Insulation Comparison Demonstration

Funded By
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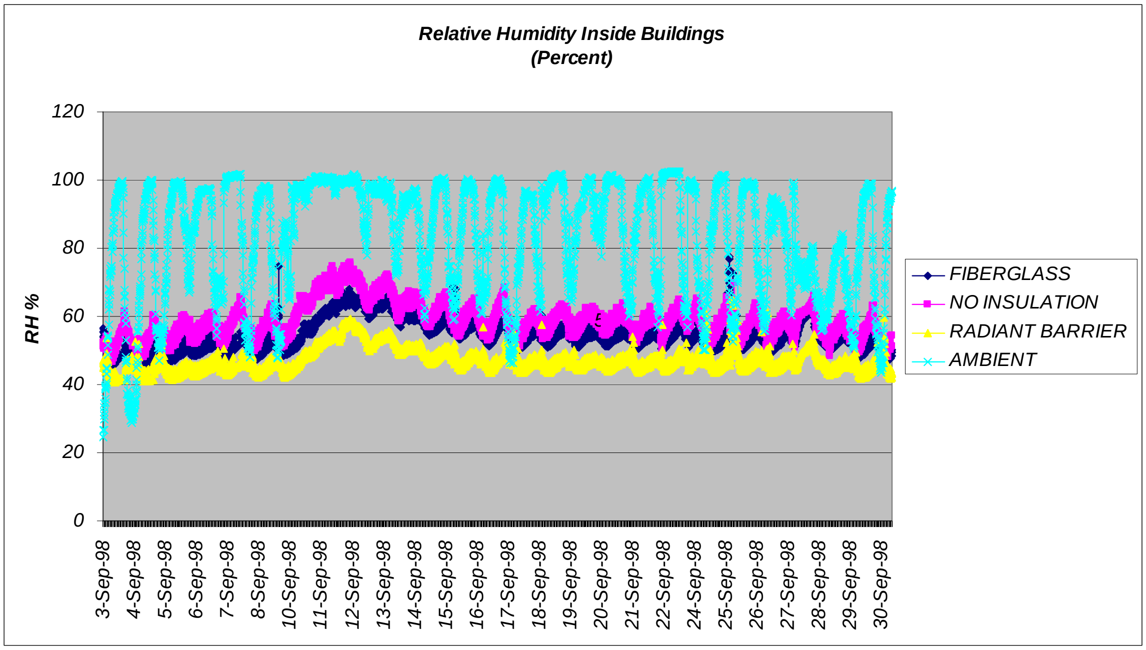
Building Insulation Demonstration

Introduction

The purpose of this demonstration was to show the relative effectiveness and performance of two different strategies in the insulation of homes in Louisiana. We compared the power required to maintain the same temperature conditions in three identically constructed structures. The demonstration took place between July of 1998 and September of 1999.

The buildings were all 8ft. wide, 12ft. long, with 7ft.- 6.5in. ceiling heights. Each had a total conditioned volume of 724 ft^3. The construction technique was standard 2X4 wood frame construction using 16 inch on center stud spacing. The roofing material was black asphalt shingles. All three buildings had a ridge vent with continuous soffits. All of the electricity provided to the three structures during the survey was donated by Cajun Electric, Co., of Baton Rouge, LA. Building No.-1 was insulated with fiberglass batts installed in all of the wall and ceiling stud cavities as per a typical installation. All of the fiberglass insulating material was donated and installed, for the project, by Red Stick Insulation, of Baton Rouge, LA. The average uninstalled cost of the R-13 that was installed in the 362 ft^2 of wall area would have been \$.25/ft^2. The average uninstalled cost of the R-19 that was installed in the 96 ft^2 of ceiling area would have been \$.34/ft^2. Building No.-2 had no insulation installed and was used as a control building. Building No.-3 used a radiant barrier material, which was made up of 1/8" of polyethylene sandwiched between reflective foil. The radiant barrier material was installed between the wall studs and the exterior sheathing, and between the ceiling dry wall and underside of the ceiling joist. All of the radiant barrier material was donated and installed for the project by Energy Savers of America, of Houma, LA. The average uninstalled cost of the radiant barrier material that was installed in the 458ft^2 of wall and ceiling area would have been \$.47/ft^2. A reflective radiant barrier film was also loosely hung from the bottom side of the roof rafters in the attic of Building No.3. The average uninstalled cost of the 192ft^2 of reflective radiant barrier film would have been \$.25/ft^2. Because Radiant Barrier materials are typically installed in walls and in ceilings as a continuous membrane with no open seams encasing the building envelope, they tend to have better infiltration control. Infiltration measurements were taken on all three buildings at 50 pascals (Pa), and the results were as follows:

- Fiberglass building 581 cfm (2.24 NACH)
- Non-insulated building 623 cfm (2.40 NACH)
- Radiant barrier building 511 cfm (1.97 NACH)



(Figure 1) *The plot above shows a comparison of the three building infiltration rates based upon outside relative humidity for the entire month of September 1998*

Each building was equipped with a standard off the shelf heating and cooling system. For cooling each building was equipped with a 5,100 btu (0.43 ton). window air conditioner. For heating each building was equipped with a free standing 1,500 watt electric strip heater. Each building was separately controlled by thermostats that were calibrated, to a single temperature indicator, prior to the start of the comparison study. The set point for each building was 72 degree F and each building was maintained with little variation as is illustrated in *Figures 4, 5, 6, 8, 10, and 12* under **Results**. The duration of the demonstration covered all four seasons, and results were analyzed from averaged data collected from one month of each season.

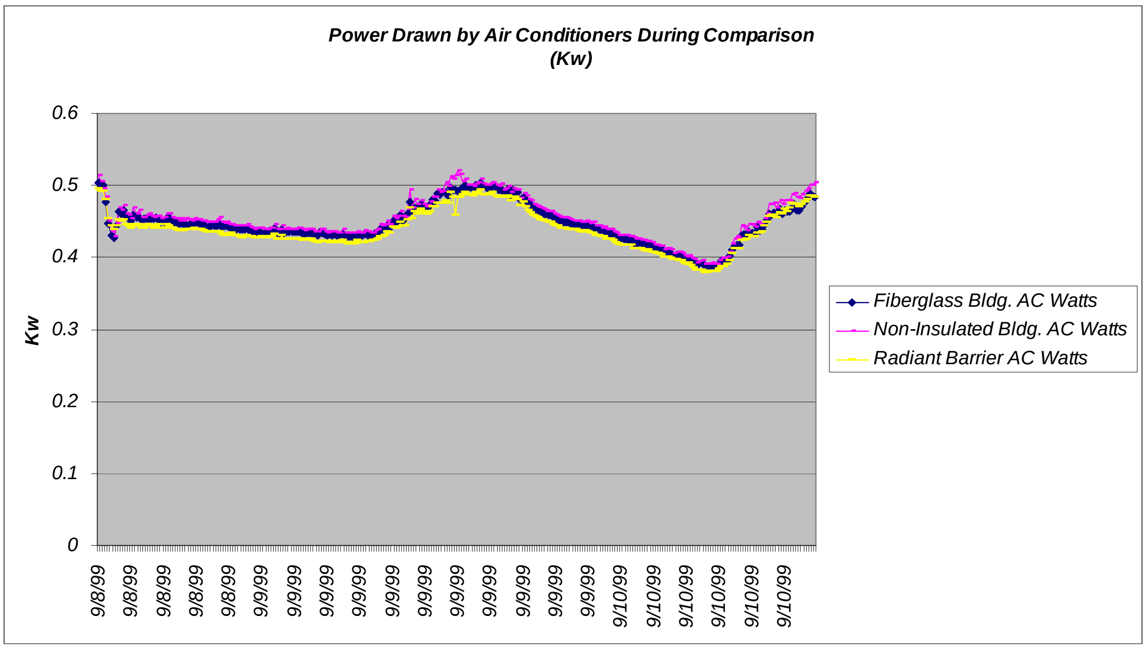
Data sampling was set to measure once every six seconds and then to log the averages of the six second measurements every 10 minutes. All data was collected using Campbell Scientific, Inc. Data Loggers. The Sampling routine was developed using Campbell Scientific, Inc. PC208 software.

The site selected was the Greater Baton Rouge Zoo, with-in the elephant compound, so that the demonstration would have broad public exposure and maximum security. It is estimated that 500 persons per week observed the demonstration.

It was expected that there would be significant differences in the performance of the insulating strategies. In building No.1, mass insulations was used to limit heat gain by conduction across the building envelope. Fiberglass is typically used in standard construction practices. In building No. 3, radiant barrier material was used. Radiant Barrier material only affects heat transfer by radiant heat gain. Building No. 2 was constructed to be identical to the other two except that no insulation was installed. The difference in building No. 2, and the others illustrates the need for insulation of some type, even in Louisiana's mild climate.

AC Comparison DATA

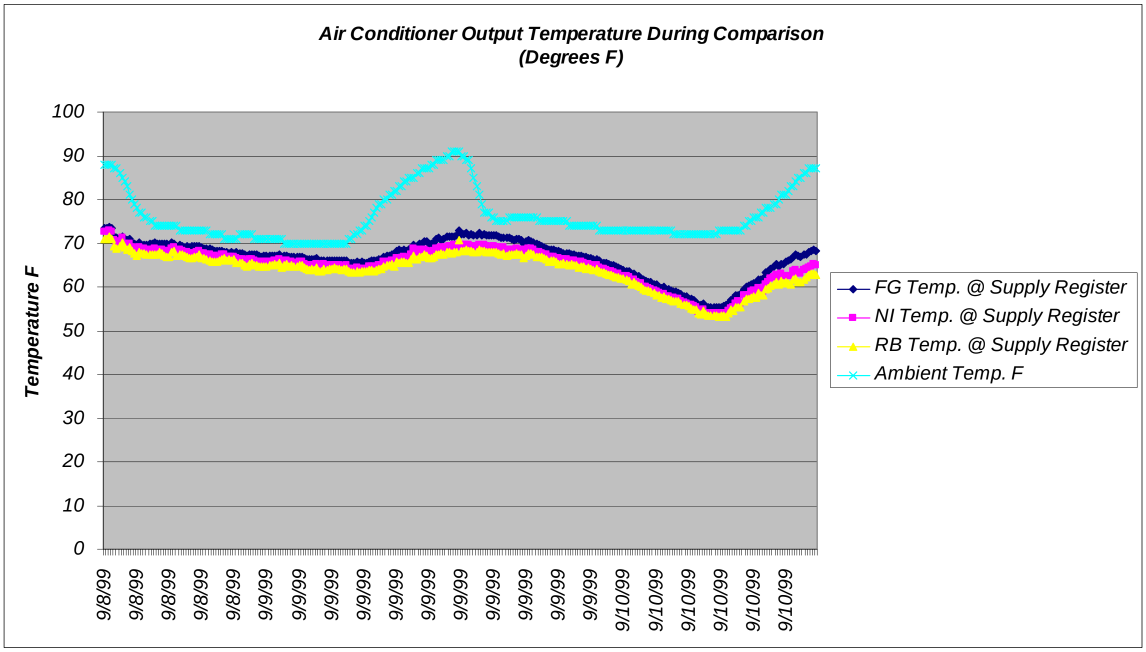
Although identical ac window units were used in this study, we compared the performance of the three units in an identical operating environment. The three units were removed from the buildings, placed under an open air pavilion 30 feet apart, set on their maximum cooling settings, and allowed to run for 72 hours. We have provided the following results:



(Figure 2) *The above chart shows that the three window units draw the same amount of energy as they follow the change in ambient temperature during the AC comparison, as noted by the "Ambient Temp. F" recorded in Figure 3, which covers the same time frame as this figure. (Data from September 8-10, 1999)*

The average power draw during the 72 hour AC Comparison was as follows:

- Fiberglass Bldg. AC = .4464 Kw
- Non-Insulated Bldg. AC = .4524 Kw
- Radient Barrier Bldg, AC = .4386 Kw



(Figure 3) *The above chart shows that the three window units delivered conditioned air out of the supply register at consistent temperatures during the AC comparison (Data from September 8-10, 1999)*

The average output temperature delivered out of the supply registers during the AC Comparison was as follows:

- Fiberglass Bldg. AC = 66.5 degrees F
- Non-Insulated Bldg. AC = 64.8 degrees F
- Radiant Barrier Bldg, AC = 63.8 degrees F

Results

As illustrated in *Figures 4, and 5*, the inside temperatures of the buildings were maintained at the 72 degree F set-point by using window air conditioners and 1,500 watt electric strip heaters, even as outside temperatures dropped to below freezing, or rose to 100 degrees F. Building No. 2, with no insulation, shows a deviation from set-point only as ambient (outside) temperature approaches freezing *(see Figure 5).* Building No. 1, with fiberglass insulation, maintained the set point because of reduced heat transfer by conduction. Building No. 3, with radiant barrier, maintained the set-point because of reduced air infiltration *(see Figure 1)* and radiant heat reflected back toward the heat source (into the building in winter, and back toward the outside in summer)

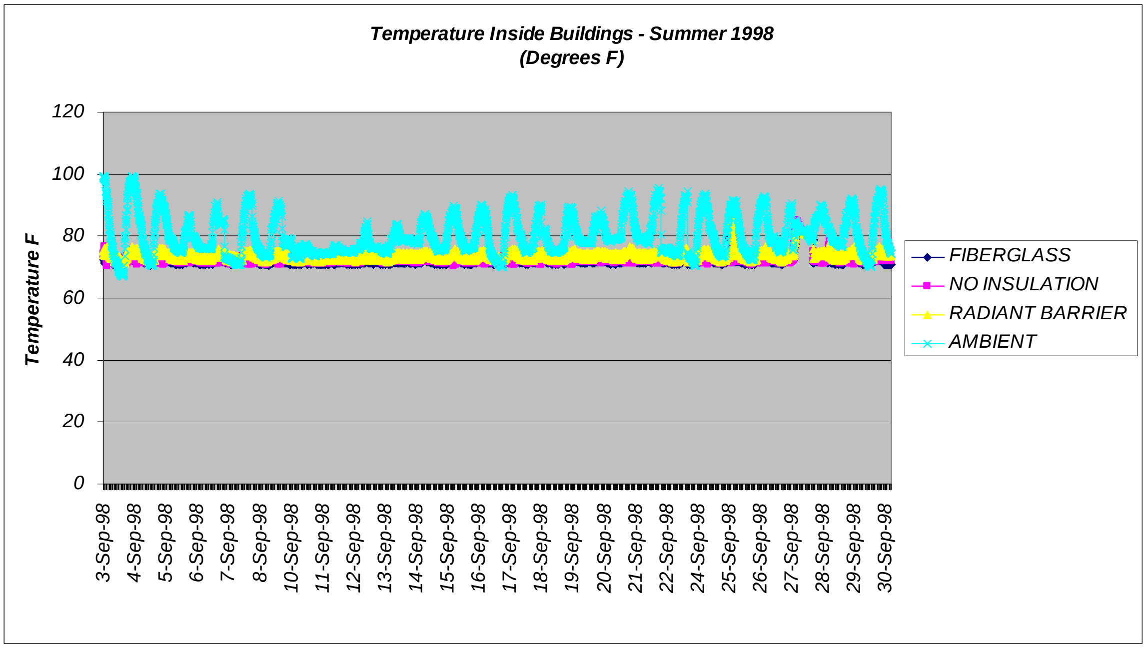
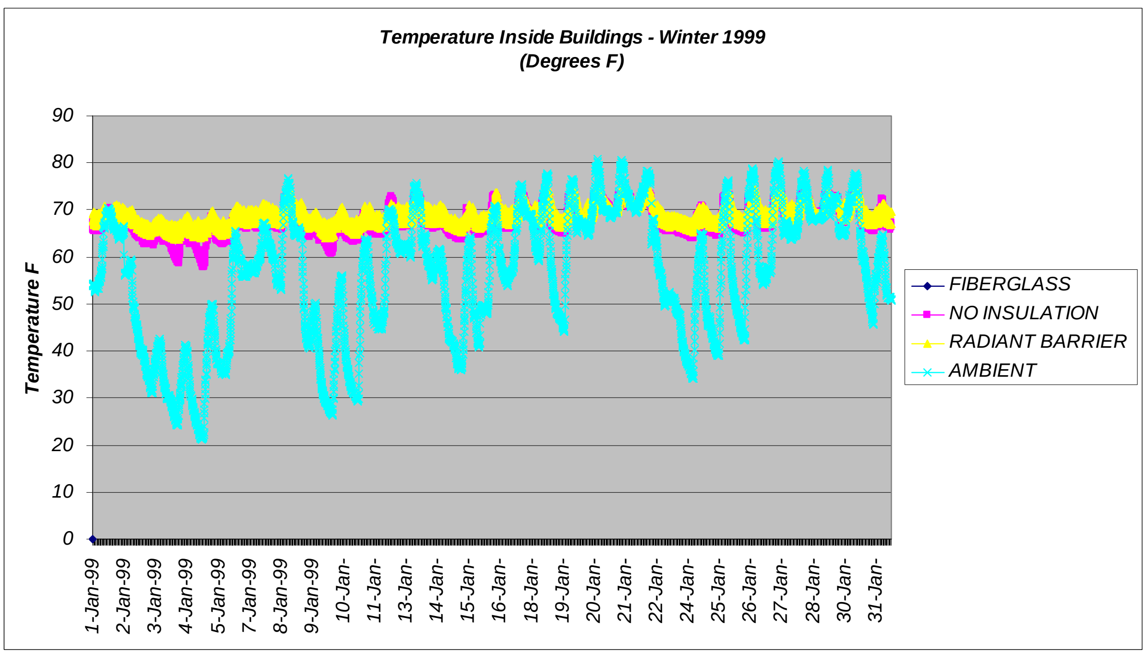


Figure 4) *For Summer conditions, we observed the above results (Data from the entire month of September1998)*



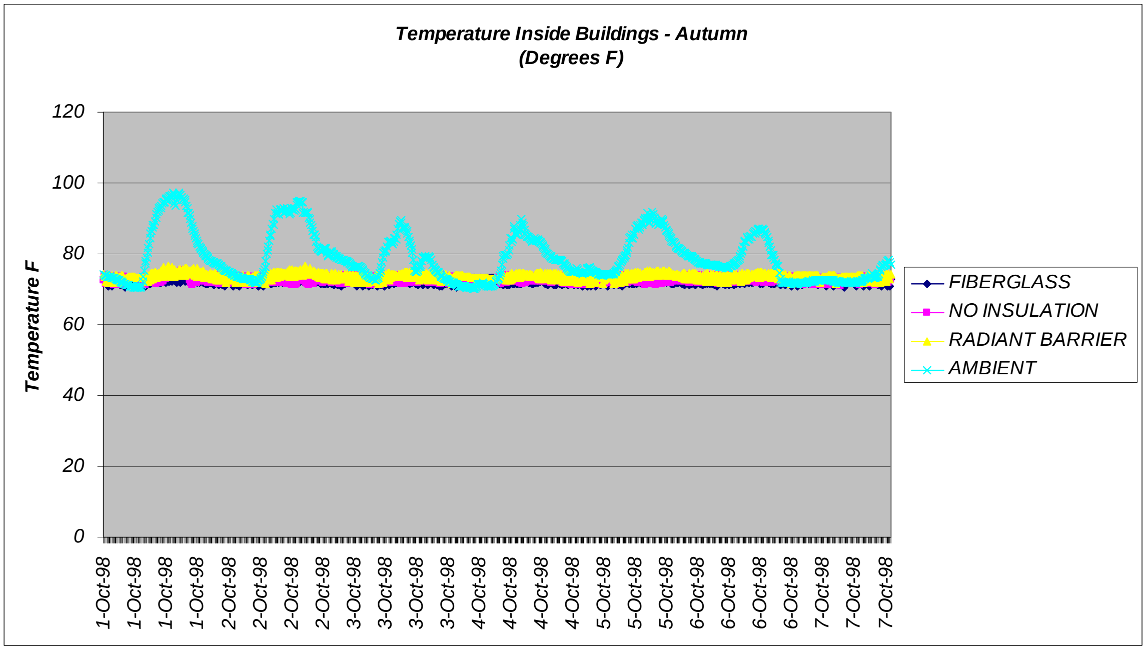
(Figure 5) *For Winter conditions, we observed the above results (Data from the entire month of January 1999)*

The kw required to maintain the inside temperatures will now be compared.

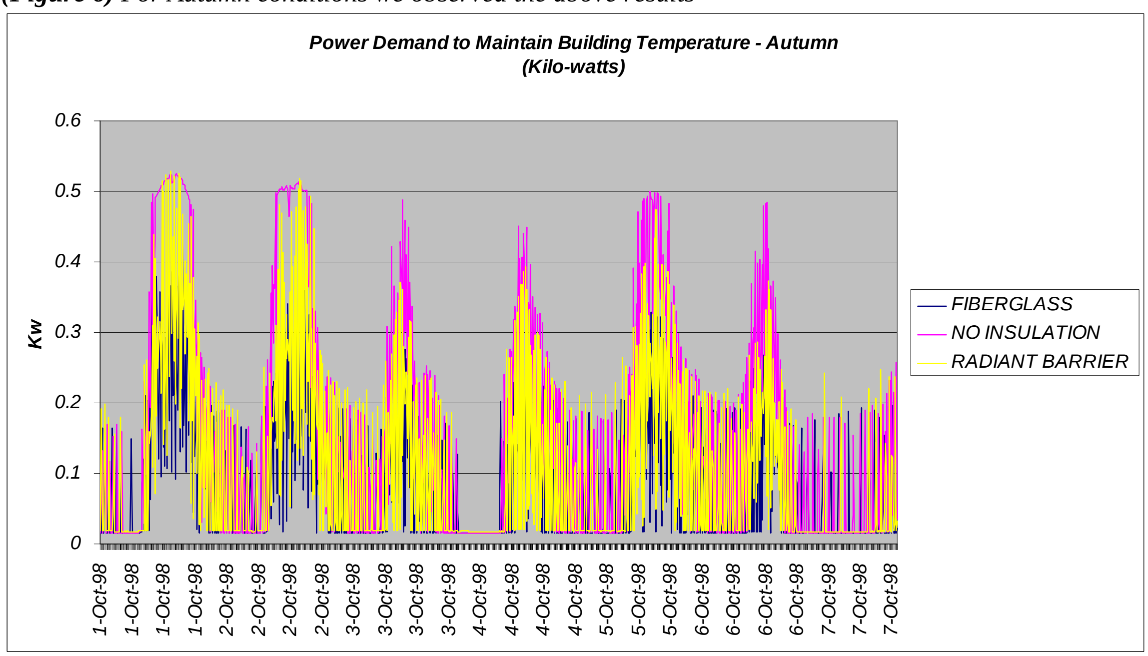
Summing the KW readings for each building we observed the following results;

Total KW	**Autumn**	**Winter**	**Spring**	**Summer**	**Jan.99**	**Aug.99**
Fiberglass	90	350	48	100	894	533
No Insulation	159	685	100	210	1819	1016
Radiant Barrier	105	502	65	109	1301	578

***The above results are for one week of each season, all of January 1999, and all of August 1999*.**



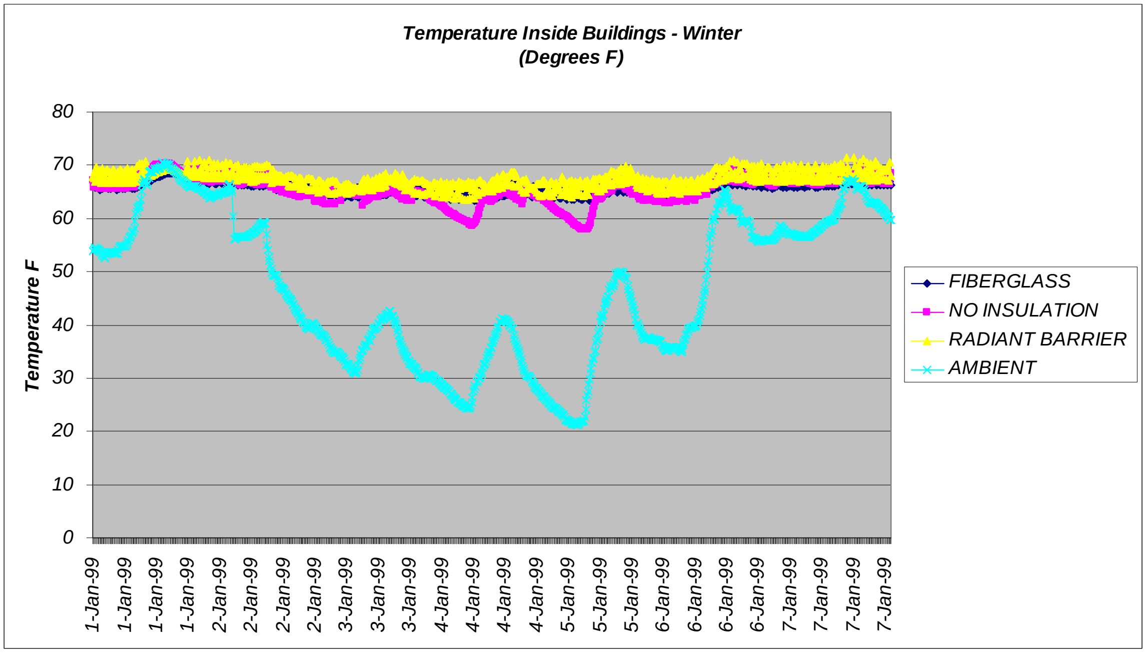
(Figure 6) *For Autumn conditions we observed the above results*



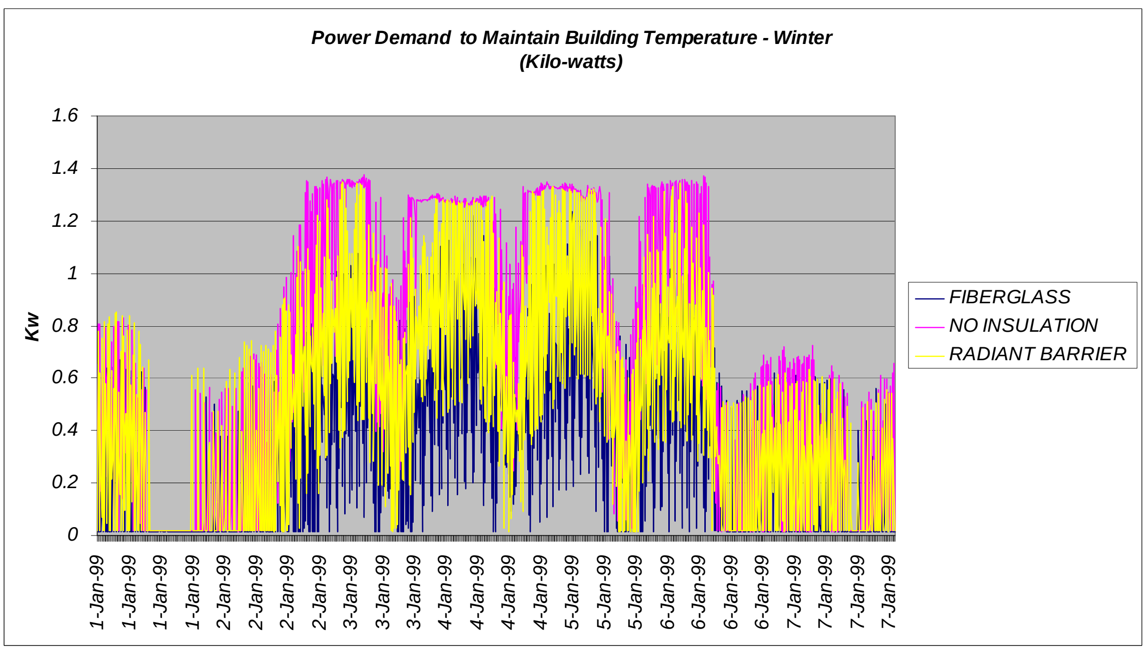
(Figure 7) *The power to maintain inside temperatures during Autumn conditions is shown above*

Power Requirement for Autumn Conditions

Fiberglass	90 KW
No Insulation	159 KW
Radiant Barrier	105 KW

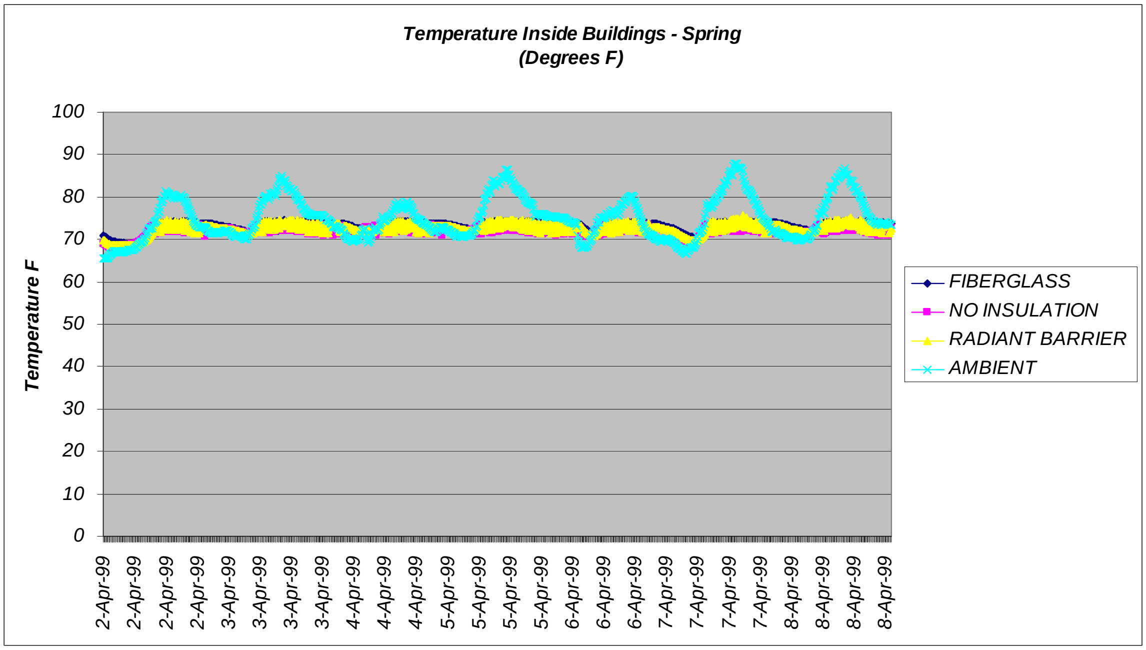


(Figure 8) *For Winter conditions we observed the above results*

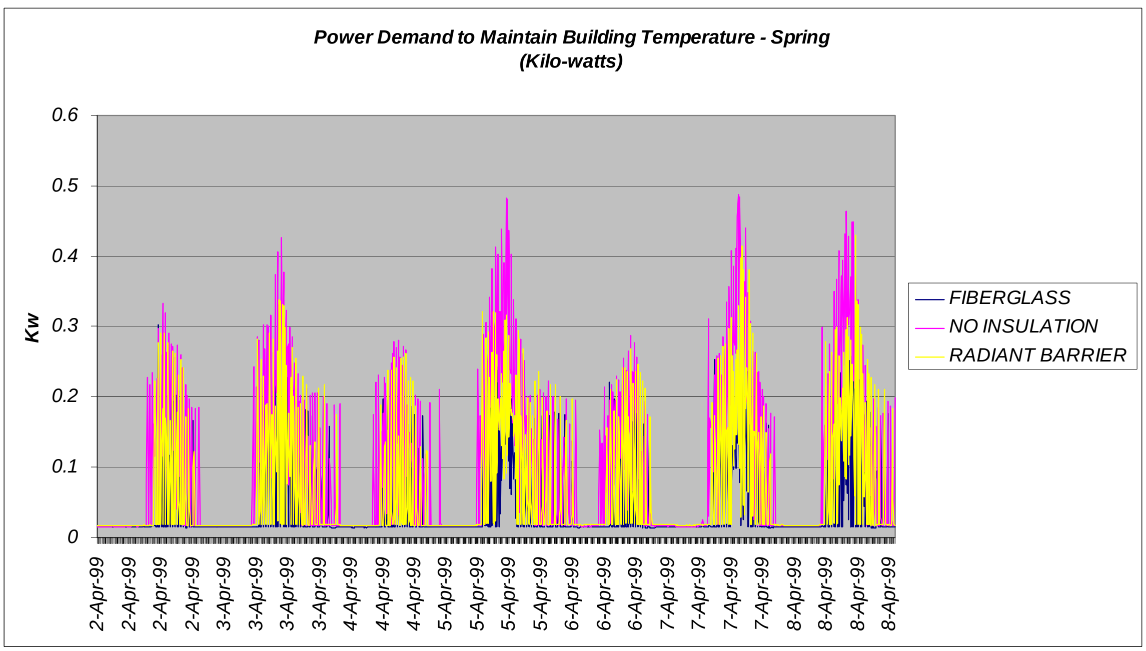


(Figure 9) *The power to maintain inside temperatures during Winter conditions is shown above*

Winter Conditions	**Power Requirements**
Fiberglass	350 KW
No Insulation	685 KW
Radiant Barrier	502 KW

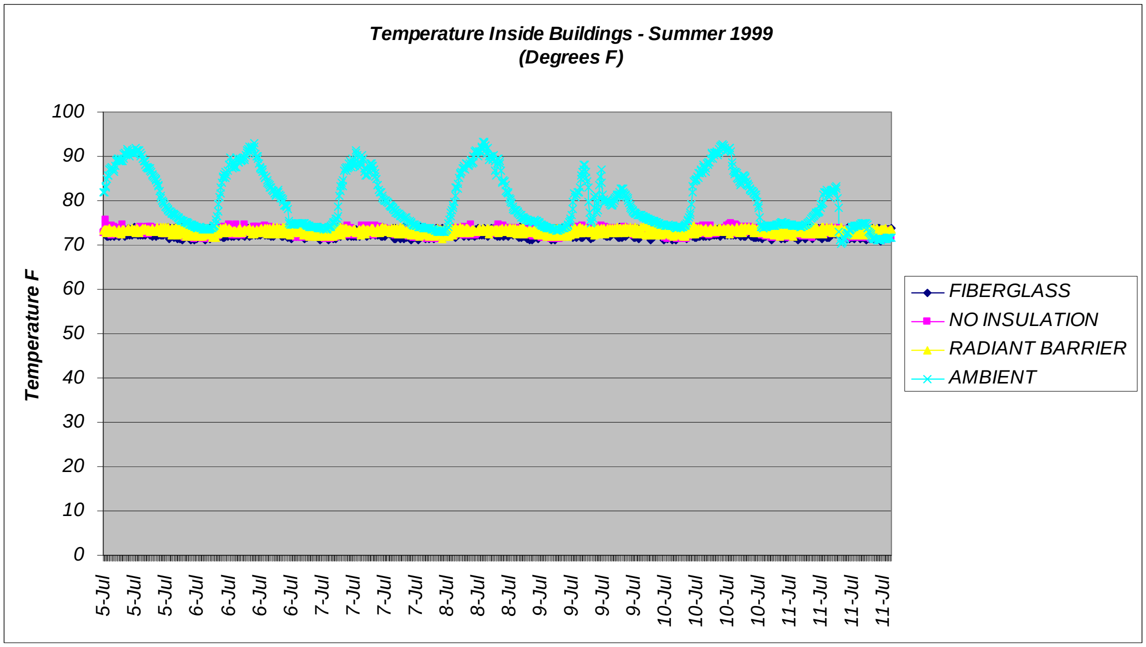


(Figure 10) *For Spring conditions we observed the above results.*

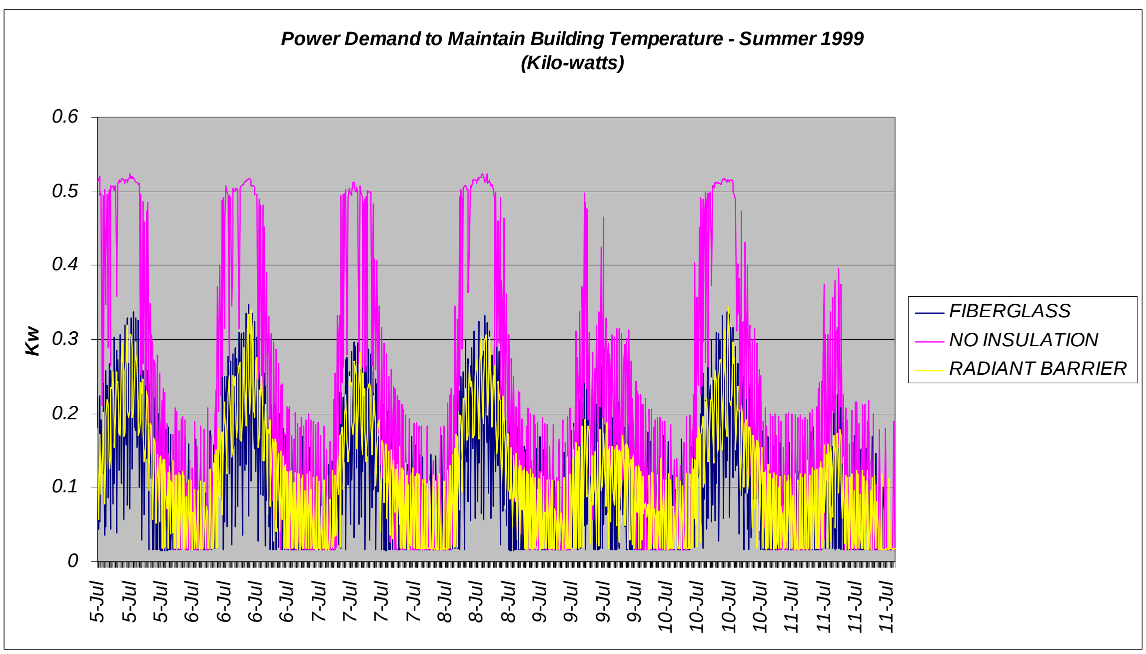


(Figure 11) *As the temperature fluctuates between day and night, observe in Figure 10 above that the building temperatures are held constant. The power to do this is shown in Figure 11. The internals in Figure 11 that show no power demand are the intervals in which the ambient outside temperatures were the same as the set point temperatures for the building interiors.*

Spring Conditions	Power Requirements
Fiberglass	48 KW
No Insulation	100 KW
Radiant Barrier	65 KW



(Figure 12) *Above is a plot of seven days of Summer conditions, note that the building inside temperatures remain constant with changing ambient temperatures*



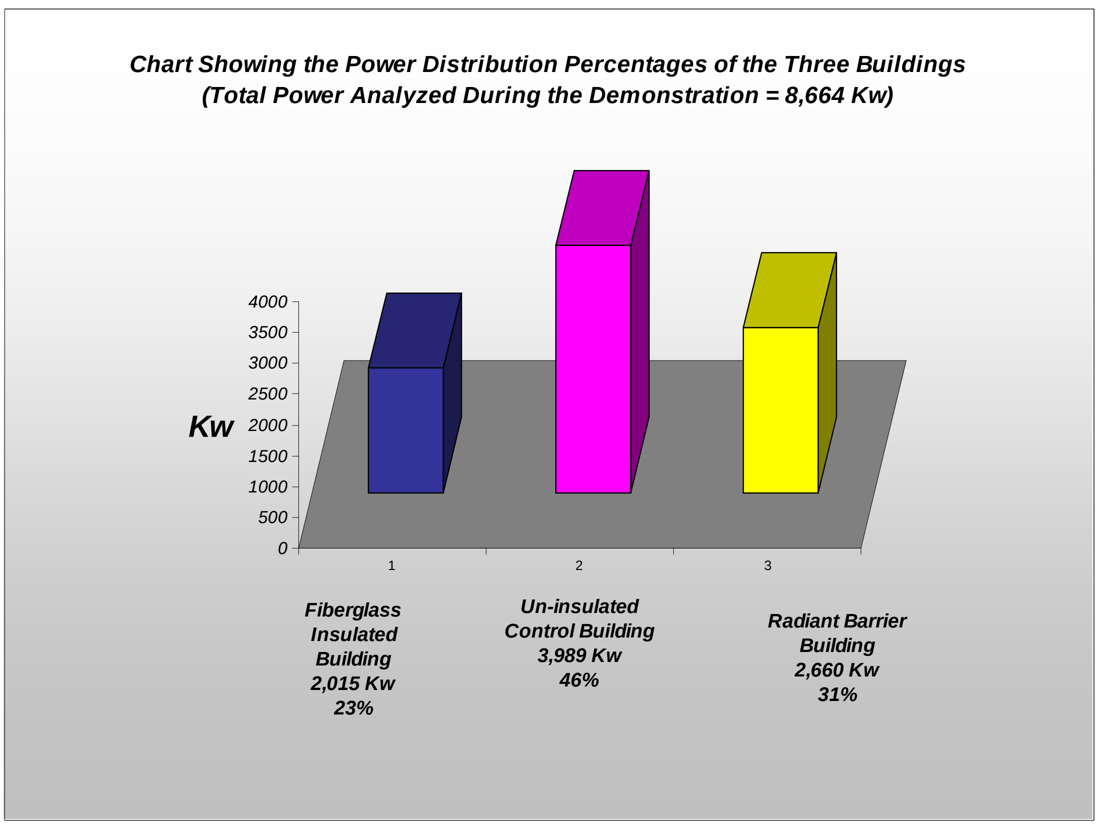
(Figure 13) *The power to maintain building temperatures for these Summer conditions is shown above*

Power Requirements for Summer Conditions

Fiberglass	100 KW
No Insulation	211 KW
Radiant Barrier	109 KW

Conclusion

This demonstration shows a simple stand alone comparison of the effectiveness of fiberglass and radiant barrier material as insulating systems, and how they affect the amount of energy required to maintain a specific interior temperature with-in two identically constructed buildings. The two different systems limit heat transfer of different types of heat gain – mass insulation affects conductive heat gain, and radiant barrier affects radiant heat gain. Our comparison tracked the amount of energy required to maintain the interior temperature of the three buildings at a constant 72 degrees F. In this demonstration mass insulation, using fiberglass, required less energy to maintain the set point temperature, for all four seasons, than did either the radiant barrier building or the non-insulated building. The radiant barrier building required more energy than the fiberglass building, but less energy than the non-insulated building, to maintain the set point temperature for all four seasons. In this specific comparison, the fiberglass insulated building performed the best out of the three buildings (*see Figure 14*). Considering the cost effectiveness of a system that uses some combination of mass, and radiant barrier insulation, the performance of such a system may be superior to either of these stand alone systems, however, this demonstration does not attempt to draw any conclusion, or correlation between such a system and any increase in performance. Our survey simply shows how the two systems performed compared to one another. This comparison also makes it obvious that, even in Louisiana's mild climate, some type of insulation is needed.



(Figure 14) *The above Chart shows the power distribution of the analyzed data collected during the project*

Photos

Outside view of the three buildings (the three bldgs. were positioned as to not shade an adjacent building)

Inside view of the identical interiors

View of the attic in the radiant barrier bldg.

View of the attic in the fiberglass bldg.

View of the attic in the non-insulated bldg. (Only the simulated duct system in the non-insulated bldg. was Insulated)

Air was circulated through a duct to simulate duct pressure and prevent air stratification

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