40% Community Case Study – G.W. Robinson Builders

Prepared by:
Janet McIlvaine, Subrato Chandra and Ken Fonorow

Draft April 4, 2008

Community:	CobbleField –	Build out 265 homes,	263 completed
	Turnberry Lake –	Build out 186 homes,	88 completed
	Garison Way –	Build out 110 homes,	42 completed
	Total –	Build out 561 homes,	393 completed

Developer/Builder: G. W. Robinson Builders, Inc

Location: Gainesville, FL

Background and Summary

In 2000 G. W. Robinson decided to build energy efficient homes with excellent indoor air quality for move-up buyers. In 2001 he became a BA partner. Working with BAIHP subcontractor Ken Fonorow of Florida H.E.R.O., in a cost shared arrangement, he developed and implemented a new set of specifications, first in the CobbleField community in 2002, then in the Turnberry Lake community in 2005, and next in a third community Garison Way. This builder has chosen to incrementally improve his specifications over the years and currently builds all homes with the recent most specs and plans to do so for the foreseeable future despite the current market downturn. **All of his homes are individually tested and rated. 123 recent vintage GW Robinson homes were analyzed for this report. They have a HERS Index between 59 and 69 (averaging 65, *Figure 1*) and Building America Benchmark (2008 version) savings range from 31% to 44% (*Figure 2*). As calculated by EnergyGauge USA (v.2.7.03), over 25% of G.W. homes achieved savings of 40% or higher.** Please see the end of this document for stagegate analysis.

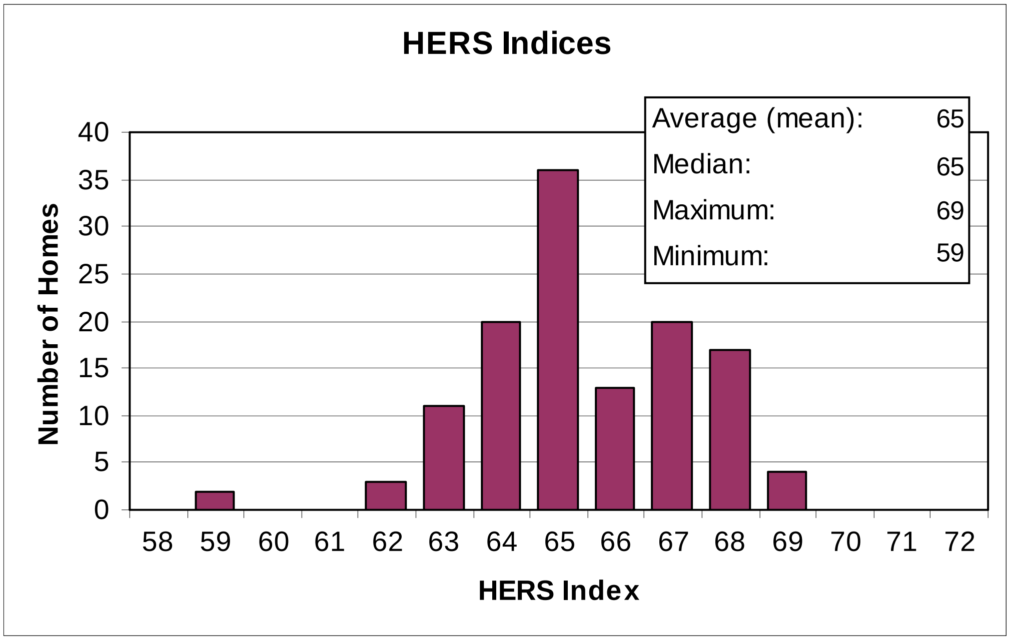


Figure 1 *HERS Indices for G.W. Robinson homes.*

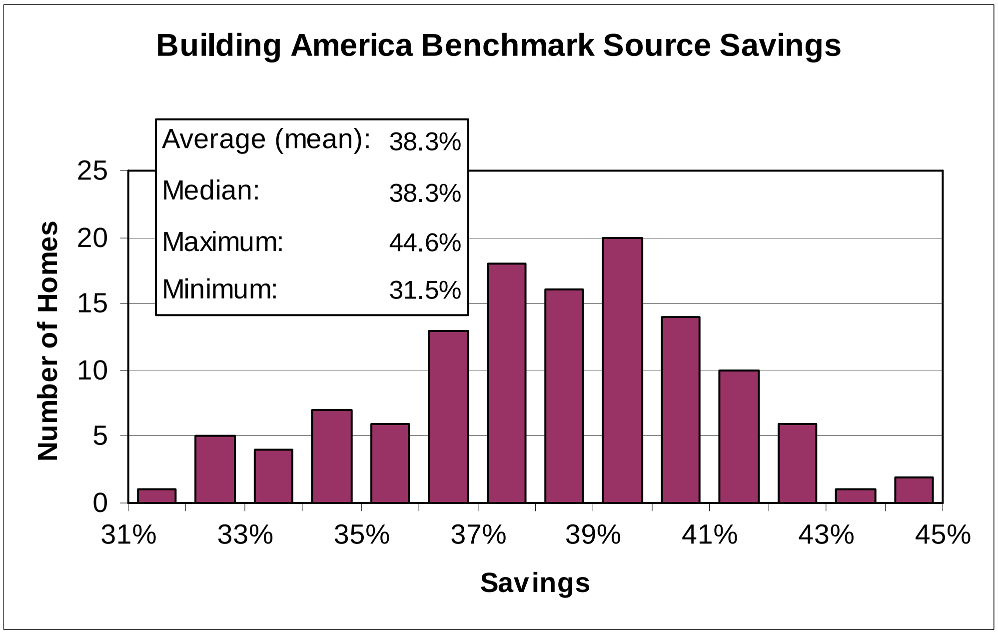


Figure 2 *Building America Benchmark Savings (2008 version) for G.W. Robinson Homes*

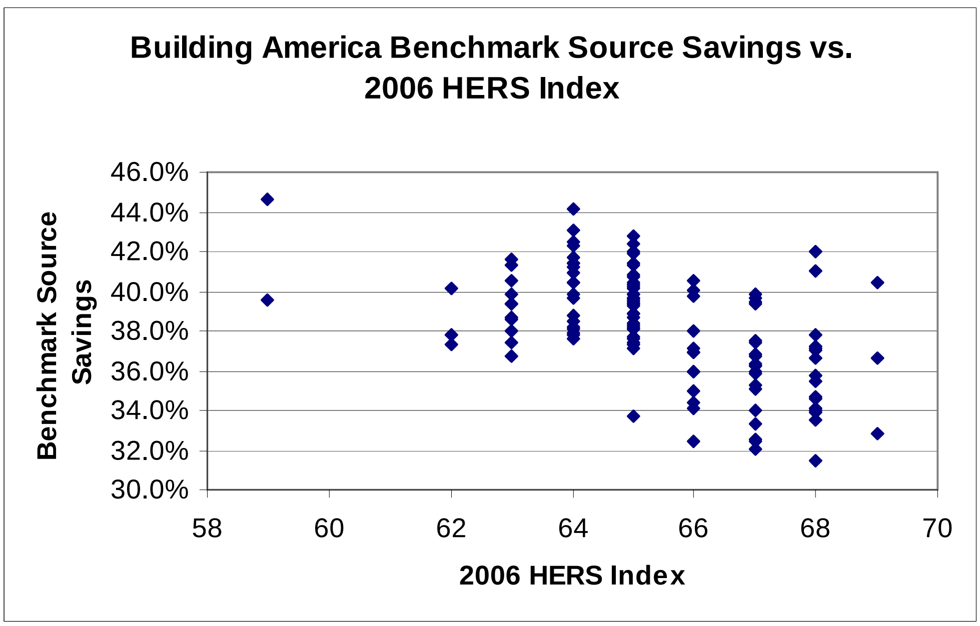


Figure 3 *Building America Benchmark Savings vs. HERS Indices in G.W. Robinson Homes*

Figure 3 shows that there is not a strong correlation between the HERS Index and Benchmark savings.

G.W. Robinson homes (*Figure 4* and *Figure 5*) range from 2,000 to 5,000 square feet with a selling price in 2006 of $300,000 to over $1,000,000 with a sales price average of $165/sf. This builder's homes enjoyed above market sales in the down market environment of 2006-2007. Compared to 91 closings in 2005, 96 closings occurred in 2006 and 73 in 2007. However, consistent with the severe slump in the Florida housing market, 2008 sales are not as strong with 8 inventory homes available for sale and 7 pre sales under construction as of March 28, 2008

Figure 4 *Homes in CobbleField (l) and Turnberry Lake (rt.)*

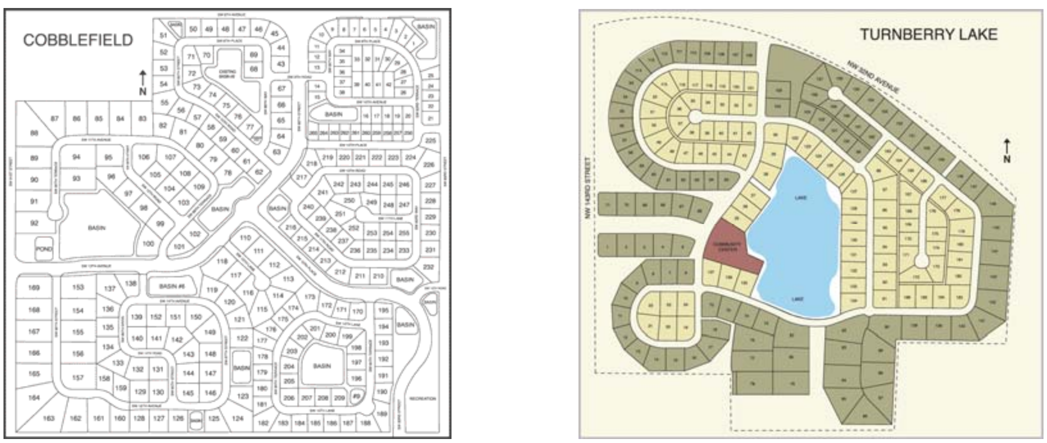


Figure 5 *Site plans for CobbleField (left) and Turnberry Lake (right)*

Energy Efficiency and Cost Neutrality Analysis

When G.W. Robinson joined the Building America program, his standard construction was compliant with the Florida Energy Code. Over time his specifications improved; current specifications are listed in Table GW-1. While most of his homes have SEER 14 air conditioners, in mid 2007 he started using SEER15 air conditioners. All of the homes built to these specifications achieve a HERS Index of 69 or lower.

Table GW-1 also shows the specs for typical new homes built in the Gainesville, Florida market and the estimated added costs for the BA specs that G.W. Robinson has implemented. The added cost data is based on a single story 2,786 sq. ft. home in the Cobblefield subdivision (File name= GWcf253, HERS=65). The table includes the costs to the homeowner - estimated using a 10% mark up. The end-use savings that make up the >40% BA Benchmark savings are detailed in Table GW-2. The bottom line (Table GW-1) is a monthly mortgage increase of $13 and an estimated monthly energy savings (Table GW-2), when compared to typical construction, of $55 yielding a net positive cash flow of over $42 per month. Note that this cost neutrality analysis is done with respect to typical new construction specifications in the regional market (the typical home has a HERS Index of 97).

HVAC Equipment Sizing:

The HVAC equipment in each home is individually sized per manual J and the ducts are designed per manual D. Figures 6 and 7 show the histograms for the cooling and heating equipment. The cooling tonnage is significantly lower than standard practice. As shown in Table GW-1, a credit of 1.5 tons and $1,500 is estimated for the typical 2,786 sq. ft. house.

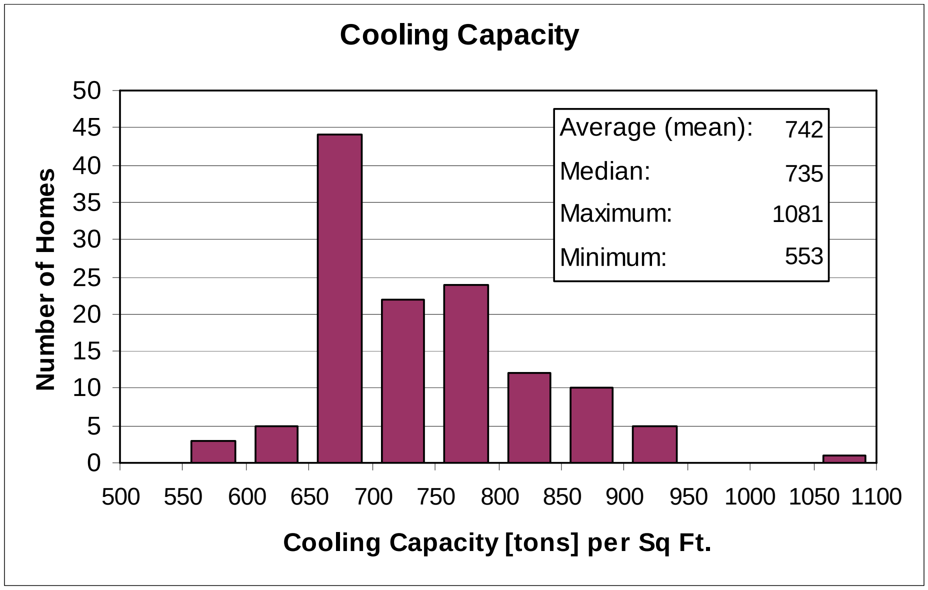
Table GW-1. Incremental Cost Details for G. W. Robinson Builders

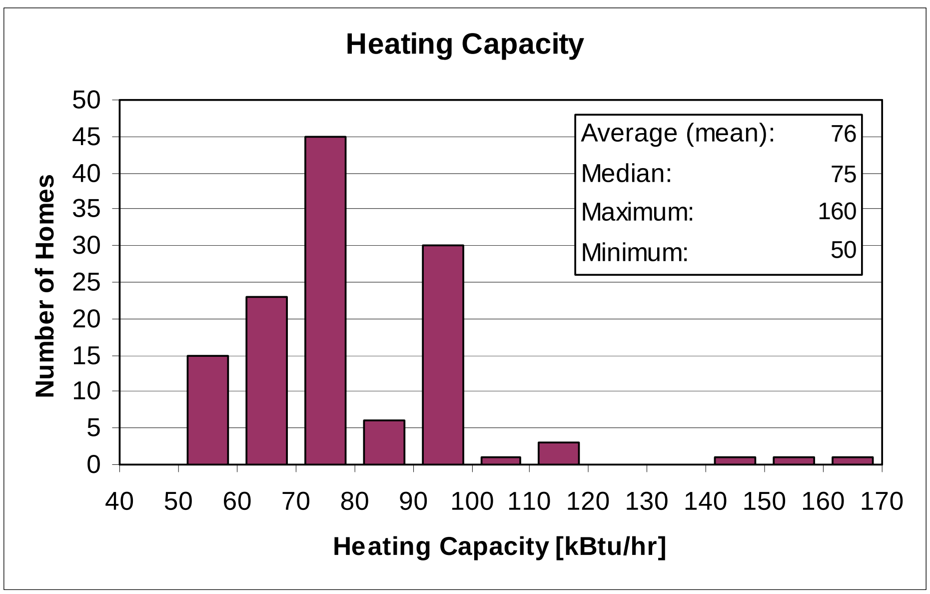
Measure	Typical Local Practice	Prototype House	Total Incremental Costs	Amortized Annual Cost (30 yr, 7%)	Notes
Engineering, Design, & Testing		Manuals J & D, Commissioning, and Rating	$400	**$2.66**	
Thermal Envelope					
Wall Insulation	R-11	R-13 Cellulose	$494	$3.30	
Attic Radiant Barrier	No	Yes	$806	$5.36	
TBIC Compliance	No	Yes	$300	$2.00	
House ACH50	6	4.5	$200	$1.33	
Wall Framing	Standard 2x4	Advanced 2x4	$0	$0.00	
Windows	2-pane Aluminum	2-pane Vinyl Low-E	*($128)*	*($0.85)*	
HVAC SYSTEM					
Heating System	80% Gas	93% Gas	$400	$2.66	
Capacity	100KBtu	60Kbtu			
Cooling System	SEER13	SEER14	$350	$2.33	
Capacity	5tons	3.5tons	*($1,500)*	*($9.98)*	
Ventilation System	None	Run Time	$300	$2.00	
Air Handler Location (Costs $500, added appraised value $1500)	Garage	Interior	*($1,000)*	*($6.65)*	
Duct Leakage	6% to out	4% to out	$165	$1.10	
WATER HEATING:					
Hot W pipe Ins	None	1/2" foam	$100	$0.67	
Water Heater(Gas)	60%	83% tankless	$900	$5.99	
Lighting					
General Lighting	10%cfl	50% CFL	$50	$0.33	
Cost to Builder			$1,837	$12.22	
Total Energy Efficiency Investment			$2,021	$161/year	Includes 10% mark up. No PV, rebates, or incentives.
PV SOLAR ELECTRIC			$0	$0	
Total with PV			$2,021	$161/year	
REBATES / INCENTIVES			$0	$0	
Total Incremental Cost to Buyer			$2,021	$161/year	$13/mo.

Table GW-2. Cost Neutrality Summary for G. W. Robinson Builders, Inc.

Description	Annual Source Energy			Estimated Source Energy Savings				Annual Utility Bill Reduction	
	Benchmark	Typical Regional Practice*	Prototype House	Percent of End-Use		Percent of Total		($0.12/kWh, $1.48/therm)	
End Use	**(MBtu/yr)**	**(MBtu/yr)**	**(MBtu/yr)**	**vs. Benchmark**	**vs. Typical**	**vs. Benchmark**	**vs. Typical**	**Prototype WRT Benchmark**	**Prototype WRT Typical**
Space Heating	48.1	45.0	26.8	44.4%	40.5%	7.6%	8.4%	$ 291	$ 248
Space Cooling	111.2	58.0	33.8	69.6%	41.8%	27.6%	11.1%	$ 810	$ 253
DHW	18.8	15.6	10.2	45.9%	35.0%	3.1%	2.5%	$ 117	$ 74
Lighting	34.9	35.7	27.4	21.4%	23.2%	2.7%	3.8%	$ 78	$ 87
Appliances and MEL	67.1	63.3	63.3	5.6%	0.0%	1.3%	0.0%	$ 39	$ -
Outside Air	0.025	0.042	0.042	-68.0%	0.0%	0.0%	0.0%	$ (0.24)	$ -
Total Usage	**280.1**	**217.7**	**161.5**	42.4%	25.8%	42.4%	25.8%	$ 1,334	$ 662
Site Generation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$ -	$ -
Net Energy Use	280.1	217.7	161.5	42.4%	25.8%	42.4%	25.8%	$ 1,334	$ 662
Added Annual Mortgage Cost w/o Site Gen. Includes 10% Profit.								$ 161	$ 161
Net Cash Flow to Consumer w/o Site Gen.								$ 1,173	$ 501
Added Annual Mortgage Cost with Site Gen.								$ 161	$ 161
Net Cash Flow to Consumer with Site Gen.								$ 1,173	$ 501

* Note that the builder implemented Building America specifications as standard practice for all of his homes in 2000.
Thus we have used typical regional practice for comparison.





Figures 6 and 7 *Cooling and heating system sizes for G. W. Robinson Builders' homes.*

Value Added Innovations

Ken Fonorow has worked with GW Robinson to develop a number of innovative techniques. One involves the position of the air handler. Previously, the builder located the air handler in the garage (as is typical conventional practice in Florida); now, the air handler is in a closet in the conditioned space. This was accomplished *without* changing the floor plan by moving the exterior wall to form a closet around the air handler separating it from the unconditioned garage (*Figure 8*). This adds approximately 15 square feet of conditioned space with an appraised value of about $1,500. The first cost of the detail adds about $500 to the total cost of the project for a net gain of $1,000.

Another innovation in the air handler closet results in an improved air barrier between the closet and the attic overhead. Figure 9 shows the view looking up at the ceiling of the air handler closet before the air handler has been set. The supply trunk line on the right will be attached to the top of the air handler while the return trunk on the left will be connected to the return plenum below the up-flow air handler.

Figure 8 *Exterior walls around air handler isolate closet from garage, create valuable conditioned square footage.*

Typically, this closet would get a drywall ceiling just like all the other closets in the house. There are several problems associated with this. First of all, drywall isn't typically available on site during the mechanical rough in when these trunk lines are put in place. Even if it is available, it's difficult to cut precisely and mechanical contractors are not accustomed to working with it. And leaving this detail to the drywall crew (later in the construction process) jeopardizes the air tightness of the closet.

Figure 9 *Air barrier in top of air handler closet created with duct board by the mechanical contractor at the time that the ducts are installed.*

The innovation here was to switch materials for the ceiling. Note in the picture (*Figure 9*) that the top of the closet is made of duct board, just like the trunk lines. The material is readily available during the mechanical rough in, is easier to cut than drywall, and the mechanical contractor is accustomed to working with it. While this innovation does result in a vapor barrier at the wrong side, it does result in less infiltration into the air handler closet where there is often very high negative pressure due to small leaks in air handler cabinet itself. It is not clear whether the vapor barrier on the wrong side is a practical issue as there is R-30 blown in cellulose over the ductboard. No condensation has been observed in actual houses on the visible side of the duct board.

Outside Air Ventilation

In energy efficient homes in general, the natural infiltration rate tends to be low, occasionally resulting in odor or wintertime high humidity complaints from the homeowner.

In the hot-humid climate, outside air ventilation brings humidity to the conditioned space increasing the latent cooling load in the house. Thus energy efficient homes in the hot-humid climate often have a low sensible cooling load while still having a fairly typical latent cooling load.

Some measures such as exhaust fans ducted to outside (*Figure 10*) help control the latent cooling load by removing warm moist air as it is produced (source control) and the use of a variable speed motor in the air handler which provides the opportunity to reduce the air flow rate across the evaporator coil resulting in enhanced dehumidification.

Figure 10 *Chase (l) for kitchen exhaust fan duct. Top of chase (r) is sealed to reduce infiltration.*

Fonorow also developed a passive ventilation system which is in use by G.W. Robinson and other builders in the Gainesville market such as Tommy Williams. When the air conditioning or heating system is running, the negative pressure in the return plenum draws outside air through a duct linking the return plenum to a filtered outside air inlet mounted in the soffit or a porch ceiling (*Figure 11*). The inlet is downstream of a filtered grill mounted to a standard one foot square boot. There is an in-line, manually set damper with a manual override to prevent flow of outside air when it would be undesirable (for example when there is a fire in the area).

Figure 11 *Outside air ventilation system details*

This outside air ventilation strategy has been implemented in over 500 homes in the Gainesville area including homes from G.W. Robinson and Tommy Williams Homes. None of the homes have reported problems with odor retention (from cooking, etc) or indoor humidity. The mechanical vent rate averaged 25 CFM (*Figure 12*) only when the air handler operated. Note that this is significantly lower than required by ASHRAE Standard 62.2 (ASHRAE, 2007). The plot at the bottom of Figure 12 shows the % of 62.2 vent rate provided in these houses. When one considers that air handlers typically run only about 25% on average, the provided mechanical ventilation rate is only about 10% of the 62.2 recommendations. Of course, the actual realized ventilation rate will be that plus the ventilation from opening and closing doors and windows plus

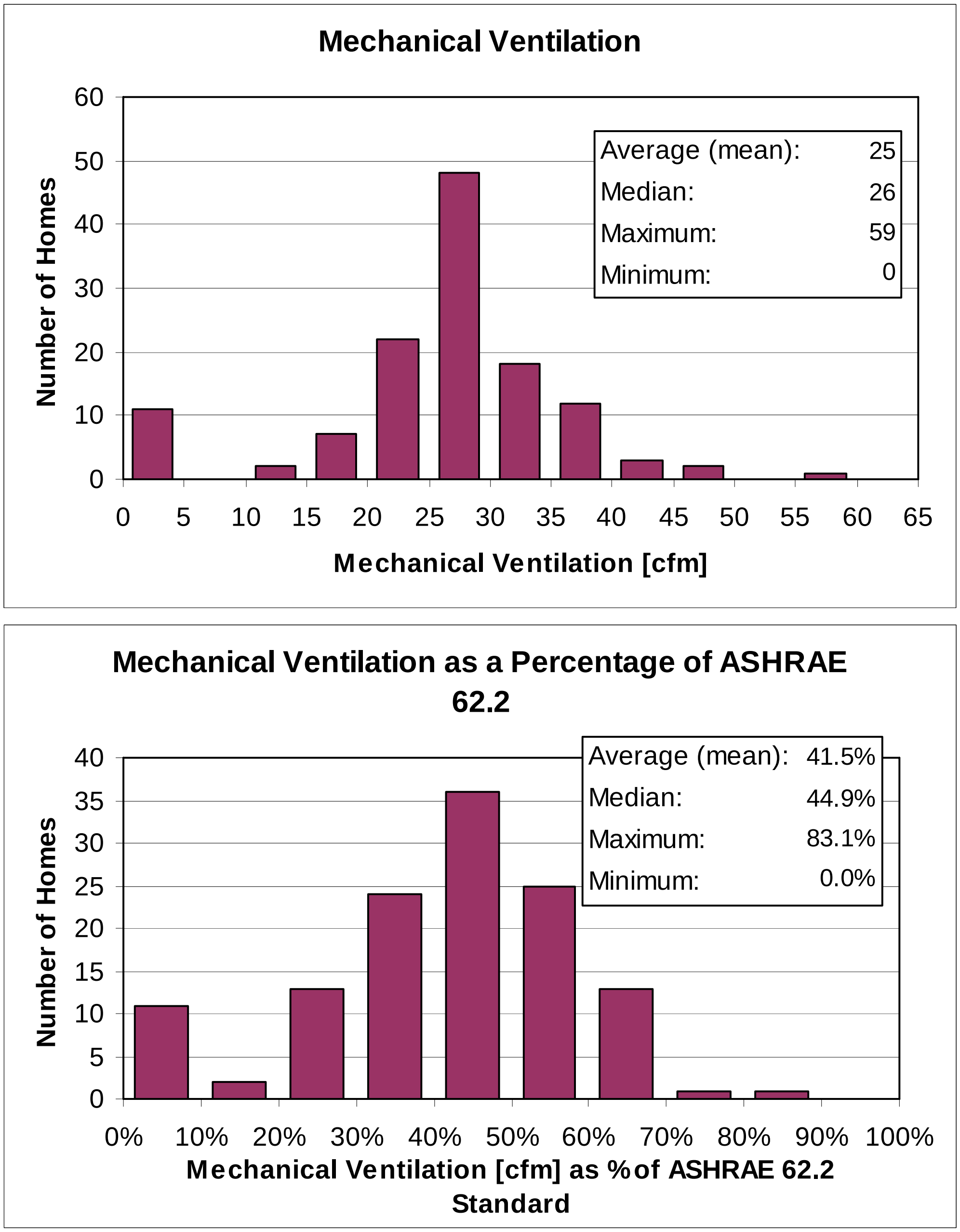


Figure 12 *Mechanical ventilation rate (outside air flow) during air handler run time. Note that ventilation levels are significantly lower than ASHRAE Standard 62 level.*

operation of the exhaust fans. That rate has not been measured. In 2008 and 2009 we plan to do field monitoring of some of these homes to evaluate the T and RH in these homes and some conventionally built homes. It is an open question at this point in time whether additional ventilation is required or not. However, we do know that no mechanical ventilation is not an option as such homes do have occasional odor and/or moisture problems.

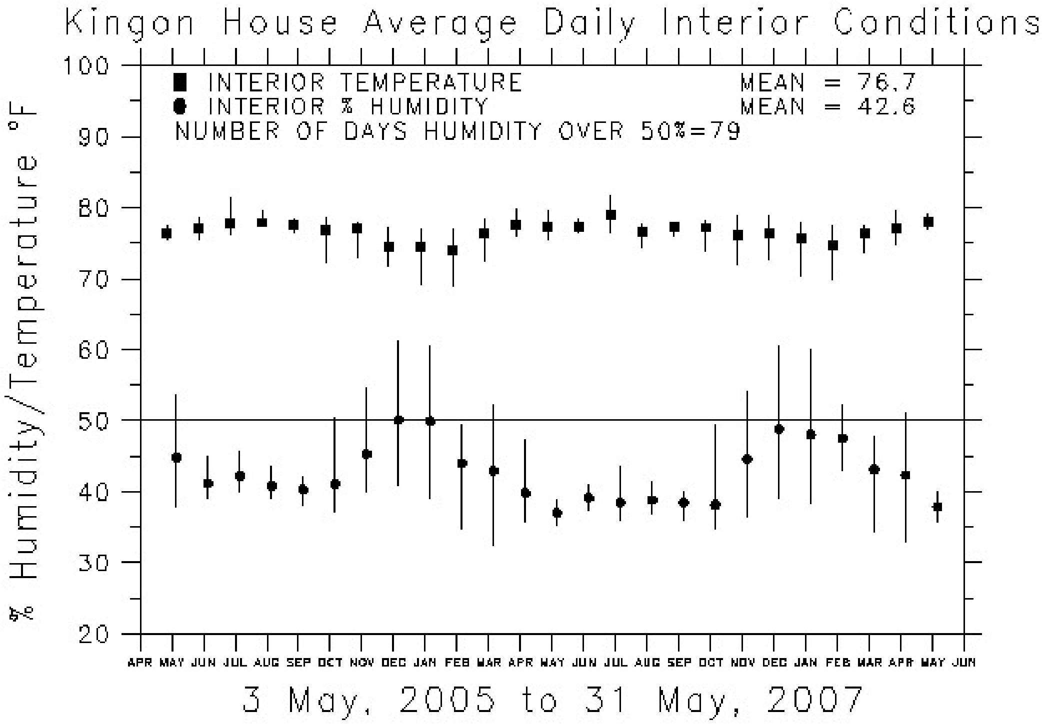


Figure 13 *Relative humidity indoors is well controlled despite high relative humidity of outside ventilation air. Plot shows range of daily average T and RH for each month.*

The plot in Figure 13 shows the indoor humidity level in a home with this type of runtime ventilation (32 cfm) built by a different builder. This house is in south Florida and is occupied by a family of four. Note that the indoor relative humidity does not frequently exceed the daily average of 50%, the recommended RH level for controlling dust mites, a major asthma and allergy trigger in American homes (Arlian, et.al. 2001.). The data plotted in Figure 13 is for over 2 years. Only 79 days (~10% of days) had daily average relative humidity exceeding 50% despite not using a central dehumidifier.

Durability, Indoor Air Quality, and Landscaping

While recognizing that a home's most significant environmental resource impact will be the energy needed for its ongoing operation, this builder also addressed the issues of durability, health, maintenance, landscaping and irrigation.

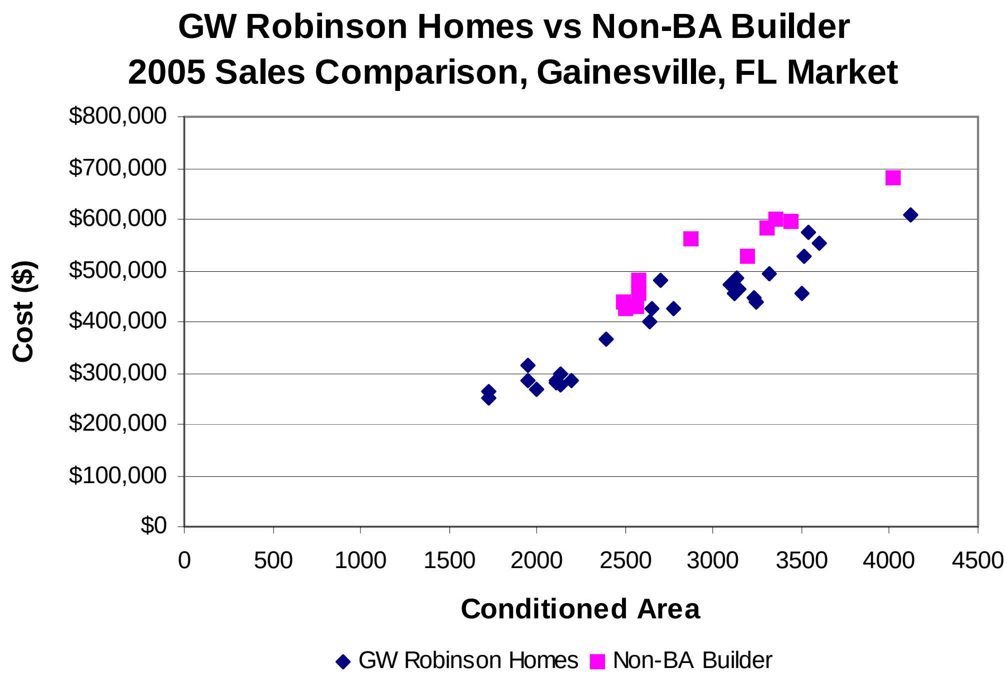
To enhance durability, each home is treated with Bora-Care®, a termiticide whose active ingredient is Disodium Octoborate Tetrahydrate (DOT), which is a mixture of borax and boric acid. A 50+ year cementitious lap siding is installed over a continuous drainage plane. The entire exterior of the home receives three coats of paint which carries a ten year warranty. Thirty year architectural shingles have been selected. To help insure better indoor air quality low volatile organic compound (VOC) paint is used in the interior, all gas burning fireplaces receive outside combustion air and all rigid duct board material used in the distribution system is a coated style to help separate the air stream from any raw fiberglass. Where applicable, alkaline copper quaternary (ACQ) wood is used, which is arsenic and chromium free.

After protecting wooded areas whenever possible, homes are landscaped with drought-tolerant indigenous species which are grouped according to their watering needs. In the Cobblefield subdivision, irrigation is provided through a municipal reclaimed water system where water that would normally be discharged via a deep well injection system is routed to the subdivision to meet the irrigation needs. It is important to note that this service is being provided to homeowners by the developer for $10 a month while a homeowner who uses the potable water for irrigation often pays $40-$50 a month.

Market Reception

This BA Partner moved forward with his vision and was rewarded by market acceptance of his high performance homes in the CobbleField development. G. W. Robinson Builders regularly includes the Building America logo in newspaper ads that echo the BA high performance goals (*Figure 14*). Figure 15 shows sales comparison for G. W. Robinson Builders and a non BA builder which shows stronger sales **and** lower overall prices for the BA builder. This data was compiled from the property appraiser public records. This builder's homes enjoyed above market sales in the down market environment of 2006-2007. Compared to 91 closings in 2005, 96 closings occurred in 2006 and 73 in 2007. However, consistent with the severe slump in the Florida housing market, 2008 sales are not as strong with 8 inventory homes available for sale and 7 pre sales under construction as of March 28, 2008. Despite the current downturn, the builder is continuing to build to the current specs and looking for additional resource conservation opportunities!

Figure 14 *G.W. Robinson Builders newspaper ad emphasizing value and energy savings. Note BA logo, center.*



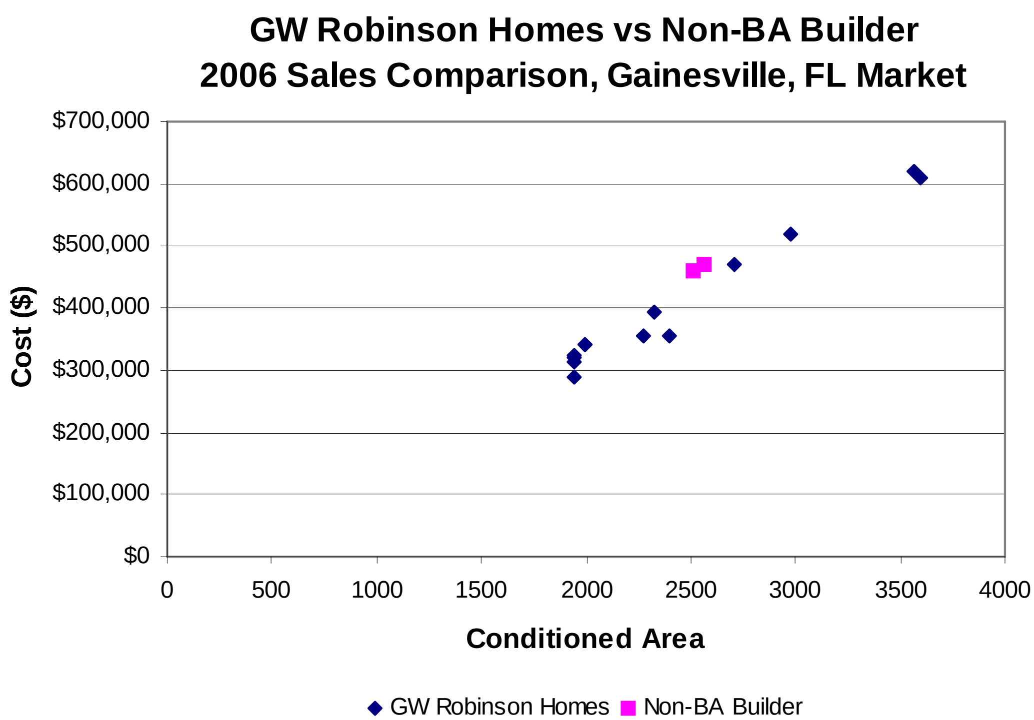


Figure 15 *Sales comparison for G. W. Robinson Builders' homes and those of a Non-BA Builder in same area for 2005 (top) and 2006 (bottom).*

Quality Assurance: Systems Engineering and Team Work

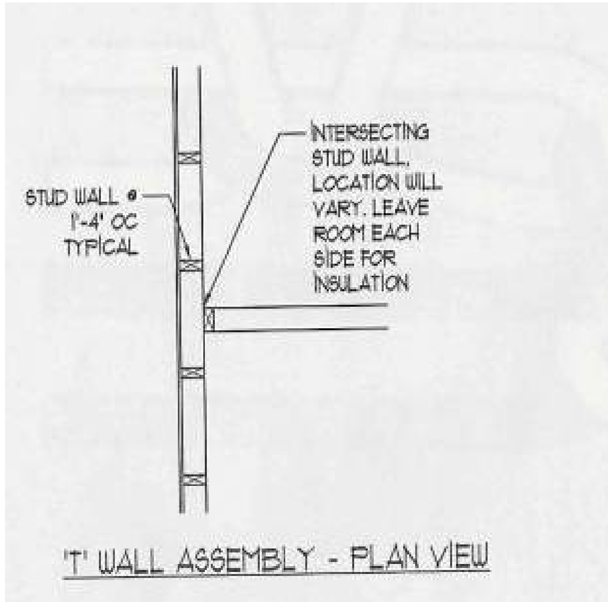
The BA integrated systems engineering approach was used in all G.W. Robinson communities to optimize the performance of homes within a financial framework which enhanced the builder's profits.

After the initial analysis to determine the specifications for the communities, Florida H.E.R.O.'s systems engineering approach includes an evaluation of each design (floor plan, elevations and specifications) to identify opportunities for improvements and ensure specifications were called out correctly. Next, Florida H.E.R.O. (a BAIHP subcontractor) does a room-by-room ACCA Manual J load calculation to determine the heating and cooling equipment size and a duct system design based on ACCA Manual D calculations. Finally the duct system plan is drawn and specifications (including duct tightness) are provided to the mechanical contractor. Important details are integrated into the construction drawings (*Figure 16* through *Figure 18*.)

Florida H.E.R.O. conducts a sub-contractor meeting after the framing of the model to discuss working together as a team. In attendance are the builder, all senior office staff, the project real estate agents and representatives or owners of all subcontractors. The builder's goals, objectives, and expectations are clearly articulated with the opportunity for the whole team to ask questions. This initial broad meeting provides the opportunity to discuss what the adoption of high performance specifications means including the interrelationship of the different building components and trades. This is an important element of the quality assurance approach, ensuring that each subcontractor knows in advance what is expected by the builder and how their work fits in with the whole project. They know that the builder will not accept a sub-contractor compromising the quality of their own work or creating an environment that compromises the work of others. For example, it would be unacceptable for the plumber to run lines in an area that has been designated for the duct system because, in these homes, the duct system is a precise design. To reduce the amount of coordination required among the mechanical, plumbing, and electrical sub-contractors, these three systems are installed in sequence on every job site. The least flexible of the three sub-systems, the duct system is installed first. Next the plumbing rough-in is installed followed by the electrical runs, the most flexible of the three major sub-systems.

Quality Assurance: Site Inspections and Preliminary Testing

Site visits are conducted at key points in the construction process to verify that specs are being met. This includes conducting a "mid-point" duct leakage test after mechanical system rough-in to locate leaks that will be sealed before the drywall is installed (for easier access.) Any other deficiencies discovered during site visits are reported back to the builder and a meeting with the trades often occurs to correct deficiencies and conduct training. Site visit activity also includes completing the new Energy Star Thermal Bypass Inspection Checklist (TBIC) which includes an inspection of the air barrier continuity, thermal barrier (insulation) integrity (*Figure 16* through *Figure 18*), and duct system layout. Figure 20 through Figure 21 show details that the builder has implemented to meet several TBIC criteria.



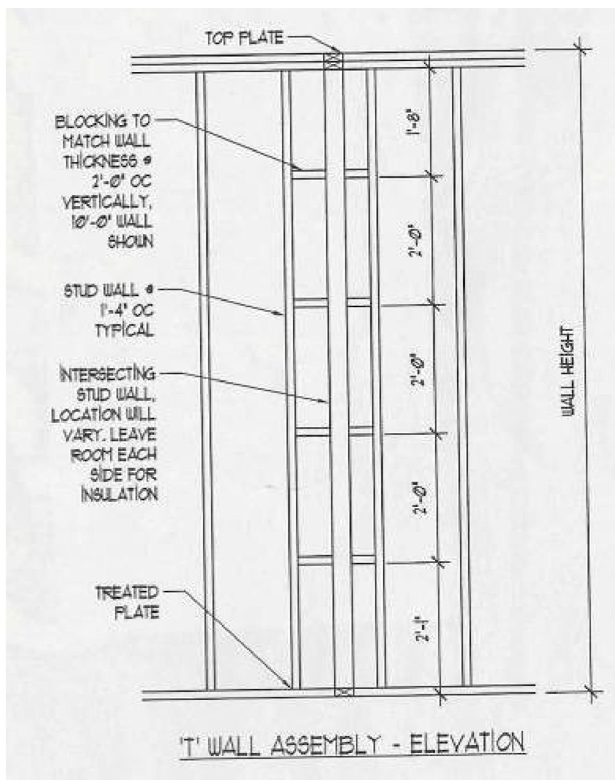


Figure 16 *Advanced framing details on construction drawings ensure that everyone on the job knows the interior-exterior wall intersections (aka "T-Wall" assembly) will be framed with "ladders" to improve insulation integrity.*

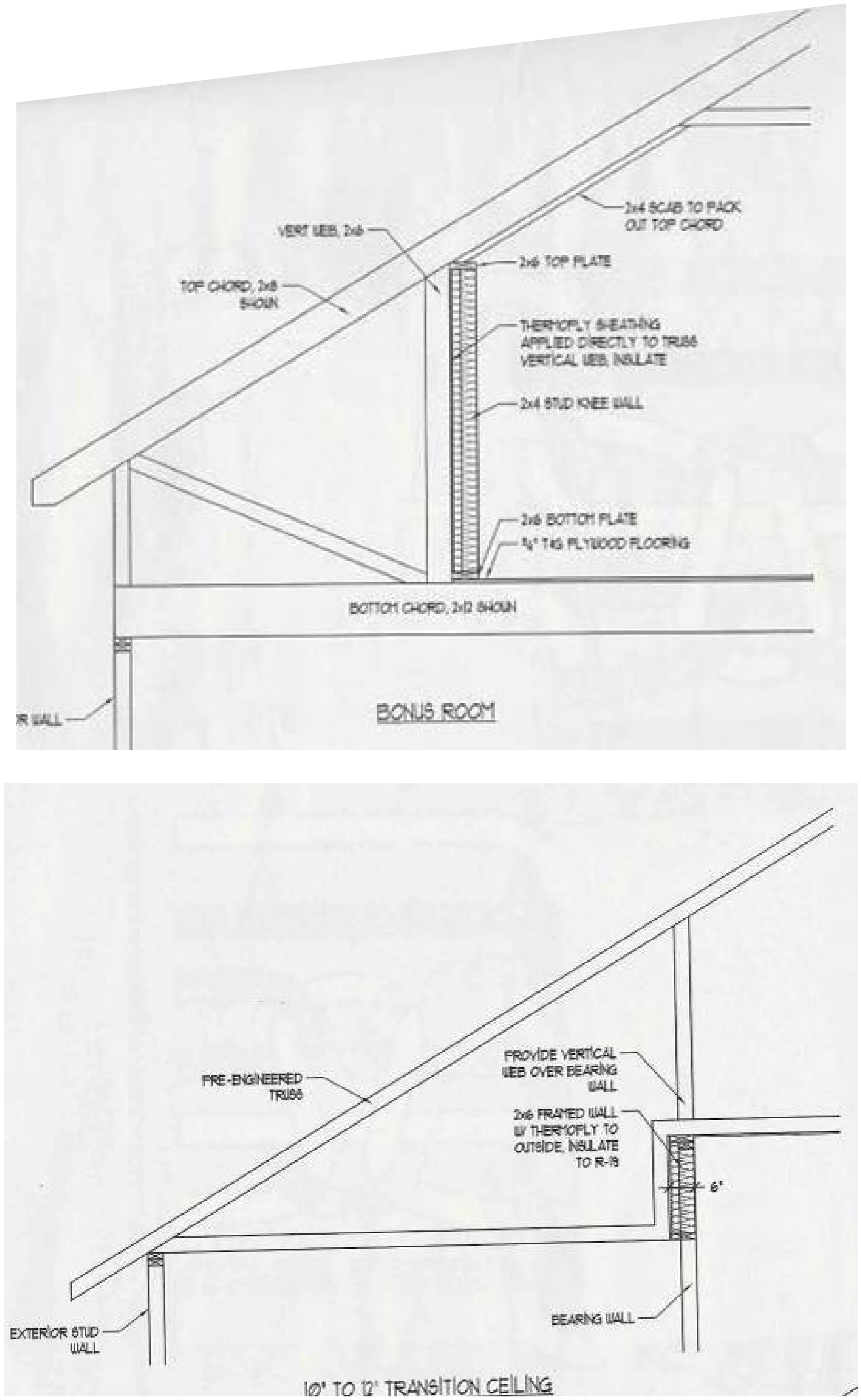


Figure 17 *Insulation details for knee walls (top) and tray ceiling (bottom) ensure a continuous thermal barrier on vertical planes in unconditioned attics.*

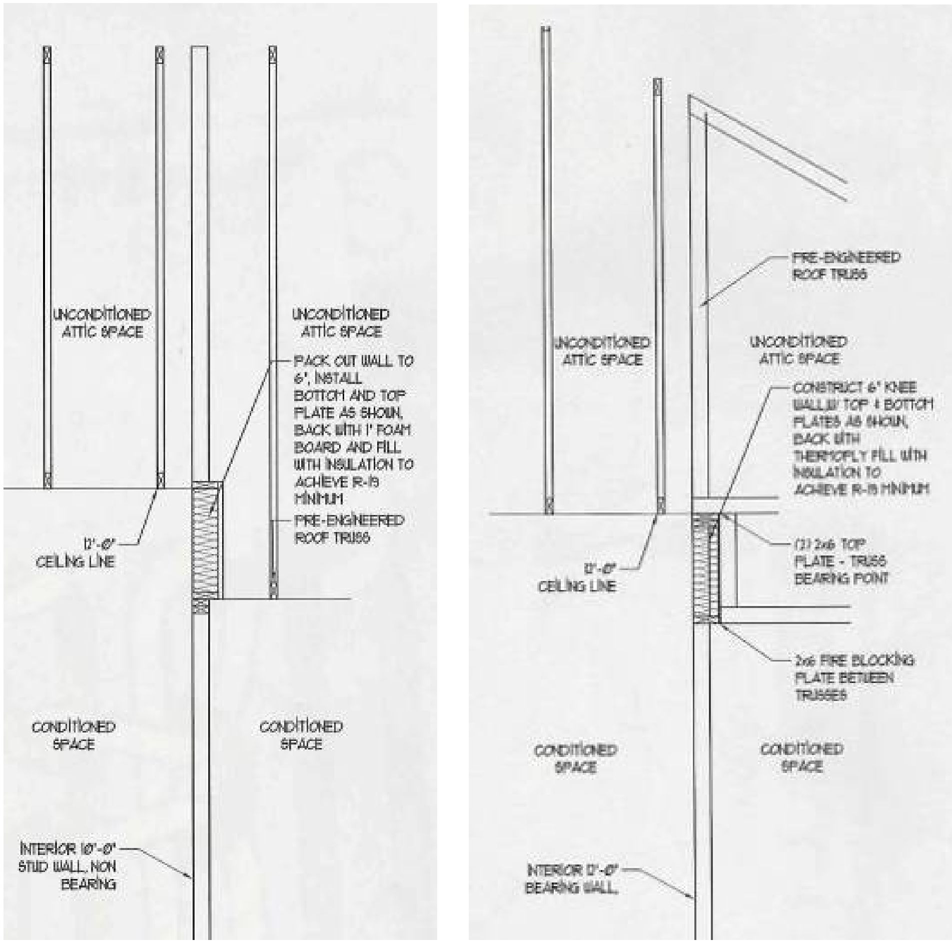


Figure 18 *Insulation details between rooms with dissimilar ceiling heights.*

Figure 19 *Note that wall behind fireplace is insulated as required by the TBIC.*

Figure 20 *Solid blocking at tray ceiling framing as required by TBIC.*

Figure 21 *Inspection of the R-13 cellulose in G. W. Robinson Builders' home to verify it has been installed with no gaps, compression, or voids as required by the TBIC.*

Quality Assurance: Performance Testing
Upon completion of the home, seven performance tests are conducted:

1. Whole House Air Tightness Testing: A computerized multi-point, whole-house air tightness depressurization test is performed using the Energy Conservatory Automated Performance Testing (APT) equipment. The pressure of the house with respect to the attic is performed concurrently. Whole house air tightness test results for G. W. Robinson Builders is shown in Figure22.

2. Duct System Air Tightness Testing: A Duct Blaster® is used to perform a duct air tightness depressurization test and quantify duct leakage (cfm25 total and cfm 25 to out). Duct air tightness is part of the mechanical contractor's scope of work. The duct leakage test is conducted on every home in accordance with standard building science practices at 25 pascals of negative pressure. This standard test pressure is well below the usual operating pressure of duct systems. Total system leakage (CFM25,total) as well as leakage to the outside (CFM25,out) are measured. The target for total duct leakage is less than or equal to 4 cfm per 100 square feet of conditioned space ($Qn \leq 0.04$) A sample of duct leakage test results for G. W. Robinson Builders is shown in Figure 23.

3. Pressure Mapping: The home is pressure mapped using a digital manometer. The pressure of rooms with doors that can isolate them from the main return are measured with reference to the house when the air handler is operational. The pressure of the home with reference to the outside is measured as well.

4. Outside Air Flow Measurement: The flow of the outside air intake is measured using the Energy Conservatory Exhaust Fan Flow Meter and the damper is adjusted as required to insure that the house is operating under positive pressure with reference to outside when the air handler is operating.

5. Static Pressure: A digital manometer and static pressure probes are used to measure the pressure that the air handler is operating under and expresses the pressure as inches of water column (IWC).

6. Temperature Drop: The temperature difference (delta T) across the coil is measured using digital thermometers.

7. Exhaust Fan Air Flow Measurement: The flow of all bath exhaust fans is measured.

These test measurements in addition to house characteristics such as make and model of the air handler and condenser section, water heater size, energy efficiency of appliances, and lighting types are noted and reported to the builder using a form entitled "Home Energy Rating Report" which also notes areas of deficiency that need to be addressed and re-evaluated.

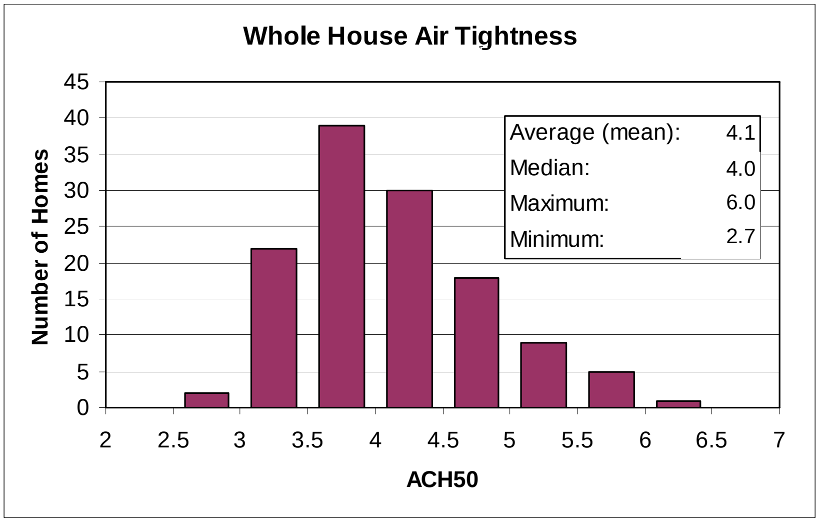


Figure 22 *Whole house air tightness measurements from a sample of homes built by G. W. Robinson Builders.*

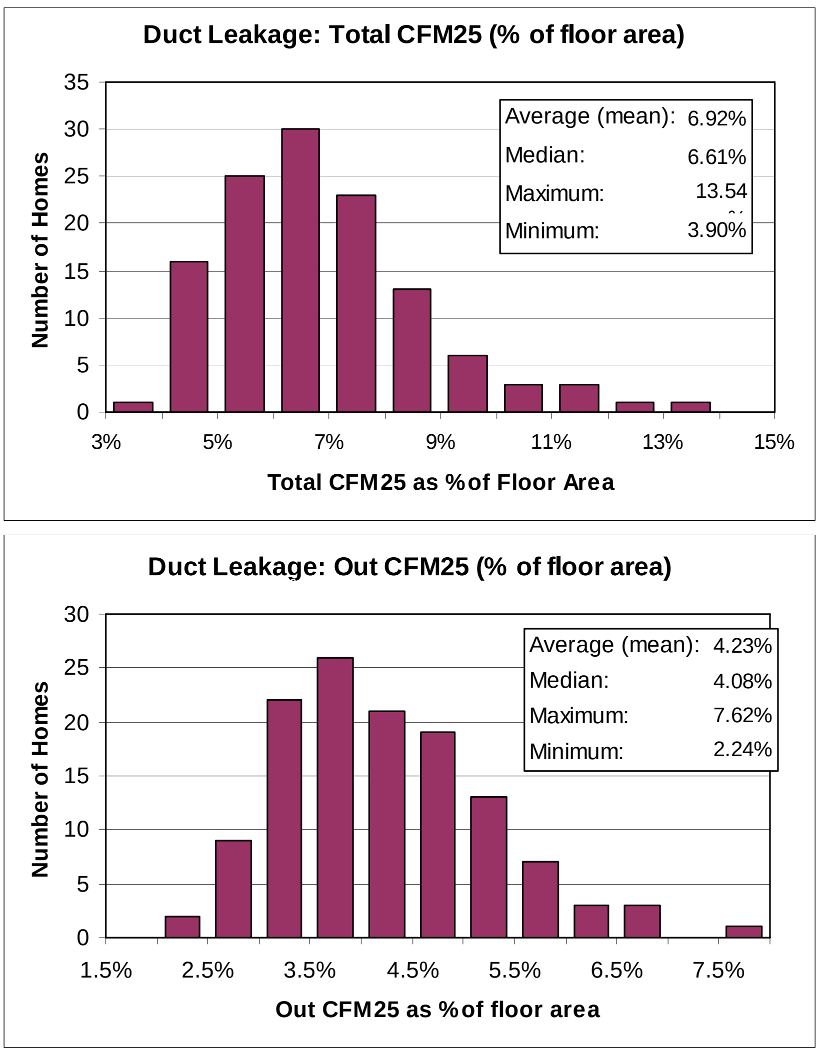


Figure 23 *Duct system air tightness measurements from a sample of homes built by G. W. Robinson Builders.*

Lessons Learned

Following is a summation of lessons learned and ongoing challenges in achieving the systems engineering approach to new home construction:

- The first step in this process requires a clear and consistent commitment of the final decision maker, be it the builder or the developer. The support of this “energy efficiency champion” is necessary to maintain improvement and quality assurance efforts.
- A scope of work including specific *performance* criteria gives sub-contractors a clear idea of what is expected from them and provides a mechanism for linking payment to work quality. An example would be to include in the contract language, a provision requiring that the mechanical system will have no greater then 10% total leakage and 5% to out when using the standard cfm25 duct test.
- Effective communication of performance expectations to the person(s) responsible for implementation in the field must be performed, often in conjunction with education and demonstration activities increases the reliability of the work done by subcontractors and the quality of energy-saving features in the houses.
- Ongoing quality assurance field inspections by either the project manager or an independent third party must be conducted to ensure consistency over time.
- Final commissioning of each home, including performance testing is an integral component of a systems approach, as it provides timely feedback to the builder.
- In order for the builder to achieve sales goals, the sales representatives must be knowledgeable about the features and benefits that have been built into the home. Thorough and repeated sales training and advertisement is critical to success.
- Cost control is essential. This builder is able to offer BA homes at less $/sq. ft. than typical efficiency homes.

DOE Stage Gate Criteria

In accordance with DOE Building America guidelines, the G.W. Robinson homes achieve the criteria for Stage Gate 3 as delineated below.

Must Meet Criteria #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.

Benchmark Savings (2008 version) for G. W. Robinson Homes range range from 31% to 44% (*Figure 2*). As calculated by EnergyGauge USA (v.2.7.03), <u>over 25% of G.W. homes achieved savings of 40% or higher</u>.

Must Meet Criteria #2: Must have a minimum of 5 builders with (1) a minimum of 10 homes per project and (2) a minimum of 5 homes completed by March/April.

As of March 2008, at least 33 homes built by G.W. Robinson have met the 40% criteria.

Must Meet Criteria #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. (*Mature market incremental first cost evaluated relative to builder standard practice.)

For an estimated incremental cost of $2,021, or $161 if amortized over 30 years at 7% interest, G. W. Robinson delivers an estimated annual energy savings of $662 for a net annual positive cash flow of $501. (See Tables GW-1 and GW-2 for details.)

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

G. W. Robinson Builders have developed marketing materials that stress high performance, energy savings, and peace of mind. Full page ads are regularly featured in the local newspaper, see Figure 14 for example. This builder's homes enjoyed above market sales in the down market environment of 2006-2007. Compared to 91 closings in 2005, 96 closings occurred in 2006 and 73 in 2007. However, consistent with the severe slump in the Florida housing market, 2008 sales are not as strong with 8 inventory homes available for sale and 7 pre sales under construction as of March 28, 2008

Should Meet Criteria #2 Market Coverage: Project case studies should cover a representative range of weather conditions and construction practices in major metropolitan areas in the targeted climate region.

G. W. Robinson Builders, Inc builds homes of 2,000 to 5,000 square feet in an inland hot humid climate that sell for $300,000 to over $1,000,000.

Should Meet Criteria #3 Builder Commitment: Should demonstrate strong builder commitment to continued construction at current or future BA performance targets.

GW Robinson Builders, Inc. have adopted the BA Package in table GW-1 as standard construction and 25% of their homes surpass the 40% BA level. As of mid 2007 they are using SEER 15 air conditioners (compared to SEER 14 listed in Table GW-1). They are committed to this level of performance and looking for opportunities for even greater resource savings (eg. Onsite recycling of construction waste)

Should Meet Criteria #4 Gaps Analysis: 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.

No technical or market barriers at the 30% level. System Engineering and testing each home is critical to success. Sales staff training and marketing of the high performance characteristics is also crucial to market differentiation. BA does result in increased sales, profits, customer satisfaction and lowers callback costs. See also “Lessons Learned” above.

Over 25% of the GW Robinson homes are meeting the 40% target. Analysis is planned to determine what will be required to consistently achieve the 40% benchmark.

Should Meet Criteria #5 Quality Assurance: Should provide documentation of builder’s energy related QA and QC processes.

G. W. Robinson Builders relies on several points of quality assurance to ensure high performance including duct design, HVAC sizing and specifications, an all hands team meeting after model is framed, TBIC and associated testing, and additional site visits by 3rd party (Florida H.E.R.O.) to ensure specs being met with a final inspection and commissioning process that involves seven tests on every single home. Site visits serve as a feedback loop to alert the project manager of any specifications that are out of range. See the following sections in the case study:

- Quality Assurance: Systems Engineering and Team Work
- Quality Assurance: Site Inspections and Preliminary Testing
- Quality Assurance: Performance Testing

Acknowledgement

This work is sponsored by the US Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy, Building Technologies Program under cooperative agreement number DE-FC26-06NT42767 managed by N.E.T.L. We appreciate the support and encouragement of our program managers -- Mr. George James, Mr. Ed Pollock, Mr. Terry Logee and Mr. William Haslebacher. This support does not constitute DOE endorsement of the views expressed in this case study.

Thanks to Carlos Colon, Jamie Cummings and Bob Abernethy for their significant contributions to this case study.

References:

ASHRAE 62.2 2007. Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. ANSI/ASHRAE Standard 62.2-2007, ASHRAE

Arlian, L. and T.A.E. Platts Mills, “The Biology of Dust Mites and the Remediation of Mite Allergens in Allergic Disease” , J. Allergy and Clinical Immunology, vol.107, number 3, March 2001, pp. S409