

TABLE 1

Costs for Radiant Barriers Installed by Contractors

Costs per Square Foot of Material*		
Type of Application	New Construction	Existing Home
Attic Floor	\$0.15 - 0.30	\$0.15 - 0.30
Roof: stapled to bottom or faces of rafters	\$0.15 - 0.30	\$0.20 - 0.45
Roof: draped over rafters	\$0.12 - 0.35	----
Roof: underside of roof deck	\$0.12 - 0.30	----

*The cost figures in this table are the costs per square foot of radiant barrier. Since the total area of the roof and gables is larger than the area of the ceiling, roof applications will require about 7 to 50 percent more material than an attic floor application, depending upon the shape of the roof.

Source: Reflective Insulation Manufacturers Association.

TABLE 2

Costs for Conventional Attic Insulation Installed by Contractors

R-Value	Cost per Square Foot
R-11	\$0.27 - 0.30
R-19	\$0.38 - 0.47
R-22	\$0.48 - 0.51
R-30	\$0.54 - 0.68
R-38	\$0.68 - 0.95

Note: The higher the R-value, the greater the insulating power.

Source: Residential Construction and Utility Cost data base, developed by NAHB National Research Center, 1986.

TABLE 3

Present Value Savings for Dusty Radiant Barrier on Attic Floor

(Note: R-11, R-19, R-30, and R-38 refer to the existing level of conventional insulation.)

City	Present Value Savings, Dollars per Square Foot of Attic Floor			
	R-11	R-19	R-30	R-38
Albany, NY	0.04-0.13	0.02-0.06	0.01-0.03	0.01-0.03
Albuquerque, NM	0.05-0.18	0.03-0.10	0.02-0.06	0.01-0.05
Atlanta, GA	0.05-0.17	0.02-0.08	0.01-0.05	0.01-0.04
Bismarck, ND	0.05-0.14	0.02-0.06	0.01-0.04	0.01-0.03
Chicago, IL	0.04-0.13	0.02-0.06	0.01-0.04	0.01-0.03
Denver, CO	0.05-0.15	0.02-0.07	0.01-0.05	0.01-0.04
El Toro, CA	0.04-0.15	0.02-0.07	0.01-0.05	0.01-0.04
Houston, TX	0.05-0.19	0.03-0.10	0.02-0.06	0.01-0.04
Knoxville, TN	0.05-0.17	0.02-0.08	0.02-0.05	0.01-0.04
Las Vegas, NV	0.07-0.24	0.03-0.12	0.02-0.07	0.02-0.06
Los Angeles, CA	0.03-0.08	0.02-0.05	0.01-0.03	0.01-0.02
Memphis, TN	0.05-0.18	0.02-0.09	0.01-0.05	0.01-0.04
Miami, FL	0.06-0.23	0.03-0.12	0.02-0.07	0.01-0.06
Minneapolis, MN	0.04-0.13	0.02-0.06	0.01-0.03	0.01-0.03
Orlando, FL	0.05-0.21	0.03-0.10	0.02-0.07	0.01-0.05
Phoenix, AZ	0.08-0.29	0.04-0.14	0.02-0.08	0.02-0.07
Portland, ME	0.04-0.10	0.02-0.04	0.01-0.02	0.01-0.02
Portland, OR	0.04-0.11	0.02-0.05	0.01-0.03	0.01-0.02
Raleigh, NC	0.05-0.16	0.02-0.08	0.01-0.05	0.01-0.04
Riverside, CA	0.06-0.21	0.03-0.10	0.02-0.06	0.01-0.05
Sacramento, CA	0.05-0.18	0.03-0.09	0.02-0.06	0.01-0.05
Salt Lake City, UT	0.05-0.16	0.02-0.08	0.01-0.05	0.01-0.04
St. Louis, MO	0.05-0.16	0.02-0.08	0.01-0.05	0.01-0.04
Seattle, WA	0.03-0.08	0.01-0.03	0.01-0.02	0.00-0.01
Topeka, KS	0.05-0.17	0.02-0.09	0.02-0.05	0.01-0.04
Waco, TX	0.06-0.21	0.03-0.10	0.02-0.06	0.01-0.05
Washington, D.C.	0.05-0.15	0.02-0.07	0.01-0.04	0.01-0.04

Note: Values represent range of savings due to variations in rate of dusting and to uncertainties in effect of dust on heat flows. This level of degradation would be typical over 25 years of exposure.

Figures in table are based on a radiant barrier that had an emissivity of 0.05 or less when clean. Savings are for a 25 year period.

TABLE 4

Present Value Savings for Radiant Barrier Attached to Bottoms of Rafters
(Note: R-11, R-19, R-30, and R-38 refer to the existing level of conventional insulation.)

City	Present Value Savings, Dollars per Square Foot of Attic Floor			
	R-11	R-19	R-30	R-38
Albany, NY	0.17-0.19	0.08-0.09	0.04-0.05	0.03-0.04
Albuquerque, NM	0.24-0.27	0.12-0.15	0.08-0.10	0.06-0.08
Atlanta, GA	0.21-0.25	0.10-0.13	0.06-0.08	0.05-0.07

Bismarck, ND	0.18-0.20	0.09-0.10	0.05-0.06	0.04-0.05
Chicago, IL	0.17-0.19	0.08-0.10	0.05-0.06	0.04-0.05
Denver, CO	0.19-0.22	0.10-0.12	0.06-0.08	0.05-0.07
El Toro, CA	0.19-0.22	0.10-0.12	0.06-0.08	0.05-0.07
Houston, TX	0.23-0.28	0.12-0.15	0.07-0.10	0.05-0.08
Knoxville, TN	0.22-0.25	0.11-0.13	0.07-0.09	0.05-0.07
Las Vegas, NV	0.30-0.36	0.15-0.19	0.09-0.12	0.07-0.10
Los Angeles, CA	0.11-0.12	0.06-0.07	0.04-0.05	0.03-0.04
Memphis, TN	0.23-0.27	0.11-0.14	0.07-0.09	0.06-0.08
Miami, FL	0.28-0.36	0.15-0.20	0.09-0.13	0.07-0.10
Minneapolis, MN	0.18-0.19	0.08-0.10	0.05-0.06	0.03-0.04
Orlando, FL	0.26-0.32	0.13-0.17	0.08-0.12	0.07-0.10
Phoenix, AZ	0.36-0.43	0.17-0.23	0.10-0.14	0.08-0.12
Portland, ME	0.14-0.15	0.06-0.06	0.03-0.04	0.03-0.03
Portland, OR	0.14-0.16	0.07-0.08	0.04-0.05	0.03-0.04
Raleigh, NC	0.20-0.24	0.10-0.12	0.06-0.08	0.05-0.07
Riverside, CA	0.27-0.37	0.13-0.17	0.07-0.10	0.06-0.08
Sacramento, CA	0.23-0.26	0.12-0.14	0.07-0.10	0.06-0.08
Salt Lake City, UT	0.21-0.24	0.10-0.12	0.06-0.08	0.05-0.07
St. Louis, MO	0.21-0.24	0.10-0.13	0.06-0.08	0.05-0.07
Seattle, WA	0.11-0.12	0.05-0.05	0.03-0.03	0.02-0.02
Topeka, KS	0.22-0.26	0.11-0.13	0.07-0.09	0.05-0.07
Waco, TX	0.26-0.31	0.13-0.17	0.08-0.11	0.06-0.09
Washington, D.C.	0.20-0.23	0.09-0.12	0.06-0.07	0.05-0.06

Note: First value applies to houses with no air-conditioning ducts in attics. Second value applies to houses with air-conditioning ducts in attics.

Figures in table are based on a radiant barrier with an emissivity of 0.05 or less, with the radiant barrier covering the insides of the gables. Savings are for a 25 year period.

TABLE 5

Present Value Savings for Radiant Barrier Draped over Tops of Rafters or Attached to Roof Deck
(Note: R-11, R-19, R-30, and R-38 refer to the existing level of conventional insulation.)

City	Present Value Savings, Dollars per Square Foot of Attic Floor			
	R-11	R-19	R-30	R-38
Albany, NY	0.16-0.17	0.07-0.08	0.04-0.05	0.03-0.04
Albuquerque, NM	0.21-0.24	0.11-0.14	0.07-0.09	0.06-0.07
Atlanta, GA	0.19-0.22	0.09-0.12	0.06-0.07	0.04-0.06
Bismarck, ND	0.17-0.18	0.08-0.09	0.05-0.06	0.03-0.04
Chicago, IL	0.15-0.17	0.07-0.09	0.04-0.05	0.03-0.04
Denver, CO	0.17-0.19	0.09-0.10	0.05-0.07	0.05-0.06
El Toro, CA	0.17-0.20	0.09-0.10	0.05-0.07	0.05-0.06
Houston, TX	0.20-0.25	0.10-0.14	0.06-0.09	0.05-0.07
Knoxville, TN	0.19-0.22	0.10-0.12	0.06-0.08	0.05-0.07
Las Vegas, NV	0.27-0.32	0.14-0.17	0.08-0.11	0.06-0.09

Los Angeles, CA	0.10-0.11	0.06-0.06	0.03-0.04	0.03-0.04
Memphis, TN	0.20-0.24	0.10-0.13	0.06-0.08	0.05-0.07
Miami, FL	0.25-0.31	0.13-0.18	0.08-0.11	0.06-0.09
Minneapolis, MN	0.16-0.18	0.07-0.09	0.04-0.05	0.03-0.04
Orlando, FL	0.23-0.28	0.11-0.15	0.07-0.10	0.06-0.09
Phoenix, AZ	0.31-0.38	0.15-0.20	0.09-0.13	0.07-0.11
Portland, ME	0.13-0.13	0.06-0.06	0.03-0.03	0.02-0.03
Portland, OR	0.13-0.14	0.06-0.07	0.04-0.04	0.03-0.04
Raleigh, NC	0.18-0.21	0.09-0.11	0.06-0.07	0.04-0.06
Riverside, CA	0.24-0.33	0.11-0.15	0.07-0.09	0.05-0.07
Sacramento, CA	0.20-0.23	0.10-0.13	0.06-0.08	0.06-0.07
Salt Lake City, UT	0.19-0.21	0.09-0.11	0.05-0.07	0.04-0.06
St. Louis, MO	0.18-0.21	0.09-0.11	0.05-0.07	0.04-0.06
Seattle, WA	0.10-0.11	0.04-0.05	0.02-0.03	0.02-0.02
Topeka, KS	0.20-0.23	0.10-0.12	0.06-0.08	0.05-0.06
Waco, TX	0.23-0.28	0.11-0.15	0.07-0.09	0.05-0.08
Washington, D.C.	0.18-0.21	0.08-0.10	0.05-0.06	0.04-0.05

Note: First value applies to houses with no air-conditioning ducts in attics. Second value applies to houses with air-conditioning ducts in attics.

Figures in table are based on a radiant barrier with an emissivity of 0.05 or less, with the radiant barrier covering the insides of the gables. Savings are for a 25 year period.

TABLE 6

Present Value Savings for Additional Insulation

City	Present Value Savings, Dollars per Square Foot of Attic Floor			
	R-11 + R-8*	R-11 + R-19	R-19 + R-11	R-19 + R-19
Albany, NY	0.76	1.10	0.35	0.48
Albuquerque, NM	0.53	0.80	0.28	0.37
Atlanta, GA	0.50	0.71	0.21	0.29
Bismarck, ND	0.90	1.35	0.45	0.61
Chicago, IL	0.69	1.02	0.33	0.45
Denver, CO	0.64	0.96	0.32	0.44
El Toro, CA	0.33	0.48	0.15	0.20
Houston, TX	0.31	0.49	0.18	0.24
Knoxville, TN	0.53	0.78	0.24	0.34
Las Vegas, NV	0.47	0.70	0.23	0.32
Los Angeles, CA	0.22	0.33	0.11	0.15
Memphis, TN	0.52	0.74	0.22	0.31
Miami, FL	0.22	0.34	0.11	0.15
Minneapolis, MN	0.80	1.21	0.42	0.57
Orlando, FL	0.25	0.37	0.12	0.17
Phoenix, AZ	0.53	0.77	0.24	0.33
Portland, ME	0.73	1.09	0.37	0.50
Portland, OR	0.50	0.77	0.27	0.36

Raleigh, NC	0.50	0.72	0.22	0.31
Riverside, CA	0.49	0.70	0.21	0.29
Sacramento, CA	0.44	0.65	0.22	0.29
Salt Lake City, UT	0.65	0.97	0.32	0.44
St. Louis, MO	0.63	0.92	0.29	0.40
Seattle, WA	0.52	0.80	0.28	0.37
Topeka, KS	0.61	0.92	0.31	0.42
Waco, TX	0.41	0.62	0.21	0.28
Washington, D.C.	0.60	0.88	0.28	0.38

*Denotes existing level of conventional attic insulation (for example, R-11), and additional amount (for example, R-8). Savings are for a 25 year period.

TABLE A1

Average Reductions In Ceiling Heat Flow Due To Addition of Radiant Barrier to R-19 Attic Floor Insulation

SUMMER COOLING CONDITIONS

Radiant Barrier Location	Whole House Tests		Test Cell Tests	
	MIMA	ORNL	FSEC*	TVA
Roof: attached to roof deck	----	----	36 - 42%	16%
Roof: draped over rafters	20%**	----	----	----
Roof: stapled between rafters	----	----	38 - 43%	----
Roof: stapled under rafters	24%	25 - 30%	----	23 - 30%
Attic Floor***	35%	32 - 35%	38 - 44%	40 - 42%

*Tested at attic air space ventilation rate of five air changes per hour. Typical average ventilation rates are somewhat lower.

**Test was a simulation of draped configuration. The radiant barrier did not extend over the rafters, but was stapled near the joints between the rafters and the roof deck.

***Values are for new and undusted radiant barrier installations; percentages will be lower for aged radiant barriers.

TABLE A2

Average Reductions in Ceiling Heat Flow Due to Addition of Radiant Barrier to R-19 Insulation

WINTER HEATING CONDITIONS

Radiant Barrier Location	Whole House Tests (ORNL)	Test Cell Tests (TVA)
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Roof: attached to roof deck	----	4%
Roof: draped over rafters	----	----
Roof: stapled between rafters	----	----
Roof: stapled under rafters	5% to 8%	8%
Attic Floor	1% to 19%	15%

Notes for Tables A1 and A2:

Caution: These % values do not represent utility bill savings and cannot be represented as such.

NOTE: All measurements represent average heat flows through the insulation path, and do not include effects of heat flow through framing.

Key to Abbreviations:

FSEC: Florida Solar Energy Center

ORNL: Oak Ridge National Laboratory

MIMA: Mineral Insulation Manufacturers Association

TVA: Tennessee Valley Authority

TABLE X

Equipment Efficiencies

	Low	Medium	High	Very High
Gas Furnace (AFUE)	0.50	0.65	0.80	0.90
Oil Furnace (AFUE)	0.50	0.65	0.80	0.90
Heat Pump (COP) Heating/Cooling	1.6/2.1	1.9/2.6	2.2/3.1	2.5/3.4
Air Conditioner (COP)	1.8	2.3	2.9	3.5
Electric Furnace	1.0	1.0	1.0	1.0
Electric Baseboard Heating	1.0	1.0	1.0	1.0

TABLE Y1

Cooling Load Factors for Radiant Barriers

(Note: R-11, R-19, R-30, and R-38 refer to the existing level of conventional insulation.)

City	R-11	R-19	R-30	R-38
Albany, NY	876	409	259	211
Albuquerque, NM	1598	851	522	426

Atlanta, GA	1673	832	516	405
Bismarck, ND	706	388	245	191
Chicago, IL	960	475	284	229
Denver, CO	1020	550	357	294
El Toro, CA	1232	636	405	351
Houston, TX	2162	1120	672	521
Knoxville, TN	1597	823	517	411
Las Vegas, NV	2535	1210	703	539
Los Angeles, CA	429	256	168	148
Memphis, TN	1832	907	555	440
Miami, FL	3090	1631	938	727
Minneapolis, MN	769	418	257	204
Orlando, FL	2575	1299	832	662
Phoenix, AZ	3308	1595	942	738
Portland, ME	297	120	82	62
Portland, OR	551	299	178	147
Raleigh, NC	1440	738	460	359
Riverside, CA	1999	931	556	448
Sacramento, CA	1592	849	542	445
Salt Lake City, UT	1286	651	409	332
St. Louis, MO	1466	757	479	369
Seattle, WA	223	119	80	65
Topeka, KS	1523	790	512	397
Waco, TX	2371	1175	713	552
Washington, D.C.	1221	622	386	301

Figures in table are based on a radiant barrier with an emissivity of 0.05 or less when clean.

TABLE Y2

Heating Load Factors for Radiant Barriers

(Note: R-11, R-19, R-30, and R-38 refer to the existing level of conventional insulation.)

City	R-11	R-19	R-30	R-38
Albany, NY	929	400	193	140
Albuquerque, NM	931	476	299	238
Atlanta, GA	605	282	163	137
Bismarck, ND	1192	513	293	206
Chicago, IL	842	377	210	144
Denver, CO	989	473	277	236
El Toro, CA	792	378	242	197
Houston, TX	387	182	108	80
Knoxville, TN	725	337	206	164
Las Vegas, NV	774	438	277	227
Los Angeles, CA	738	390	227	188
Memphis, TN	630	304	180	164
Miami, FL	99	47	28	26
Minneapolis, MN	1062	447	223	154

Orlando, FL	275	130	77	62
Phoenix, AZ	606	321	191	162
Portland, ME	1112	490	253	194
Portland, OR	937	427	238	186
Raleigh, NC	741	342	219	162
Riverside, CA	892	422	248	189
Sacramento, CA	821	397	236	192
Salt Lake City, UT	906	415	223	187
St. Louis, MO	738	324	169	136
Seattle, WA	904	364	197	133
Topeka, KS	868	379	219	176
Waco, TX	477	225	138	119
Washington, D.C.	912	386	212	182

Figures in table are based on a radiant barrier with an emissivity of 0.05 or less when clean.

TABLE Y3

Cooling Load Factors for Additional Insulation (Note: R-11, R-19, R-30, and R-38 refer to the existing and addition levels of conventional insulation.)

City	R-11 to R-19	R-19 to R-30	R-30 to R-38
Albany, NY	1171	258	87
Albuquerque, NM	1100	689	189
Atlanta, GA	1649	508	184
Bismarck, ND	695	226	84
Chicago, IL	1061	293	99
Denver, CO	715	344	117
El Toro, CA	854	384	123
Houston, TX	1310	945	247
Knoxville, TN	1476	527	193
Las Vegas, NV	1960	997	369
Los Angeles, CA	214	122	25
Memphis, TN	1797	584	219
Miami, FL	1694	883	315
Minneapolis, MN	471	259	90
Orlando, FL	1435	691	284
Phoenix, AZ	3175	1334	488
Portland, ME	392	66	27
Portland, OR	368	316	60
Raleigh, NC	1375	434	153
Riverside, CA	1983	713	241
Sacramento, CA	1145	582	194
Salt Lake City, UT	966	462	159
St. Louis, MO	1482	444	186
Seattle, WA	169	73	23
Topeka, KS	991	465	193
Waco, TX	1606	819	317

Washington, D.C.	1210	392	138
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TABLE Y4

Heating Load Factors for Additional Insulation (Note: R-11, R-19, R-30, and R-38 refer to the existing and addition levels of conventional insulation.)

City	R-11 to R-19	R-19 to R-30	R-30 to R-38
Albany, NY	5358	2751	1030
Albuquerque, NM	3460	1697	626
Atlanta, GA	2660	1332	497
Bismarck, ND	7072	3610	1369
Chicago, IL	4923	2569	952
Denver, CO	4765	2450	872
El Toro, CA	1977	923	336
Houston, TX	1358	632	242
Knoxville, TN	3145	1584	599
Las Vegas, NV	2114	1042	375
Los Angeles, CA	1706	814	295
Memphis, TN	2711	1359	489
Miami, FL	254	121	38
Minneapolis, MN	6399	3323	1239
Orlando, FL	712	390	125
Phoenix, AZ	1444	744	318
Portland, ME	5870	3096	1137
Portland, OR	3980	1992	738
Raleigh, NC	2977	1489	606
Riverside, CA	2302	1121	406
Sacramento, CA	2651	1294	467
Salt Lake City, UT	4623	2321	858
St. Louis, MO	4010	2038	759
Seattle, WA	4328	2295	831
Topeka, KS	4297	2199	802
Waco, TX	1966	968	353
Washington, D.C.	3999	2014	731

TABLE Z

Discount Factors Adjusted for Average Fuel Price Escalation (Based on 7 percent discount rate and 25 year life.)

Census Region	Electricity	Fuel Oil	Natural Gas
1	11.68	15.33	13.85
2	11.37	15.56	14.42
3	11.50	15.33	14.36

4	12.12	15.58	4.46
U. S. Average	11.56	15.41	14.33

Region 1: Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania

Region 2: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas

Region 3: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas

Region 4: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, Hawaii

Source: "Energy Prices and Discount Factors for Life-Cycle Cost Analysis 1988," NISTIR 85-3273-3, U. S. Department of Commerce, November 1988.