Mineral Insulation Manufacturers Association

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EXECUTIVE SUMMARY

ATTIC INSULATION PERFORMANCE:

FULL SCALE TESTS OF CONVENTIONAL INSULATION AND RADIANT BARRIERS

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Executive Summary

This report documents the tests sponsored by the Mineral Insulation Manufacturers Association (MIMA) on methods for reducing summer and, to a limited extent, winter heat transfer through attics. The tests, conducted in Ocala, Florida during 1987 and 1988, investigated the comparative performance of radiant barriers and conventional fiber glass insulation in reducing the ceiling heat flows that result in loads on the air conditioning and heating systems.

While it has been accepted that attic insulation reduces ceiling heat flows and hence the energy usage of houses in southern climates, only limited data on the field performance of insulation in attics had been published prior to 1987. In the early 1980s, small scale tests conducted by the Florida Solar Energy Center (FSEC) indicated that a radiant barrier (single layer of foil) installed in an attic would significantly reduce the heat flow through the ceiling, especially under summer conditions. This spurred interest in radiant barriers and led to incorporation of a credit for radiant barriers in the 1986 Florida Energy Code. Concurrently, the Tennessee Valley Authority (TVA) and the Oak Ridge National Laboratory (ORNL) initiated field tests on radiant barriers. With these tests and previous work by Joy (1958) and McQuiston (1984), a substantial, albeit sometimes conflicting, data base was developing. A review of the data led MIMA members to conclude that the discrepancies could not be resolved without additional data. Not only had different protocols been used by each research organization, but potentially important parameters that might have caused the different results to occur had not been measured. In September, 1986 MIMA approved a research project to provide data on the performance of attics in southern climates.

A duplex (850 ft^2 per unit) in Ocala, Florida was instrumented with approximately 150 sensors to measure temperatures, heat flows, air velocities, ventilation rates and weather data. The tests allowed direct side-by-side comparisons of attic performance and provided detailed information to verify models to predict attic performance. Unique features of this program included careful characterization of the actual installed insulation R-value, verification of the accuracy of the heat flow meter measurements, measurement of attic ventilation rates under natural ventilation conditions and detailed consideration of the many variables that affect attic heat transfer rates.

The results of the MIMA tests are summarized as follows:

1. Increasing the insulation level from R-19 to R-30 using fiber glass insulation resulted in a 33% average summer ceiling heat flow reduction.

2. When compared with a base level of R-19 fiber glass insulation, foil installed in either the draped configuration or covering the bottom of the top chords of the trusses resulted in an additional 20% to 26% average summer ceiling heat flow reduction.

3. Clean foil installed on top of the R-19 insulation resulted in a 35% average summer ceiling heat flow reduction. However, after only 17 months of exposure, the emittance of foil samples left in the attics had increased from 0.03 to 0.09 due to dust accumulation. As discussed in Section 15 of this report, dust accumulation will significantly reduce the performance of a horizontal radiant barrier.

4. Fiber glass insulation was more effective in reducing peak ceiling heat flows than truss mounted radiant barriers and performed the same as a clean horizontal radiant barrier. Increasing the insulation level from R19 to R30 reduced the peak heat flows by 38%. Adding a radiant barrier to R19 insulation reduced the peak ceiling heat flows by 30% for the draped configuration and by 38% for the clean horizontal configuration.

5. Radiant barriers delay the time of the peak ceiling heat flow by less than one hour, indicating that radiant barriers will not significantly reduce energy costs by shifting the load to off peak periods.

6. Adding foil to the gables in either of the truss configurations (draped or covering the bottom of the top chords of the trusses) did not measurably increase the performance of the radiant barrier installation.

7. Under mild winter conditions with a base level of R19 fiber glass insulation, the addition of a radiant barrier in either the draped or horizontal configurations reduced ceiling heat flows by less than 10% compared with R19 insulation alone.

For truss mounted radiant barriers, the MIMA summer data are in good agreement with the TVA and ORNL summer data; all of these studies show approximately 1/2 of the ceiling heat flow reductions measured by FSEC. While the TVA/ORNL/MIMA data indicate that horizontally mounted radiant barriers perform better than truss mounted, the FSEC data indicates that foil performance is independent of foil location. The reason for the differences between the FSEC data and the rest of the data is unknown. The following table summarizes the summer test results of TVA, ORNL, MIMA and FSEC for radiant barriers installed in attics with R-19 fiber glass insulation. Note that the TVA/ORNL/MIMA tests all used attics with natural ventilation while the FSEC tests used forced ventilation at fixed rates of 0 (unvented) and 5 air changes per hour (ACH).

COMPARISON OF AVERAGE SUMMER CEILING HEAT FLOW REDUCTIONS
R19 PLUS A RADIANT BARRIER
VS R19 FIBER GLASS INSULATION ALONE

Radiant Barrier or Insulation Option	**Full Scale Test House Results**			**Small Scale Test Cell Results**			
	MIMA 1987	MIMA 1988	ORNL 1985	TVA 1985	TVA 1987	FSEC 1985 0ACH	FSEC 1985 5ACH
Truss Mounted:							
Deck	-	-	-	16%	-	-	42%
Draped	20%	26%	-	-	-	-	-
Between Rafters	-	-	-	-	-	19%	42%
Bottom of Rafters	-	23%	25%	23%	30%	-	-
Horizontal:							
Top of Insulation (clean)	35%	35%	32%	40%	-	18%	42%
Increasing Insulation to R30	-	33%	-	-	27%	-	-

Of the options MIMA investigated, increasing the insulation level from R19 to R30 results in the largest ceiling heat flow reduction and will therefore achieve the greatest energy savings. The truss mounted radiant barriers are not as effective in reducing the ceiling heat flow. A horizontal radiant barrier, while initially as effective as additional insulation, will degrade as dust accumulates and will not perform as well over the long term as either of the above options.

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