Assignment #5: Blower Door Analysis

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Subject: Final Test Hut Analysis

1) Purpose

The purpose of this report is to gain a solid understanding on how the structural and enclosure systems incorporate to minimize heat and air transfer in a building. A blower-door test was used to analyze our student-built test huts, illustrating the connection between building construction and building efficiency. Our results helped us to comprehend how important insulation and final finishing touches are; in addition, the critical relation between structural and enclosure systems was crystalized.

2) Specifications

Test Hut #1	Dry-bulb (°F)	Wet-bulb (°F)	Relative Humidity (%)
Outside Temp.	70.6	32.4	24.5
Inside Temp.	92.3	61	24.6

<u>Dimensions and Specifications</u>

Floor Length: 7.1ft Floor Width: 3ft Floor Area: 25ft^2
Volume of Space: 200ft^3 Wall Structure: 2”x4” stud wall 16” O.C. spacing.

Roof Structure: Gable roof with a ridge connecting rafters; plumb cut 24” O.C., ceiling joists, fiberglass-batt insulation covering ceiling of roof.

Air Barrier: 6 mil. Polyethelene air barrier

<u>Blower Door Test</u>

Test Hut #1 (50Pa)	Flow (cfm)	EQLA (in^2)	Air Change (AC/H)	EQLA/Area (in^2/100ft^2)
	192.50	31.40	68	120.5

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3) Blower Door Test Analysis

The blower door test analysis was the final arbiter of group number one's construction capability. Our EQLA was 120.5 in^2 for every 100ft^2, or roughly 10%. In a small hut this seems to be a large leakage area. However, considering the inherent losses through the blower door itself, we found our losses to be typical of a space this size. Our air-change per hour (AC/H) rate was 68, telling us that there were significant leakage points throughout the structure.

Observations of air flow using the smoke pencil and infra-red imaging camera revealed the highest leakage areas and least insulated areas in the hut. We found that points around the window and door were the least sealed, results of which were noticed using the smoke pencil. The infra-red camera allowed us to see insulation deficiencies mainly in the walls and corners of the hut, which were visible as blue sections in the pictures.

Recalling the construction of the building itself, a few things could have been done to improve building performance. Finishing tape on all joints and seams would have created a better initial seal. Additionally, mudding the joints of the drywall with compound would have greatly increased the sealing capacity of the building corners. Using brand-new insulation would have increased the R-value of the walls; having an adequate supply of foam insulation for the window and door would have created a better enclosed space.

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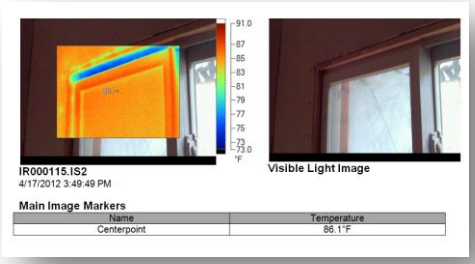
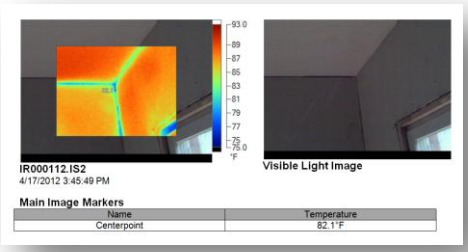
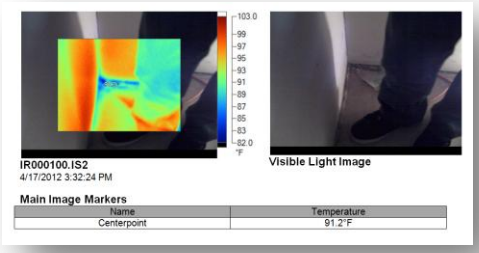
4) Heat Loss and Variations in R-value

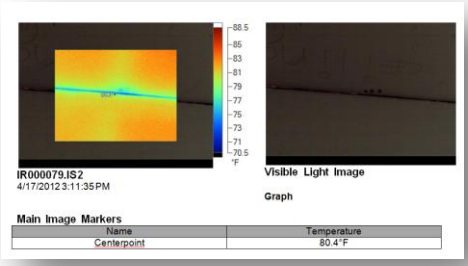
Based on our observations prior to drywall installation and infra-red analysis, there were some insulation deficiencies:

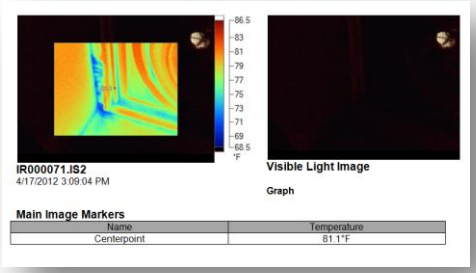
- Because we had limited time to work on this project and we were using recycled insulation material, our insulation job was not perfect.
- We also could not use the sealing foam effectively to seal the window and the door.
- Poor drywall installation caused unsealed corners and edges.
- Poor taping and trimming had also negative affect on our insulation.
- We did not do any finishing (mudding, painting, etc.)

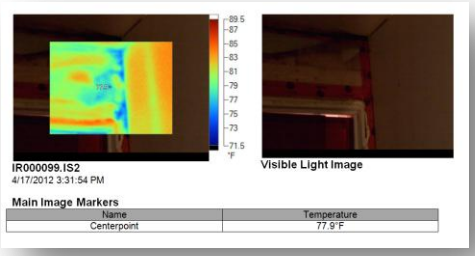












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5) (Please see the diagram attached)

6) R-Value Calculations and Comparisons

Even though Hut 1 theoretically should have a better value because 40% of Hut 1's insulating material (rigid foam) is preventing the thermal bridging, both Hut 1 and Hut 2 have similar R-values. The reason for this is Hut 2 is using less wood which means less thermal bridging. It also has thicker studs (2"x6") which have better R-value, meaning less thermal bridging.

Hut1	R12+R8
Insulated part	20.85
Through the stud 12.2%	14.23
Average	20.00

Hut2	R20
Insulated part	21.42
Through the stud 10.6%	9.35
Average	20.14

Hut3	R12
Insulated part	11.3
Through the stud 12.2%	0.76
Average	12.06

Total R values are different for Hut 1 and Hut 2 because of percentage difference.

Hut1	R12+R8
Insulated part	18.64
Through the stud 10.6%	15.08
Average	20.15

Hut2	R20
Insulated part	21.42
Through the stud 10.6%	9.35
Average	20.14

When we use similar percentages we have **approximately** same Total R values.

7) Cost vs. R Value

Given then EPS is more costly than fibreglass-batt insulation, and that labour costs would be more for Hut 1 due to the need for more installed material, it would be a better investment to frame using 24" O.C. spacing with 2"x6" lumber, and using a higher R-valued insulating material. Obviously, test hut 3 is not worth consideration because of the significantly lower R-value.

8) Observations

In addition to the construction observation listed above, it is worth noting that the abilities of the work crew are major contributing factors in overall building performance. Minor miscalculations in measuring, cutting, stapling, drilling, etc., can and did have an influence on our blower-door test, which would, in a real setting, mean significant differences in heating and cooling costs. Therefore, a critical factor in building a structure should always be to find a trustworthy contractor.

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9) Conclusion

In conclusion, the construction and testing of a free-standing building allowed us to see firsthand the impact of our design and construction quality on building performance. The blower-door analysis was the litmus test for the overall seal of our structure; calculated as equivalent leakage area or EQLA. We found our results to be higher than a typical building of the same size, but not by much. We identified major contributing factors to be: poor insulation, holes in vapour barrier, poor drywall installation and unfinished joints (no taping or sealant). Taking greater care to resolve these issues would have greatly improved the efficiency of Hut #1.

A comparison between Hut #1 and Hut #2 showed that cost savings can be achieved using advanced framing techniques and higher R-valued insulation. The cost effectiveness of Hut #2 was due to less material needed and the subsequent savings on labour costs. This highlights a need to choose a trustworthy contractor in order to achieve the best building results for the lowest possible cost.