

**ENERGY ANALYSIS FOR HEATED RUBB STRUCTURES PROVIDED WITH
VARIOUS INSULATION LEVELS**

INTRODUCTION

The purpose of this report is to assess the cost/benefit energy tradeoffs of partly insulating a heated Rubb building so as to allow natural light transmission through the roof. In order to conduct this analysis, estimated heating system cost information from an independent heating contractor was obtained. This analysis was conducted for Rubb buildings configured with various insulation levels.

For the majority of Rubb building users, the purpose for heating is primarily for occupant comfort during warehousing, aircraft maintenance or other process operations. Radiant heat is typically the preferred heating option. It is believed that the use of radiant heat, in combination with insulated walls and an un-insulated roof, will provide reasonable energy efficiency and a comfortable working environment. This is due to the fact that the highly translucent roof of a standard Rubb building will typically offset the need for artificial lighting of the structure during daylight hours.

For purposes of this review, we analyzed a 100' span x 270' long Rubb BVE range structure with 16.4' side walls. The structure has the following exterior surface areas:

Gable wall area above 16.4' height:	2,300 sf
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The design parameters were assumed to be for Detroit, Michigan with a design low temperature of 5°F and the ability to maintain a 50° temperature differential (i.e. 55° inside at 5°F outside) with average interior temperatures typically kept at 60°F during the heating season. Degree days were calculated at 3,113.

The Rubb building is well sealed against air infiltration and we assumed 0.25 air changes per hour, and that a single 12' x 12' roller shutter door is open for approximately 5 minutes every hour. For purposes of assessing the cost of the heating equipment, we utilized premium Co-Ray-Vac system components. Estimated equipment costs were increased by a factor of 1.8 to allow for installation and 15% was added to allow for contractors overhead and profit.

These assumptions are deemed to be conservative in that higher air infiltration rates, increased air changes and/or lower equipment costs will all tend to move the cost benefit equation more in favor of a Rubb building with lower insulation levels.

RUBB TECHNICAL REPORT

#9806

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<u>ENERGY CALCULATIONS</u>	<u>Options</u>				
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
<u>Building Surface Areas and Insulation Levels</u>					
28,600 sf Roof Area:	R-1	R-1	R-4	R-4	R-11
2,300 sf Gable Area above 16.4' height:	R-1	R-1	R-4	R-4	R-11
12,000 sf Wall Area to 16.4':	R-11	R-19	R-4	R-11	R-11
<u>Infiltration & Floor Loss (BTU/hr)</u>					
Floor Loss:	20,350	20,350	20,350	20,350	20,350
Infiltration Loss:	<u>148,830</u>	<u>148,830</u>	<u>148,830</u>	<u>148,830</u>	<u>148,830</u>
	169,180	169,180	169,180	169,180	169,180
<u>Transmission Loss (BTU/hr)</u>					
Main Roof:	1,431,000	1,431,000	357,750	357,750	130,221
Sidewall and Door:	43,337	26,345	110,880	43,337	43,337
Upper Gable Wall:	130,000	130,000	32,500	32,500	11,830
Lower Gable Wall (to 16'):	<u>14,560</u>	<u>8,160</u>	<u>40,000</u>	<u>14,560</u>	<u>14,560</u>
	1,618,897	1,595,505	541,130	448,147	199,948
Total Heat Loss:	1,788,084	1,764,692	710,318	617,335	369,136
Co-Ray-Vac Adjustment Factor for Radiant Heat:	0.80	0.80	0.80	0.80	0.80
Input Rate: (Without Height Correction)	1,430,467	1,411,754	568,254	493,868	295,309
Height Correction Factor:	<u>1.02</u>	<u>1.02</u>	<u>1.02</u>	<u>1.02</u>	<u>1.02</u>
Adjusted Input Rate (BTU/hr):	1,459,077	1,439,989	579,619	503,745	301,215

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	<u>Options</u>				
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
<u>EQUIPMENT & INSTALLATION</u>					
A. Estimated Co-Ray-Vac System Cost Installed:	\$60,000	\$57,000	\$24,000	\$16,000	\$16,000
B. Estimated Insulation Cost:	<u>\$18,000</u>	<u>\$20,000</u>	<u>\$82,000</u>	<u>\$88,000</u>	<u>\$106,000</u>
Net Heating Equipment and Installation (A + B):	\$78,000	\$77,000	\$106,000	\$104,000	\$122,000
Equipment & Insulation Cost Premium as compared to lowest cost option B:	\$1,000	---	\$29,000	\$27,000	\$45,000
<u>Energy Analysis</u>					
A. Estimated Heating Cost/Year @ \$0.70/Therm	\$10,000	\$10,000	\$4,000	\$4,000	\$3,000
B. Annual Lighting Savings*:	<u>\$6,000</u>	<u>\$6,000</u>	---	---	---
Estimated Net Annual Energy Cost (A - B):	\$4,000	\$4,000	\$4,000	\$4,000	\$3,000

*The translucent roof allows building use without the need for lighting during daytime hours. The analysis assumes a required 30 footcandle light level for 12 hours/day for 250 days per year. At \$0.10/kwh and 19.2 kw/hr energy usage this results in approximately \$6,000 savings per year.

CONCLUSION

From the above analysis it can be seen that the lighting cost energy savings approximately offset the increase in heating costs due to the un-insulated translucent roof membrane. Therefore, for a moderately heated Rubb building in a northern climate, our energy analysis shows that there is little to no net energy savings associated with insulating translucent roof areas.

Referenced Reports and Letters:

Heating Cost Information: The Gourley Co. Waltham, MA
 Insulation and Lighting Cost Information: Rubb Inc,

Rubb, Inc. November 1998