used to document completion of DOE's Annual Joule milestone for each climate and performance level.
** Mature market incremental first cost evaluated relative to builder standard practice

"Should Meet" Criteria

Marketability

1. Based on initial response from model homes, should be marketable relative to the value-added benefit seen by consumers at increased or neutral cost.

Market Coverage

2. Project case studies should cover a representative range of weather conditions and

construction practices in major metropolitan areas in the targeted climate region.

Builder Commitment

3. Should demonstrate strong builder commitment to continued construction at current or future BA performance targets.

Gaps Analysis

4. Should include a summary of builder technical support requirements, gaps analysis, lessons learned, optimal builder business practices, what not to do, documentation of failures, recommendations for policy improvements, and remaining technical and market barriers to achieving current and future performance levels.

Quality Assurance

5. Should provide documentation of builder's energy related QA and QC processes.

Appendix B : Energy Gauge Source Energy Summaries

Building America

Source Energy Summary 2008

Project Title: Forest City- NC TAMS Plan 113

Climate: HI_HONOLULU_INTL_ARPT

11/24/2009

Honolulu , HI

End Use:	Benchmark					Prototype					Savings
	kWh	Therm	Gal	MBTU	Cost	kWh	Therm	Gal	MBTU	Cost	Source
Total Space Heating:	5	0	0	0.057	1	1	0	0	0.011	0	80.0%
Heating:	4	0	0	0.046	1	1	0	0	0.011	0	
Heating Fan:	1	0	0	0.011	0	0	0	0	0.000	0	
Total Space Cooling:	12223	0	0	140.337	2873	5231	0	0	60.059	1255	57.2%
Cooling:	10446	0	0	120	2456	4340	0	0	50	1041	
Cooling Fan:	1777	0	0	20.402	417	891	0	0	10.230	214	
Total Hot Water:	2215	0	0	25.434	522	269	0	0	3.085	160	87.9%
Lighting Subtotal:	2184	0	0	25.079	393	608	0	0	6.986	110	72.1%
Wired Lighting:	1818	0	0	20.874	327	506	0	0	5.813	91	72.2%
Plug Lighting:	366	0	0	4.204	66	102	0	0	1.173	18	72.1%
Appliance Subtotal:	5456	0	0	62.643	1115	5456	0	0	62.643	1126	0.0%
Refrigerator:	669	0	0	7.681	156	669	0	0	7.681	162	0.0%
ClothesWasher:	105	0	0	1.206	24	105	0	0	1.206	24	0.0%
ClothesDryer:	835	0	0	9.587	198	835	0	0	9.587	203	0.0%
Dishwasher:	206	0	0	2.365	48	206	0	0	2.365	48	0.0%
Cooking:	605	0	0	6.946	143	605	0	0	6.946	143	0.0%
Other Appls:	3036	0	0	34.858	546	3036	0	0	34.858	546	0.0%
Ceiling Fan:	0	0	0	0.000	0	0	0	0	0.000	0	
OAVentilation Fan:	34	0	0	0.390	11	35	0	0	0.402	11	-2.9%
Total:	22118	0	0	253.94	4916	11600	0	0	133.18	2662	47.6%
Generation(PV):	0	0	0	0	0	0	0	0	0.000	0	
Net:	**22118**	**0**	**0**	**253.94**	**4916**	**11600**	**0**	**0**	**133.18**	**2662**	**47.6%**

EnergyGauge USA 2.8 page 2

Figure 4. Energy Gauge Source Energy Summary for Above-Code Plan 113

Building America

Source Energy Summary 2008

Project Title: Forest City- NC TAMS Plan 113 (IECC 06)

Climate: HI_HONOLULU_INTL_ARPT

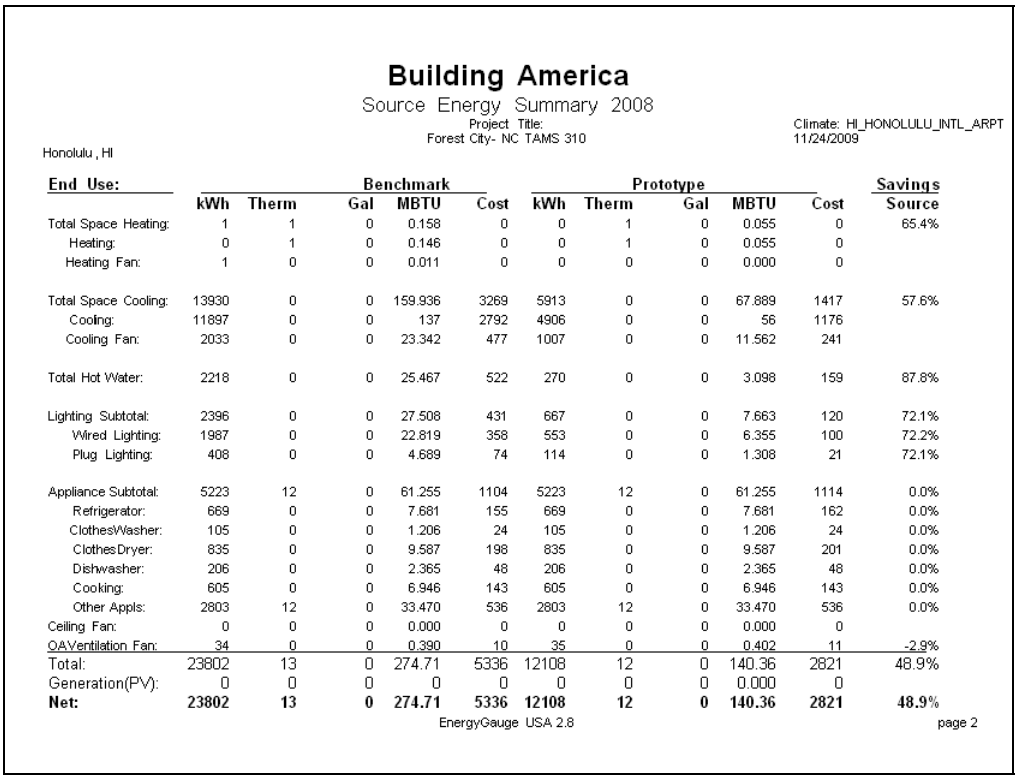
11/24/2009

Honolulu , HI

End Use:	Benchmark					Prototype					Savings
	kWh	Therm	Gal	MBTU	Cost	kWh	Therm	Gal	MBTU	Cost	Source
Total Space Heating:	4	0	0	0.046	1	3	0	0	0.034	0	25.0%
Heating:	4	0	0	0.046	1	3	0	0	0.034	0	
Heating Fan:	0	0	0	0.000	0	0	0	0	0.000	0	
Total Space Cooling:	12210	0	0	140.188	2873	6808	0	0	78.165	1612	44.2%
Cooling:	10436	0	0	120	2456	5572	0	0	64	1319	
Cooling Fan:	1774	0	0	20.368	417	1236	0	0	14.191	293	
Total Hot Water:	2215	0	0	25.434	520	2413	0	0	27.705	572	-8.9%
Lighting Subtotal:	2184	0	0	25.079	393	2259	0	0	25.940	407	-3.4%
Wired Lighting:	1818	0	0	20.874	327	1880	0	0	21.584	338	-3.4%
Plug Lighting:	366	0	0	4.204	66	379	0	0	4.355	68	-3.6%
Appliance Subtotal:	5456	0	0	62.643	1115	5456	0	0	62.643	1118	0.0%
Refrigerator:	669	0	0	7.681	156	669	0	0	7.681	159	0.0%
ClothesWasher:	105	0	0	1.206	24	105	0	0	1.206	24	0.0%
ClothesDryer:	835	0	0	9.587	198	835	0	0	9.587	198	0.0%
Dishwasher:	206	0	0	2.365	48	206	0	0	2.365	48	0.0%
Cooking:	605	0	0	6.946	143	605	0	0	6.946	143	0.0%
Other Appls:	3036	0	0	34.858	546	3036	0	0	34.858	546	0.0%
Ceiling Fan:	0	0	0	0.000	0	0	0	0	0.000	0	
OAVentilation Fan:	34	0	0	0.390	11	34	0	0	0.390	11	0.0%
Total:	22104	0	0	253.77	4914	16973	0	0	194.87	3720	23.2%
Generation(PV):	0	0	0	0	0	0	0	0	0.000	0	
Net:	**22104**	**0**	**0**	**253.77**	**4914**	**16973**	**0**	**0**	**194.87**	**3720**	**23.2%**

EnergyGauge USA 2.8 page 2

Figure 5. Energy Gauge Source Energy Summary for IECC 2006 Complaint Plan 113



Building America

Source Energy Summary 2008

Project Title: Forest City- NC TAMS 310

Climate: HI_HONOLULU_INTL_ARPT

11/24/2009

Honolulu , HI

End Use:	Benchmark					Prototype					Savings
	kWh	Therm	Gal	MBTU	Cost	kWh	Therm	Gal	MBTU	Cost	Source
Total Space Heating:	1	1	0	0.158	0	0	1	0	0.055	0	65.4%
Heating:	0	1	0	0.146	0	0	1	0	0.055	0	
Heating Fan:	1	0	0	0.011	0	0	0	0	0.000	0	
Total Space Cooling:	13930	0	0	159.936	3269	5913	0	0	67.889	1417	57.6%
Cooling:	11897	0	0	137	2792	4906	0	0	56	1176	
Cooling Fan:	2033	0	0	23.342	477	1007	0	0	11.562	241	
Total Hot Water:	2218	0	0	25.467	522	270	0	0	3.098	159	87.8%
Lighting Subtotal:	2396	0	0	27.508	431	667	0	0	7.663	120	72.1%
Wired Lighting:	1987	0	0	22.819	358	553	0	0	6.355	100	72.2%
Plug Lighting:	408	0	0	4.689	74	114	0	0	1.308	21	72.1%
Appliance Subtotal:	5223	12	0	61.255	1104	5223	12	0	61.255	1114	0.0%
Refrigerator:	669	0	0	7.681	155	669	0	0	7.681	162	0.0%
ClothesWasher:	105	0	0	1.206	24	105	0	0	1.206	24	0.0%
ClothesDryer:	835	0	0	9.587	198	835	0	0	9.587	201	0.0%
Dishwasher:	206	0	0	2.365	48	206	0	0	2.365	48	0.0%
Cooking:	605	0	0	6.946	143	605	0	0	6.946	143	0.0%
Other Appls:	2803	12	0	33.470	536	2803	12	0	33.470	536	0.0%
Ceiling Fan:	0	0	0	0.000	0	0	0	0	0.000	0	
OAVentilation Fan:	34	0	0	0.390	10	35	0	0	0.402	11	-2.9%
Total:	23802	13	0	274.71	5336	12108	12	0	140.36	2821	48.9%
Generation(PV):	0	0	0	0	0	0	0	0	0.000	0	
Net:	**23802**	**13**	**0**	**274.71**	**5336**	**12108**	**12**	**0**	**140.36**	**2821**	**48.9%**

EnergyGauge USA 2.8

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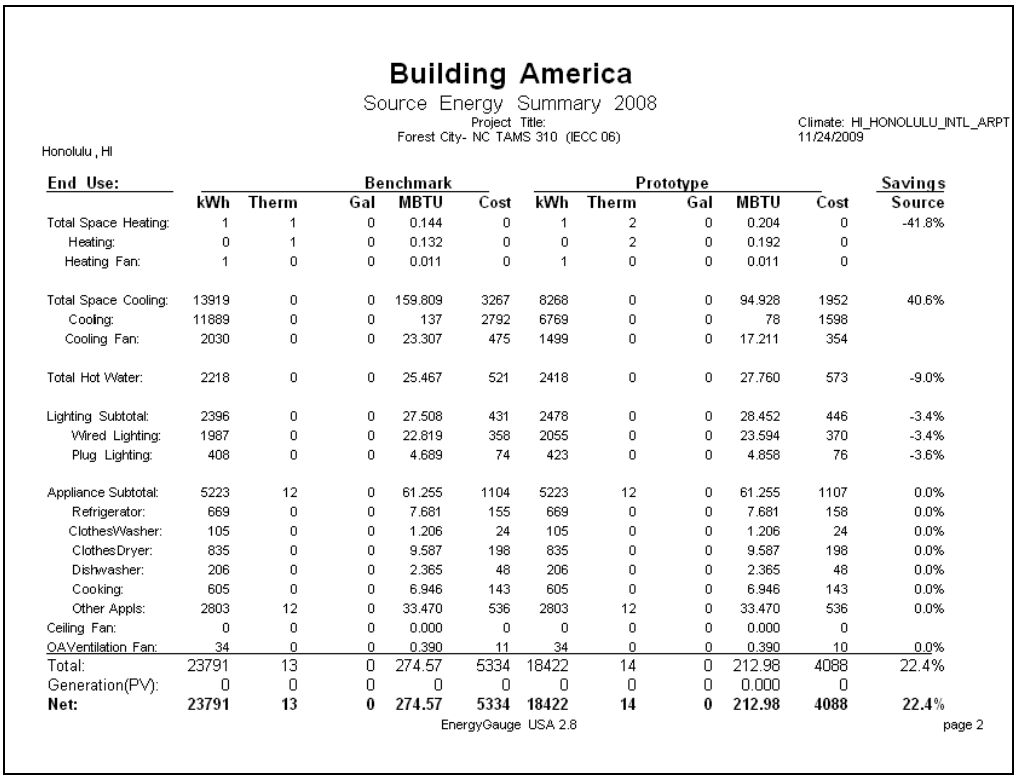
Figure 6. Energy Gauge Source Energy Summary for Above-Code Plan 310



Building America

Source Energy Summary 2008

Project Title: Forest City- NC TAMS 310 (IECC 06)

Climate: HI_HONOLULU_INTL_ARPT

11/24/2009

Honolulu , HI

End Use:	Benchmark					Prototype					Savings
	kWh	Therm	Gal	MBTU	Cost	kWh	Therm	Gal	MBTU	Cost	Source
Total Space Heating:	1	1	0	0.144	0	1	2	0	0.204	0	-41.8%
Heating:	0	1	0	0.132	0	0	2	0	0.192	0	
Heating Fan:	1	0	0	0.011	0	1	0	0	0.011	0	
Total Space Cooling:	13919	0	0	159.809	3267	8268	0	0	94.928	1952	40.6%
Cooling:	11889	0	0	137	2792	6769	0	0	78	1598	
Cooling Fan:	2030	0	0	23.307	475	1499	0	0	17.211	354	
Total Hot Water:	2218	0	0	25.467	521	2418	0	0	27.760	573	-9.0%
Lighting Subtotal:	2396	0	0	27.508	431	2478	0	0	28.452	446	-3.4%
Wired Lighting:	1987	0	0	22.819	358	2055	0	0	23.594	370	-3.4%
Plug Lighting:	408	0	0	4.689	74	423	0	0	4.858	76	-3.6%
Appliance Subtotal:	5223	12	0	61.255	1104	5223	12	0	61.255	1107	0.0%
Refrigerator:	669	0	0	7.681	155	669	0	0	7.681	158	0.0%
ClothesWasher:	105	0	0	1.206	24	105	0	0	1.206	24	0.0%
ClothesDryer:	835	0	0	9.587	198	835	0	0	9.587	198	0.0%
Dishwasher:	206	0	0	2.365	48	206	0	0	2.365	48	0.0%
Cooking:	605	0	0	6.946	143	605	0	0	6.946	143	0.0%
Other Appls:	2803	12	0	33.470	536	2803	12	0	33.470	536	0.0%
Ceiling Fan:	0	0	0	0.000	0	0	0	0	0.000	0	
OAVentilation Fan:	34	0	0	0.390	11	34	0	0	0.390	10	0.0%
Total:	23791	13	0	274.57	5334	18422	14	0	212.98	4088	22.4%
Generation(PV):	0	0	0	0	0	0	0	0	0.000	0	
Net:	**23791**	**13**	**0**	**274.57**	**5334**	**18422**	**14**	**0**	**212.98**	**4088**	**22.4%**

EnergyGauge USA 2.8

page 2

Figure 7. Energy Gauge Source Energy Summary for IECC 2006 Complaint Plan 310

Appendix C : Annual Incremental Mortgage Cost Calculation

Energy Efficiency Feature	Builder Cost	10% Markup	Total	Monthly Cost	Annual Cost
R13 Exterior Walls	$147	$14.73	$162.03	$1.08	$12.94
R25 Ceiling (Under Attic)	$0	$0.00	$0.00	$0.00	$0.00
Highly Efficient Windows	$599	$59.90	$658.90	$4.38	$52.60
16 SEER A/C unit	$592	$59.20	$651.20	$4.33	$51.99
Improved Duct Sealing, Envelope Sealing, and Testing	$663	$66.29	$729.14	$4.85	$58.21
120 gal Water Heater 0.9 EF	$1,570	$157.00	$1,727.00	$11.49	$137.88
Pipe Insulation Water Distribution	$150	$15.00	$165.00	$1.10	$13.17
32 sq ft solar collector	$4,800	$480.00	$5,280.00	$35.13	$421.54
100% CFL Lighting	$100	$10.00	$110.00	$0.73	$8.78
Totals	**$8,621.15**	**$862.12**	**$9,483.27**	**$63.09**	**$757.11**

Table 3. Annual Mortgage Increase Calculation

Appendix D : Third Party Verification Protocols

ENERGY STAR Qualified Homes
Thermal Bypass Inspection Checklist

Home Address:_____ City:_____ State:_____

Thermal Bypass	Inspection Guidelines	Corrections Needed	Builder Verified	Rater Verified	N/A
1. Overall Air Barrier and Thermal Barrier Alignment	**Requirements:** Insulation shall be installed in full contact with sealed interior and exterior air barrier except for alternate to interior air barrier under item no. 2 *(Walls Adjoining Exterior Walls or Unconditioned Spaces)*				
	All Climate Zones:				
	1.1 Overall Alignment Throughout Home	☐	☐	☐	☐
	1.2 Garage Band Joist Air Barrier (at bays adjoining conditioned space)	☐	☐	☐	☐
	1.3 Attic Eave Baffles Where Vents/Leakage Exist	☐	☐	☐	☐
	Only at Climate Zones 4 and Higher:				
	1.4 Slab-edge Insulation (A maximum of 25% of the slab edge may be uninsulated in Climate Zones 4 and 5.)	☐	☐	☐	☐
	Best Practices Encouraged, Not Req'd.:				
	1.5 Air Barrier At All Band Joists (Climate Zones 4 and higher)	☐	☐	☐	☐
	1.6 Minimize Thermal Bridging (e.g., OVE framing, SIPs, ICFs)	☐	☐	☐	☐
2. Walls Adjoining Exterior Walls or Unconditioned Spaces	**Requirements:** • Fully insulated wall aligned with air barrier at both interior and exterior, OR • Alternate for **Climate Zones 1 thru 3**, sealed exterior air barrier aligned with RESNET Grade 1 insulation fully supported • Continuous top and bottom plates or sealed blocking				
	2.1 Wall Behind Shower/Tub	☐	☐	☐	☐
	2.2 Wall Behind Fireplace	☐	☐	☐	☐
	2.3 Insulated Attic Slopes/Walls	☐	☐	☐	☐
	2.4 Attic Knee Walls	☐	☐	☐	☐
	2.5 Skylight Shaft Walls	☐	☐	☐	☐
	2.6 Wall Adjoining Porch Roof	☐	☐	☐	☐
	2.7 Staircase Walls	☐	☐	☐	☐
	2.8 Double Walls	☐	☐	☐	☐
3. Floors between Conditioned and Exterior Spaces	**Requirements:** • Air barrier is installed at any exposed fibrous insulation edges • Insulation is installed to maintain permanent contact with sub-floor above including necessary supports (e.g., staves for blankets, netting for blown-in) • Blanket insulation is verified to have no gaps, voids or compression. • Blown-in insulation is verified to have proper density with firm packing				
	3.1 Insulated Floor Above Garage	☐	☐	☐	☐
	3.2 Cantilevered Floor	☐	☐	☐	☐
4. Shafts	**Requirements:** Openings to unconditioned space are fully sealed with solid blocking or flashing and any remaining gaps are sealed with caulk or foam (provide fire-rated collars and caulking where required)				
	4.1 Duct Shaft	☐	☐	☐	☐
	4.2 Piping Shaft/Penetrations	☐	☐	☐	☐
	4.3 Flue Shaft	☐	☐	☐	☐
5. Attic/ Ceiling Interface	**Requirements:** • All attic penetrations and dropped ceilings include a full interior air barrier aligned with insulation with any gaps fully sealed with caulk, foam or tape • Movable insulation fits snugly in opening and air barrier is fully gasketed				
	5.1 Attic Access Panel (fully gasketed and insulated)	☐	☐	☐	☐
	5.2 Attic Drop-down Stair (fully gasketed and insulated)	☐	☐	☐	☐
	5.3 Dropped Ceiling/Soffit (full air barrier aligned with insulation)	☐	☐	☐	☐
	5.4 Recessed Lighting Fixtures (ICAT labeled and sealed to drywall)	☐	☐	☐	☐
	5.5 Whole-house Fan (insulated cover gasketed to the opening)	☐	☐	☐	☐
6. Common Walls Between Dwelling Units	**Requirements:** Gap between drywall shaft wall (i.e., common wall) and the structural framing between units is fully sealed at all exterior boundary conditions				
	6.1 Common Wall Between Dwelling Units	☐	☐	☐	☐

Home Energy Rating Provider: _____ Rater Inspection Date: _____ Builder Inspection Date: _____

Home Energy Rater Company Name: _____ Builder Company Name: _____

Home Energy Rater Signature: _____ Builder Employee Signature: _____

Posted 06/02/08

Figure 8. Energy Star® Thermal Bypass Checklist

Appendix E : Preliminary Testing and Inspection Results and Recommendations

BIRA
BUILDING INDUSTRY RESEARCH ALLIANCE

August 31, 2009

ConSol
7407 Tam O'Shanter Dr
Stockton, CA 95210

Forest City
5173 Nimitz Road
Honolulu, HI 96818

Subject: Aug 24-28th Test Results, Recommendations and Action Items

Attn: Will Boudra, Ian Lange and Ken Rappolt

During the week of Aug 24th, ConSol conducted preliminary Builders Challenge HERS tests on a sample of Forest City's housing stock. ConSol tested homes from six communities: Ford Island, Camp Catlin, Mololani, Waikulu, Heleloa and NCTAMS. The homes were subjected to a full battery of tests including duct leakage, infiltration, insulation evaluation, and equipment verification.

The tests revealed that the HVAC ducting was the most problematic area. The homes displayed a large range in terms of build quality. The Mololani homes were well built and sealed, using metal chased returns, and were very close to meeting the 6% duct leakage Builders Challenge requirement. However, the NCTAMS and Camp Catlin systems were unsealed dry-wall ducts and had duct leakage ranging from 18-25%.

Fortunately, aside from the HVAC systems, the homes are very well constructed. They are very well insulated and sealed, which prevents heat transfer to the outside. The remainder of this report will provide the findings of each of the test units in detail and then offer suggestions regarding areas of improvement, if any.

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Observations

Project/Community Name: NCTAMS	
Lot/ Address	
Tests Completed	Duct Leakage Thermal Camera Infiltration test
Test Results and Findings	
Duct Leakage	209 CFM 17.4%
Infiltration	3250 CFM 7.2 SLA
Thermal Camera	Passed – No Anomalies
Qualifies for Builders Challenge	No – Ducts are too leaky

The insulation appeared to be properly installed, evident through the thermal camera, and there were no anomalies. The unit was pressurized for the blower door test, and noticed significant air infiltration through the kitchen flow hood and the attic common wall, similar to previous units.

The NCTAMS ducts appeared to be in the same condition as the Camp Catlin units. In the air return, drywall has been used as the barrier and is not properly sealed. Additionally, the water drip pan has been installed in the return, so if mold starts to grow in it, air will not be filtered and mold will be spread across the living areas.

Image 68 - NCTAMS air return

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Recommendations

HVAC Installation:
Use UL 181 mastic and seal all penetrations and connections in the return and the connections to the return and furnace. Attention needs to be paid to the back side of the unit and ensure that it is sealed properly.

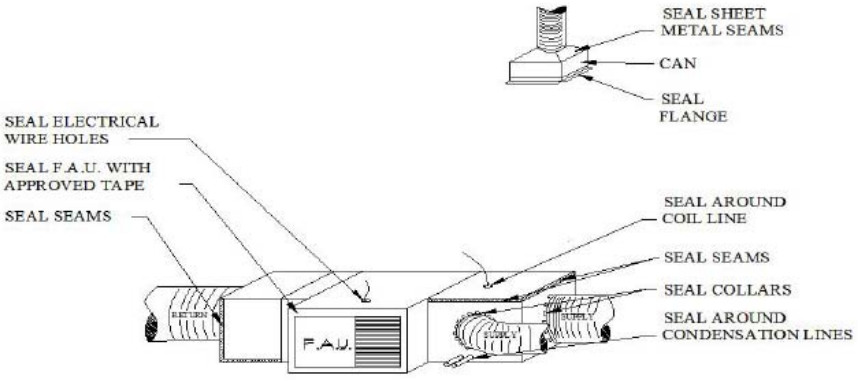

Figure 1. Areas to seal

Image 69. Proper sealing

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Furthermore, remove the return grill and seal the return can to the drywall. (see register can pictures for an example). Remove all register grills then seal all supply register cans to the drywall (see the following picture and notice there is no gap between metal and drywall)

Image 70. Proper sealing around vent cans

Blower Door:
Attention needs to be paid to the common wall between units. It is necessary to completely isolate each unit and seal all penetrations between the units through the attic.
On the exterior walls, be sure that all penetrations are sealed on the walls and the top plate of the unit. See the thermal pictures for examples of heat transfer through walls.
All kitchen vent penetrations going from the kitchen to the attic need to be sealed properly. As the vent penetrations are now, there is unobstructed air flow from the attic to the living area.

Insulation:
The insulation appeared to be installed properly, but the connections between the studs need to be sealed properly. (see thermal pictures for examples)

Ducts:
All units have fresh air ducts in the return that had to be taped off to get a reading. Dampers were installed on the ducts, but did not have weather striping so the unit could not be tested without taping them off. The installation of a damper that is properly sealed with weather stripping and that is in the closed position while the system is off, and then opens when the system comes on is highly recommended for testing both the ducts and the entire home for infiltration.

The HVAC sub has been instructed to look at the Mololani project so they can mimic the installation practices used there.

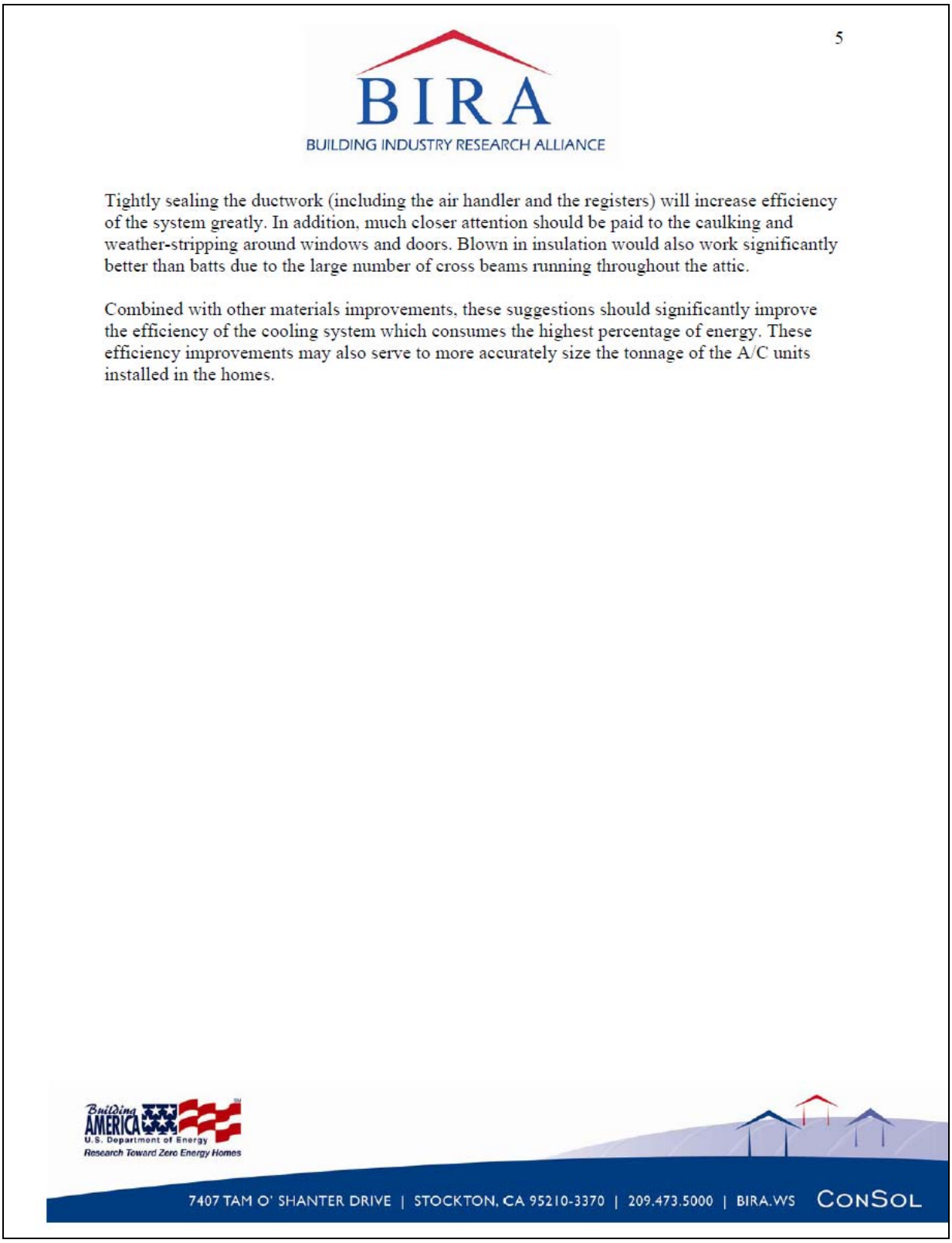

Figure 9. NCTAMS Testing and Inspection Results and Recommendations