

Measure Information Template – Prescriptive Trade-off Alternative of Insulation for Roof Reflectance

2008 California Building Energy Efficiency Standards

Asphalt Roofing Manufacturers Association

April 10, 2007

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Overview

Description	<p><i>It is imperative to note that the Asphalt Roofing Manufacturers Association <u>opposes</u> the inclusion of requirements for roof reflectance and emittance that are not cost-effective. Based on research and analyses undertaken by ARMA and our member companies which has been provided to the commission, the proposed requirements are not cost effective. However, we submit this measure in the event that the Commission chooses to move forward with this proposal in spite of this fact.</i> This measure is for adding the overall envelope approach to the proposed 2008 Title 24, Part 6 “Prescriptive Requirements for Building Envelopes” section for steep-slope residential applications. A family of look-up tables will replace the existing invalid calculation procedure.</p>
Type of Change	<p>Prescriptive Requirement This proposal would completely remove and replace the existing text in Section 143(b), “Overall Envelope Approach” in the draft proposed prescriptive requirement (“Inclusion of Solar Reflectance and Thermal Emittance Prescriptive Requirements for Residential Roofs in Title 24 – Revised May 17, 2006). This proposal offers an alternative solution to the “cool roof” requirement prescribed in the aforementioned proposal. The proposal would necessitate text changes the Title 24, Part 6 Standards and the Compliance Manual.</p>

Energy Benefits	Energy savings resulting from inclusion of this language would be identical to those proposed in the draft proposed prescriptive requirement (<i>"Inclusion of Solar Reflectance and Thermal Emittance Prescriptive Requirements for Residential Roofs in Title 24 – Revised May 17, 2006"</i>).
Non-Energy Benefits	The proposed language provides the consumer with the choice of varying strategies to comply with the energy goals set forth in Title 24, Part 6 by allowing them the flexibility to choose from a number of performing roof systems that meet their needs not only in terms of energy savings, but also in aesthetics. Additionally, offering more options will yield more cost-effective solutions.
Environmental Impact	There is no discernable difference in the impact to the environment from the language in the proposed prescriptive requirement (<i>"Inclusion of Solar Reflectance and Thermal Emittance Prescriptive Requirements for Residential Roofs in Title 24 – Revised May 17, 2006"</i>).
Technology Measures	<p>Measure Availability and Cost This proposal encourages the consideration of alternative energy-saving technologies, specifically the use of additional levels of insulation to off-set the energy savings associated with a "cool roof" without the need for additional maintenance or cleaning. Numerous insulation products are readily available in the marketplace.</p> <p>Useful Life, Persistence and Maintenance Insulation is proven technology in the energy savings arena and has been available to the general public in excess of 100 years. It has a long history of maintaining its performance and energy-saving characteristics over an extended period of time, requires no maintenance over its useful life and is recyclable.</p>
Performance Verification	Since this measure simply increases the insulation levels being used in the building envelope, the only performance verification measures would be the inspections already recommended in the California Title 24, Part 6 Residential Compliance Manual.
Cost Effectiveness	Adding additional insulation is a cost-effective means to save energy and is equal to or less-costly to the use of a "cool" roof. "Cool" roofing materials command a significant premium over "non-cool" products readily available in the marketplace. In addition, insulation has a considerably longer life-cycle than an exterior roofing system, requires no maintenance over its useful life, and offers energy savings value in cold months/climates in addition to the warm months/climates as opposed to a "cool" roof which only offers savings in warm months/climates.

Analysis Tools	Analysis has been completed using the MICROPAS software and verified using the ATTICSIM software (ASTM C1340). No additional analysis tools are required.
Relationship to Other Measures	This proposal simply offers an alternative to the draft proposed prescriptive requirement (<i>“Inclusion of Solar Reflectance and Thermal Emittance Prescriptive Requirements for Residential Roofs in Title 24 – Revised May 17, 2006”</i>).

Methodology

Using the MICROPAS software with the enhanced attic module, a family of simulations was performed to determine the energy equivalency of a “non-cool” roof with additional insulation (to that prescribed in the California Energy Code) to the prescribed “cool” roof with code-level insulation. The simulations included the effects of:

- Inspected vs. Non-inspected Ducts
- Inspected vs. Non-inspected Insulation
- Time-Dependent Valuation (TDV) of Energy
- Radiant Barriers
- California Climate Zone (9-16)
- Existing Insulation R-value (R11, R19, R30, R38)
- Duct Insulation R-value
- Removal of Ducts from Attic

Tables of attic insulation R-values needed to off-set the lack of a “cool” roof have been computed and tabulated. Since the proposed energy savings are identical and obtained at a reduced cost, no life-cycle cost analysis is required.

Analysis and Results

The analysis revealed that equal energy savings equal to that of a “cool” roof can be easily attained by increasing insulation levels. In most cases, modest increases in insulation off-set the lack of a “cool” roof. Appendix A includes a series of 10 tables where the required insulation levels needed to achieve equal energy performance are tabulated, as well as a series of charts detailing the results in graphic form.

Recommendations

We are proposing to delete all current text contained in Section 143(b), “Overall Envelope Approach” in the draft proposed prescriptive requirement (*“Inclusion of Solar Reflectance and Thermal Emittance Prescriptive Requirements for Residential Roofs in Title 24 – Revised May 17, 2006”*) and replace it with the following:

(b) Overall Envelope Approach

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2. Any roofing product that does not meet the prescriptive requirement for a “cool” roof as defined in Section 118(i)(2) may be used in association with increased levels of insulation where the R-value increase produces identical net energy savings as the prescriptive “cool” roof. See pages XX-YY of the Residential Compliance Manual for the additional insulation R-value required based on roof surface reflectance and existing insulation R-value.

Material for Compliance Manuals

Per the language above, the tables in Appendix A would be appropriate for inclusion in the Residential Compliance Manual.

Bibliography and Other Research

Tables provided by Oak Ridge National Laboratories.

Appendices

Appendix A – “Insulation R-value - Surface Reflectance Trade-off Tables”

R-value of "Non-cool" Roof that Equals TDV-weighted Annual Load of "Cool" Roof

No Ducts

Ni = No Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	42.6	33.7	21.4	12.5
10	43.1	34.0	21.6	12.6
11	41.9	33.1	21.0	12.2
12	41.4	32.7	20.8	12.0
13	42.7	33.7	21.5	12.5
14	41.7	33.0	21.0	12.2
15	43.6	34.4	21.9	12.8
16	39.2	30.9	19.7	11.4

Nn = No Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	43.1	34.0	21.6	12.6
10	43.6	34.3	21.8	12.7
11	42.3	33.3	21.2	12.3
12	41.6	32.8	20.9	12.1
13	43.2	34.1	21.6	12.6
14	42.1	33.2	21.1	12.3
15	44.4	34.9	22.1	12.9
16	39.0	30.8	19.7	11.4

Code Ducts

ii - Inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	48.5	37.6	23.2	13.2
10	51.8	39.6	24.1	13.6
11	51.1	38.8	23.4	13.2
12	46.8	36.2	22.4	12.7
13	55.7	41.7	24.8	13.8
14	49.6	38.0	23.1	13.1
15	60.3	44.4	26.0	14.3
16	40.1	31.6	20.0	11.6

in = Inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	49.3	38.0	23.4	13.4
10	52.7	40.1	24.4	13.8
11	51.9	39.2	23.6	13.2
12	47.3	36.5	22.5	12.8
13	56.8	42.3	25.0	13.9
14	50.3	38.3	23.3	13.2
15	62.1	45.4	26.3	14.5
16	40.1	31.6	20.1	11.6

R-2.8 Ducts

ii - Inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	52.7	40.1	24.3	13.7
10	58.5	43.6	25.7	14.3
11	57.6	42.6	24.9	13.7
12	50.2	38.3	23.3	13.1
13	66.5	47.6	26.9	14.5
14	57.9	42.7	25.0	13.8
15	84.2	56.5	30.0	15.7
16	41.1	32.3	20.4	11.7

in = Inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	53.7	40.7	24.5	13.8
10	59.8	44.3	26.0	14.4
11	58.6	43.1	25.1	13.8
12	50.8	38.7	23.5	13.2
13	68.2	48.5	27.3	14.7
14	58.9	43.3	25.2	13.9
15	88.3	58.2	30.5	15.8
16	41.1	32.3	20.4	11.7

Ni = No Ducts, Inspected Insulation
Nn = No Ducts, Non-inspected Insulation
ii - Inspected Ducts, Inspected Insulation
in = Inspected Ducts, Non-inspected Insulation
ni = Non-inspected Ducts, Inspected Insulation
nn = Non-inspected Ducts, Non-inspected Insulation
CZ = Climate Zone
TDV = Time-dependent Valuation

Minimum Code requirement is R30

Minimum Code requirement is R38

ni = Non-inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	56.2	42.2	25.1	14.1
10	65.7	47.7	27.3	14.9
11	64.4	46.4	26.3	14.2
12	53.0	40.0	24.0	13.4
13	79.5	54.1	29.1	15.3
14	66.3	47.3	26.6	14.4
15	133.8	76.0	35.0	17.2
16	41.1	32.3	20.4	11.8

nn = Non-inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	57.4	42.9	25.4	14.2
10	67.5	48.6	27.6	15.0
11	66.0	47.1	26.6	14.3
12	53.7	40.5	24.3	13.5
13	82.2	55.4	29.5	15.5
14	67.7	48.0	27.0	14.5
15	146.3	79.5	35.9	17.4
16	41.1	32.3	20.4	11.8

ni = Non-inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	61.5	45.3	26.4	14.5
10	75.7	52.9	29.1	15.6
11	74.4	51.3	28.0	14.8
12	56.8	42.4	25.0	13.9
13	101.7	63.8	31.9	16.2
14	81.5	54.9	29.1	15.2
15	383.6	122.7	43.1	19.2
16	41.9	32.9	20.7	11.9

nn = Non-inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	63.0	46.1	26.7	14.7
10	78.1	54.0	29.5	15.7
11	76.7	52.4	28.4	14.9
12	57.7	42.9	25.3	14.0
13	106.3	65.7	32.5	16.4
14	84.3	56.1	29.5	15.4
15	516.3	132.6	44.4	19.5
16	42.0	32.9	20.8	11.9

R-value of "Non-cool" Roof that Equals TDV-weighted Annual Load of "Cool" Roof

No Ducts

Ni = No Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	42.6	33.7	21.4	12.5
10	43.1	34.0	21.6	12.6
11	41.9	33.1	21.0	12.2
12	41.4	32.7	20.8	12.0
13	42.7	33.7	21.5	12.5
14	41.7	33.0	21.0	12.2
15	43.6	34.4	21.9	12.8
16	39.2	30.9	19.7	11.4

Nn = No Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	43.1	34.0	30.0	30.0
10	43.6	34.3	30.0	30.0
11	42.3	33.3	30.0	30.0
12	41.6	32.8	30.0	30.0
13	43.2	34.1	30.0	30.0
14	42.1	33.2	30.0	30.0
15	44.4	34.9	30.0	30.0
16	39.0	38.0	38.0	38.0

Code Ducts

ii - Inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	48.5	37.6	23.2	13.2
10	51.8	39.6	24.1	13.6
11	51.1	38.8	23.4	13.2
12	46.8	36.2	22.4	12.7
13	55.7	41.7	24.8	13.8
14	49.6	38.0	23.1	13.1
15	60.3	44.4	26.0	14.3
16	40.1	31.6	20.0	11.6

in = Inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	49.3	38.0	30.0	30.0
10	52.7	40.1	30.0	30.0
11	51.9	39.2	30.0	30.0
12	47.3	36.5	30.0	30.0
13	56.8	42.3	30.0	30.0
14	50.3	38.3	30.0	30.0
15	62.1	45.4	30.0	30.0
16	40.1	38.0	38.0	38.0

R-2.8 Ducts

ii - Inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	52.7	40.1	24.3	13.7
10	58.5	43.6	25.7	14.3
11	57.6	42.6	24.9	13.7
12	50.2	38.3	23.3	13.1
13	66.5	47.6	26.9	14.5
14	57.9	42.7	25.0	13.8
15	84.2	56.5	30.0	15.7
16	41.1	32.3	20.4	11.7

in = Inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	53.7	40.7	30.0	30.0
10	59.8	44.3	30.0	30.0
11	58.6	43.1	30.0	30.0
12	50.8	38.7	30.0	30.0
13	68.2	48.5	30.0	30.0
14	58.9	43.3	30.0	30.0
15	88.3	58.2	30.0	30.0
16	41.1	38.0	38.0	38.0

Ni = No Ducts, Inspected Insulation

Nn = No Ducts, Non-inspected Insulation

ii - Inspected Ducts, Inspected Insulation

in = Inspected Ducts, Non-inspected Insulation

ni = Non-inspected Ducts, Inspected Insulation

nn = Non-inspected Ducts, Non-inspected Insulation

CZ = Climate Zone

TDV = Time-dependent Valuation

Minimum Code requirement is R30
Not energy equal R-value

Minimum Code requirement is R38
Not energy equal R-value

ni = Non-inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	56.2	42.2	30.0	30.0
10	65.7	47.7	30.0	30.0
11	64.4	46.4	30.0	30.0
12	53.0	40.0	30.0	30.0
13	79.5	54.1	30.0	30.0
14	66.3	47.3	30.0	30.0
15	133.8	76.0	35.0	30.0
16	41.1	38.0	38.0	38.0

nn = Non-inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	57.4	42.9	30.0	30.0
10	67.5	48.6	30.0	30.0
11	66.0	47.1	30.0	30.0
12	53.7	40.5	30.0	30.0
13	82.2	55.4	30.0	30.0
14	67.7	48.0	30.0	30.0
15	146.3	79.5	35.9	30.0
16	41.1	38.0	38.0	38.0

ni = Non-inspected Ducts, Inspected Insulation

CZ	R38	R30	R19	R11
9	61.5	45.3	30.0	30.0
10	75.7	52.9	30.0	30.0
11	74.4	51.3	30.0	30.0
12	56.8	42.4	30.0	30.0
13	101.7	63.8	30.0	30.0
14	81.5	54.9	30.0	30.0
15	383.6	122.7	43.1	30.0
16	41.9	38.0	38.0	38.0

nn = Non-inspected Ducts, Non-inspected Insulation

CZ	R38	R30	R19	R11
9	63.0	46.1	30.0	30.0
10	78.1	54.0	30.0	30.0
11	76.7	52.4	30.0	30.0
12	57.7	42.9	30.0	30.0
13	106.3	65.7	30.0	30.0
14	84.3	56.1	30.0	30.0
15	516.3	132.6	44.4	30.0
16	42.0	38.0	38.0	38.0