Submitted Electronically

September 6, 2016

Federal Trade Commission
Attn: Hampton Newsome
600 Pennsylvania Ave. NW
Washington, DC 20580
https://ftcpublic.commentworks.com/ftc/rvaluerule

Re: 16 CFR part 460 – R-value Rule Review, File No. R811001

Dear Mr. Newsome:

The Center for the Polyurethanes Industry[1] and Spray Foam Coalition[2] of the American Chemistry Council appreciate the opportunity to provide comment on the Advanced Notice of Proposed Rulemaking (ANPR) of the Federal Trade Commission's (FTC) *Trade Regulation Rule Concerning the Labeling and Advertising of Home Insulation* (R-value Rule).

We believe there is a continuing need for the R-value Rule because it helps protect consumers from misleading advertising claims and promotes fair competition among manufacturers of residential insulation products. The FTC's systematic review presents an opportunity to strengthen the consumer protections offered under the current Rule and further fair competition.

In an effort to make consumers more informed buyers when it comes to evaluating the performance of competing insulation products, our comments propose enhancements to the current Rule that will clarify what R-value means in terms of overall insulation performance. This clarification presents the opportunity to provide consumers with more complete information on other physical characteristics that can impact insulation performance. We provide specific

[1] The Center for the Polyurethanes Industry (CPI) serves as the voice of the polyurethanes industry in North America, promoting its development and coordinating with polyurethane trade associations across the globe. The polyurethane industry supports research and initiatives that serve its communities and customers. The business of polyurethane is a $26.5 billion enterprise and a key element of the U.S. economy. The industry operates in more than 1,000 locations in the U.S. and directly employs more than 46,500. A major job creator in the U.S., each job in the polyurethanes industry yields five more jobs indirectly for an approximate total of 235,000 jobs supported.

[2] The Spray Foam Coalition (SFC) champions the use of spray polyurethane foam in U.S. building and construction applications and promotes its economic, environmental and societal benefits while supporting the safe manufacture, transport, and application of spray polyurethane foam. SFC consists of manufacturers of spray polyurethane foam systems as well as suppliers of raw materials and machinery used to apply the foam.

changes to the disclosure statements that are required for product labels and insulation ads. We believe that presenting additional information can facilitate more informed purchasing decisions and, ultimately, further the intent of the R-value Rule.

Additionally, our comments respond to the FTC's questions on material testing. Specifically, we oppose adoption of ASTM C1303 as a mandatory standard for all closed-cell foam insulation products. Furthermore, our comments illustrate why the R-value Rule should be amended to allow for the continual recognition of revised or new consensus-based material specifications and testing standards.

I. R-value: What does it tell consumers about insulation performance?

In the ANPR, FTC states that the purpose of the R-value Rule's disclosure requirements are to "enable[ ] consumers to evaluate the performance and cost effectiveness of competing insulation products." However, today there is an overreliance on R-value as the predominant, or only, factor in selecting insulation products. Additional information on insulation products should be provided to inform buyers.

R-value provides a measure of how well an insulation product reduces heat flow under laboratory or controlled testing conditions as determined by the relevant material property test. The laboratory and controlled testing conditions may not represent field (or "as installed") conditions. The ASTM test procedures used to determine R-value promote fair competition by ensuring R-value testing is conducted and reported in a consistent manner. And the values derived from a specific material property test can provide a means of comparing in-kind insulation products.

However, R-value is just one material property that can impact insulation performance. As stated above, R-value is not necessarily indicative of installed performance. Unfortunately, the disclosure statements required under the current R-value Rule can lead consumers to believe that R-value is the only measure of insulation performance. A growing body of building science demonstrates that other physical properties, in addition to assembly design and quality of installation, impact performance. Therefore, the disclosure statements required under the R-value Rule should be revised to clearly state that R-value is a way to quantify one physical property of insulation products. The R-value Rule should also position consumers to recognize additional factors that can impact installed performance. We offer specific changes to the Rule's disclosure statements in Section III of our comments.

II. What factors can impact insulation performance?

Consumers should be made aware of the multitude of factors beyond R-value that impact the installed performance of insulation products. After all, homeowners purchase insulation to achieve a desired level of energy efficiency and comfort. R-value alone is an insufficient metric to make an informed decision on how best to achieve that desired level of performance.

A. Air Sealing and Air Permeability:

The air sealing properties of an insulation material (and the assembly within which a product is installed) can dramatically impact energy savings. Insulation products can provide thermal resistance by reducing both conductive and convective heat flows. Eliminating convective heat transfer (air flow) through walls and roof assemblies can provide significant energy savings. The U.S. Department of Energy estimates that up to 40% of a building's heating and cool energy is lost due to air leaks.[3]

Spray polyurethane foam (SPF) insulation products have been recognized as air barriers when installed at typical thicknesses. Material testing for air permeability is completed in accordance with industry standards, including ASTM E2178 Standard Test Method for Air Permeance of Building Materials[4] and ASTM E283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Difference Across the Specimen.[5] Therefore, the use of spray foam insulation (and other air impermeable foam insulations) can lead to greater energy savings by eliminating air leakage in parts of the home where the insulation is installed.[6]

Specifically, the Building Science Corporation's (BSC) Thermal Metric project confirms the inherent differences between insulation materials, including air sealing, when determining the thermal performance of insulation materials.[7] In June 2015, BSC published a series of conclusions on high R-value wall performance, including an observation that all studied wall assemblies regardless of insulation material experienced a loss in energy performance due to air movement. However, the degree to which air movement impacted the energy performance of the wall assembly was dependent upon the physical properties of the insulation material used. For example, the test results showed the inherent air sealing benefits of SPF insulations used in wall

[3] https://www.energystar.gov/index.cfm?c=new_homes_features.hm_f_reduced_air_infiltration.

[4] Information on ASTM E2178 is available at: https://www.astm.org/Standards/E2178.htm.

[5] Information on ASTM E283 is available at: https://www.astm.org/Standards/E283.htm.

[6] Additional information on air barrier materials and testing requirements is available through the Air Barrier Association of America here: http://www.airbarrier.org/materials/index_e.php.

[7] Information on Building Science Corporation's Thermal Metric project is available at: http://buildingscienceconsulting.com/project/thermal-metric-project.

cavities. The report states, "Sealed spray foam assemblies achieved the same level of airtightness as other sealed assemblies, but the ratio from as-built to sealed was smaller" (emphases added). The "as-built" assemblies were constructed to be representative of real-world construction scenarios.

The Thermal Metric project report did conclude that insulation materials installed to the same R-value perform similarly when air sealed both inside and outside. The investigators sealed the test assemblies by using continuous sheets of polyethylene on both sides of the assemblies.[8] However, constructing a wall assembly with effectively zero air leakage is not representative of typical conditions. The "perfect" air seal used in the Thermal Metric project was constructed for equipment calibration purposes; an in-field application using interior and exterior sheets of polyethylene would result in severe moisture management issues in the wall assembly in most U.S. climates. Therefore, it is important to place the study's results in context and take note of the inherent air sealing properties of SPF insulation.

B. Quality of Installation:

Quality of installation can also have a significant impact on the performance of insulation materials. Manufacturers of SPF insulation provide detailed installation instructions to help ensure that products perform as designed. Consumers should be aware of how poor installation can impact performance. For example, compression of fibrous insulation materials can reduce their effectiveness.[9] Similarly, proper application techniques must be used when applying SPF insulation to ensure products are installed at specified depths and in contact with the proper surfaces. Given the importance of proper installation, additional language should be included in the R-value Rule's disclosure statements to draw attention to this important factor.

C. Performance is more than R-value:

Overreliance on R-value can inhibit the public's understanding of building energy efficiency. Building energy codes now include requirements that evaluate the performance of wall and roof assemblies to determine compliance. These "performance" requirements offer builders more flexibility to meet today's energy code requirements and, therefore, can lead to greater adoption of energy efficient building techniques.

[8] *See* Section 1.1.3 Air Transfer System of the Thermal Metric Summary Report (June 2015 Update) for a description of the air transfer system that was used to perform the wall specimen testing. The Summary Report is available at: http://buildingscienceconsulting.com/project/thermal-metric-project.

[9] As an example, see the product chart produced by Owens Corning regarding compressed R-values available at: http://www2.owenscorning.com/literature/pdfs/10017857%20Building%20Insul%20Compressed%20R-Value%20Chart%20Tech%20Bulletin.pdf.

Performance-based requirements often require lower R-values for individual components of the assembly when compared to traditional prescriptive compliance pathways. For example, the California Energy Commission (CEC) recently revised its attic insulation requirements for residential homes. The California 2013 building energy code requires a mandatory minimum R-30 insulation to be installed on the attic floor.[10] Under the 2016 amended provisions, the CEC recognized the added benefits of applying insulation to the ceiling plane of the attic (or the underside of the roof deck) and now requires R-22 insulation when installed in this manner.[11]

Despite California's advancement, other public officials have been slow to adopt these performance requirements because they have been taught to evaluate energy efficiency in terms of R-value. In other words, we have been taught to think "more is always better" when it comes to R-value. California's new building energy efficiency requirements are proving this thinking is outdated and incorrect.

This traditional (and incorrect) line of thinking has also had the unintended consequence of creating a perception that twice the amount of insulation will deliver twice the energy savings. The rule of diminishing returns for insulation is well understood. The R-value Rule should be amended to clarify this misunderstanding and help consumers make smarter insulation choices.

Recognition of other factors that impact insulation performance is important because consumers invest in insulation to save money on utility bills and increase the comfort and durability of their homes. Holding out R-value as the determinative factor in evaluating insulation performance deprives consumers of valuable information. Below we suggest ways to amend the R-value Rule's disclosure requirements to better inform consumers about insulation performance.

III. The R-value Rule's disclosure requirements can be improved to help consumers understand what factors impact insulation performance.

The purpose of the R-value Rule is to enable consumers to evaluate the performance of competing insulation products. Therefore, our suggested revisions to the disclosure statements required under the current R-value Rule are intended to provide easily-understandable language that makes consumers more informed buyers. Our aim is not to complicate a homeowner's task of comparing insulation products or create burdensome disclosure requirements for

[10] 2013 Title 24, Part 6 Standards, Subchapter 7, Section 150.0(a) Ceiling and Rafter Roof Insulation: http://energycodeace.com/site/custom/public/reference-ace-2013/index.html#!Documents/section1500mandatoryfeaturesanddevices.htm#ceilingandrafterroofinsulation.htm.

[11] For a description of "what's new" in the 2016 Title 24 building efficiency standards, visit: http://energycodeace.com/site/custom/public/reference-ace-2013/index.html?topiconly=true#!Documents/chapter3buildingenveloperequirements2016.htm#32132whatsnewfor2016.htm.

manufacturers. However, omitting certain details on insulation performance deprives consumers from information that a typical homeowner could use to make more informed decisions.

Therefore, we recommend that the FTC propose changes to the disclosure statements identified below. These disclosure statements are the primary way consumers interface with the R-value Rule and create a simple, uniform way to provide consumers with information on insulation performance. Below we include redline edits to the disclosure statements required under the current R-value Rule. A redline version of the full text of the current R-value Rule is attached as Exhibit A. All of the redlined changes included in Exhibit A should be considered part of our public comment submission.

A. Section 406.5:

Revise Section 406.5 as follows:

> **R-value measures resistance to heat flow under laboratory or controlled testing conditions that may not represent field ("as installed") conditions. R-values given in labels, fact sheets, ads, or other promotional materials must be based on tests done under the methods listed below.**

The definition of R-value in Section 406.5 should be expanded to clarify the usefulness of R-values. While standardized testing promotes fair competition, consumers should be made aware of the limits of what R-value represents in terms of insulation performance. Adding the underlined language above provides a more accurate description of R-value as measured under consensus-based standards.

B. Section 406.12(c):

Revise Section 406.12(c) as follows:

> **The following statement: "R means resistance to heat flow in laboratory testing. ~~The h~~ Higher ~~the~~ R-values can result in greater~~, the greater the~~ insulating power. As installed, other physical properties of insulation like air permeance, air sealing and quality of installation will impact performance."**

As discussed in Section II of our comments, a multitude of factors can impact the actual in-field performance of insulation, including other physical properties of insulation beyond R-value like air permeance. Therefore, we believe it is important to include *air permeance* in the revised disclosure statement. Importantly, consensus-based testing standards are available to test and report the air permeability of insulation products. Additionally, air sealing and quality of installation will impact insulation performance.

C. Section 406.13(d):

Revise Section 406.13(d) as follows:

> **For ~~air duct~~ fibrous insulation, the chart must be followed by this statement: "The R-value of this insulation varies depending on how much it is compressed during installation."**

As discussed in Section II of our comments, compression can impact the performance of fibrous materials. The Scope of 406.13(d) should be expanded to include all fibrous insulation materials because compression is not unique to air duct insulation. It is important to note that rigid foam insulation must also be installed according to manufacturer specifications. However, the physical properties of rigid foam insulation do not present concerns regarding compression.

D. Section 406.13(e):

Revise Section 406.13(e) as follows:

> **After the chart and any statement dealing with the specific type of insulation, ALL fact sheets must carry this statement, boxed, in 12-point type:**
>
> **READ THIS BEFORE YOU BUY**
>
> **WHAT YOU SHOULD KNOW ABOUT R-VALUES**
>
> **THE CHART SHOWS THE R-VALUE OF THIS INSULATION. R MEANS RESISTANCE TO HEAT FLOW IN LABORATORY TESTING. ~~THE~~ HIGHER ~~THE~~ R-VALUES CAN RESULT IN, ~~THE~~ GREATER ~~THE~~ INSULATING POWER. ~~COMPARE INSULATION R-VALUES BEFORE YOU BUY.~~**
>
> **HOWEVER, THERE ARE OTHER FACTORS TO CONSIDER. THE AMOUNT OF INSULATION YOU NEED DEPENDS MAINLY ON THE CLIMATE YOU LIVE IN. ALSO, YOUR FUEL SAVINGS FROM INSULATION WILL DEPEND UPON THE CLIMATE, THE TYPE AND SIZE OF YOUR HOUSE, THE AMOUNT OF INSULATION ALREADY IN YOUR HOUSE, AND YOUR FUEL USE PATTERNS AND FAMILY SIZE. AS INSTALLED, OTHER PHYSICAL PROPERTIES OF INSULATION LIKE AIR PERMEANCE, AIR SEALING AND QUALITY OF INSTALLATION WILL IMPACT PERFORMANCE. IF YOU BUY TOO MUCH INSULATION, IT WILL COST YOU MORE THAN WHAT YOU'LL SAVE ON FUEL.**

TO GET THE MARKED R-VALUE, IT IS ESSENTIAL THAT THIS INSULATION BE INSTALLED PROPERLY.

As stated above, the R-value Rule's disclosure statements should identify other factors that can impact insulation performance as installed. R-value alone provides an insufficient basis for consumers to compare competing insulation products. Revising this disclosure statement is an opportunity to provide easily-understandable information to consumers on insulation performance.

E. Section 406.18(a):

Revise Section 406.18(a) as follows:

If your ad gives an R-value, you must give the type of insulation and the thickness needed to get that R-value. Also, add this statement explaining R-values: "~~The~~ Higher ~~the~~ R-value<u>s can result in</u><u>,</u> ~~the~~ greater ~~the~~ insulating power. Ask your seller for the fact sheet on R-values <u>and information on other physical properties like air permeance, air sealing and quality of installation that will impact installed performance.</u>"

Product advertising is a primary channel for consumers to learn and collect information about insulation performance. Therefore, the disclosure statements for insulation ads should be revised to match the language suggested above for product labels.

F. Section 406.19(b)

Revise Section 406.19(b) as follows:

If you say or imply in your ads, labels, or other promotional materials that insulation can cut fuel bills or fuel use, you must make this statement about savings: "Savings vary. Find out why in the seller's fact sheet on R-values. Higher R-values <u>can</u> mean greater insulating power. <u>As installed, other physical properties of insulation like air permeance, air sealing and quality of installation will impact performance.</u>"

As stated above, product advertising is a primary channel for consumers to learn and collect information about insulation performance. Therefore, insulation ads, like product labels, should be revised to make consumers aware of other factors that can impact the installed performance of insulation products.

IV. Comments on "Specific Questions Related to R-value Rule."

A. Data is lacking to justify the adoption of ASTM C1303 as a uniform standard for all closed-cell foam products.

We are concerned that insufficient data has been generated to demonstrate that ASTM C1303 is an appropriate method for estimating long-term thermal performance for all closed-cell insulation products. The limitations of this testing standard are recognized in the standard itself – Section 1.3 of the standard explains that the test method is not appropriate for impermeable faced closed-cell foam insulation products.

The SPF industry hypothesized that the skin formed on the surface of closed-cell spray polyurethane foam acts as an impermeable facer and, therefore, provides a benefit to the long-term thermal performance of products. It was also hypothesized that the destruction of this skin during the ASTM C1303 specimen preparation procedure would produce lower long-term thermal performance values as compared to actual long-term performance. To test the hypothesis, the industry initiated a five-year project to measure the long-term thermal performance of products. The purpose of the multi-year study is to develop sufficient and credible data that can be used to determine the most appropriate method for the preparation and conditioning of SPF insulation specimens prior to thermal testing. The study involves newly sprayed specimens that are aged and tested over a multi-year period. The study will conclude with a comparative analysis of data and specimen preparation procedures.

Interim study results presented at the October 2015 ASTM Committee Meetings suggest that discrepancies may exist between values generated following ASTM C1303 and actual long-term thermal performance. The October 2015 presentation is attached as Exhibit B.

Therefore, in the absence of adequate data to substantiate the reliability of ASTM C1303 for all closed cell foam products and pending the results of the industry research described above, it is premature to adopt C1303 as a mandatory industry requirement. The spray foam industry would be pleased to provide updates to the FTC on the progress of the 5-year research project as it moves towards completion.

B. The R-value Rule should be amended to allow for the continual incorporation of new or amended consensus-based material specifications.

The current R-value Rule creates the perception that only the standards listed in Section 406.5 may be used as the basis for determining R-value. However, the insulation industry is continually updating the consensus-based material specifications and, in some instances, developing new specifications for product categories. In its current form, the R-value Rule can place a burden on industry by requiring the use of outdated material specifications. The current Rule may also act as a disincentive for industry to continuously maintain and improve material test specifications.

Therefore, the R-value Rule should be modified to allow for the continual incorporation of updated material specifications that are listed in Section 406.5 of the Rule. Additionally, the FTC should recognize a simple process for incorporating new consensus-based material specifications that may be developed in the years between the Commission's systematic reviews.

As an example, the open-cell spray foam industry is developing a material specification standard – ASTM Work Item 30150 New Specification for Spray-Applied Open Cellular Polyurethane Thermal Insulation.[12] According to the ASTM website, the "standard will provide a consensus document that specifies the material property requirements and related testing for this type of spray polyurethane foam." However, this Work Item is not referenced in the current R-value Rule and may not be finalized prior to the completion of the current review cycle. The result may be another ten (or more) years of waiting before the industry has an opportunity to incorporate this standard in the R-value Rule.

By allowing for the incorporation of new (or revised) test standards developed between review cycles, the FTC will be encouraging continual development in the insulation industry and reducing the burden on material manufacturers. The benefits of this change could be immediate.

To illustrate, consider that current testing protocol requires foam insulation manufacturers to age products for a period of 180-days prior to R-value testing. Polyurethane rigid foams of low density exposed to air show a decrease of R-value with time. This is mainly because of the inward diffusion of air into the foam cells. In closed-cell foam insulation products, the bulky molecules (e.g., hydrofluorocarbons, hydrofluoroolefins) do not easily pass through cell walls at ordinary temperatures and are retained**.** However, closed-cell and open-cell foams use different types of blowing agents in the manufacturing process. Open-cell foams use water as the blowing agent to form CO_2 that expands to form the insulating cell structure. In open-cell foams, the CO_2 quickly leaves the product and is replaced by air.

The SPF industry hypothesized that open-cell foams reach a terminal R-value shortly after manufacture, which would make the 180-day aging requirement overly burdensome. The industry initiated a research project to determine an appropriate time period for room temperature aging prior to the thermal performance measure of open cell spray foam. The research project and results are described in the industry report attached as Exhibit C. In summary, the research demonstrated that a 30-day room temperature aging requirement for open-cell spray foam products is sufficient to reach a terminal R-value. We anticipate that this research will be used to inform the development of Work Item 30150 and ultimately lead to a final ASTM standard.

[12] https://www.astm.org/DATABASE.CART/WORKITEMS/WK30150.htm.

The open-cell spray foam industry's efforts provide one example of why it is important to amend the R-value Rule to include a simple process for incorporating new or revised consensus-based material specifications.

Finally, in response to the FTC's question about test standards that should be removed from the R-value Rule, we suggest that the references to GSA Specification HH-I-530A be deleted. The GSA Specification provides an outdated and unnecessary method for aging foam insulation specimens. Aging requirements are included in the standards for each foam product. References to the GSA Specification only introduce confusion. The R-value Rule should rely on the expertise and process of consensus standard development organizations for appropriate testing requirements. Therefore, Section of 406.5(a)(1) of the R-value Rule should be revised to state that foam insulation products be aged in accordance with "the appropriate consensus-based material specification."

V. Conclusion

We appreciate the opportunity to provide comment and information as the FTC conducts its systematic review of the R-value Rule. As the Commission notes in the ANPR, the foam insulation industry has advanced greatly over the past decade. We would be pleased to provide additional information and answer questions related to foam insulation, in particular SPF products. We also welcome the opportunity to participate in a multi-stakeholder workshop should the Commission see such an exchange as an appropriate way to gather additional information prior to issuing any formal proposed rulemaking.

Please contact me at justin_koscher@americanchemistry.com, (202) 249-6617, with questions or requests for additional information.

Respectfully submitted,

Justin Koscher
Director

Attachments (3)

Exhibit A

Redline Markup of the R-value Rule (16 CFR part 460)

Code of Federal Regulations

Title 16 - Commercial Practices

Volume: 1
Date: 2011-01-01
Original Date: 2011-01-01
Title: PART 460 - LABELING AND ADVERTISING OF HOME INSULATION
Context: Title 16 - Commercial Practices. CHAPTER I - FEDERAL TRADE COMMISSION. SUBCHAPTER D - TRADE REGULATION RULES.

PART 460—LABELING AND ADVERTISING OF HOME INSULATION

Sec.

Authority:38 Stat. 717, as amended (15 U.S.C. 41 et seq.).

Source:44 FR 50242, Aug. 27, 1979, unless otherwise noted.

§ 460.1 What this regulation does.

This regulation deals with home insulation labels, fact sheets, ads, and other promotional materials in or affecting commerce, as "commerce" is defined in the Federal Trade Commission Act. If you are covered by this regulation, breaking any of its rules is an unfair and deceptive act or practice or an unfair method of competition under section 5 of that Act. You can be fined heavily (up to $11,000 plus an adjustment for inflation, under § 1.98 of this chapter) each time you break a rule.

[70 FR 31274, May 31, 2005]

§ 460.2 What is home insulation.

Insulation is any material mainly used to slow down heat flow. It may be mineral or organic, fibrous, cellular, or reflective (aluminum foil). It may be in rigid, semirigid, flexible, or loose-fill form. Home insulation is for use in old or new homes, condominiums, cooperatives, apartments, modular homes, or mobile homes. It does not include pipe insulation. It does not include any kind of duct insulation except for duct wrap.

§ 460.3 Who is covered.

You are covered by this regulation if you are a member of the home insulation industry. This includes individuals, firms, partnerships, and corporations. It includes manufacturers, distributors, franchisors, installers, retailers, utility companies, and trade associations. Advertisers and advertising agencies are also covered. So are labs doing tests for industry members. If you sell new homes to consumers, you are covered.

§ 460.4 When the rules apply.

You must follow these rules each time you import, manufacture, distribute, sell, install, promote, or label home insulation. You must follow them each time you prepare, approve, place, or pay for home insulation labels, fact sheets, ads, or other promotional materials for consumer use. You must also follow them each time you supply anyone covered by this regulation with written information that is to be used in labels, fact sheets, ads, or other promotional materials for consumer use. Testing labs must follow the rules unless the industry members tells them, in writing, that labels, fact sheets, ads, or other promotional materials for home insulation will not be based on the test results.

§ 460.5 R-value tests.

R-value measures resistance to heat flow under laboratory or controlled testing conditions that may not represent field ("as installed") conditions. R-values given in labels, fact sheets, ads, or other promotional materials must be based on tests done under the methods listed below. They were designed by the American Society of Testing and Materials (ASTM). The test methods are:

(a) All types of insulation except aluminum foil must be tested with ASTM C 177-04, "Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus;" ASTM C 518-04, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus;" ASTM C 1363-97, "Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus" or ASTM

C 1114-00, “Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus.” The tests must be done at a mean temperature of 75 [degrees] Fahrenheit and with a temperature differential of 50 [degrees] Fahrenheit plus or minus 10 degrees Fahrenheit. The tests must be done on the insulation material alone (excluding any airspace). R-values (“thermal resistance”) based upon heat flux measurements according to ASTM C 177-04 or ASTM C 518-04 must be reported only in accordance with the requirements and restrictions of ASTM C 1045-01, “Standard Practice for Calculating Thermal Transmission Properties from Steady-State Conditions.”

(1) For polyurethane, polyisocyanurate, and extruded polystyrene, the tests must be done on samples that fully reflect the effect of aging on the product's R-value. To age the sample, follow the procedure in ~~paragraph 4.6.4 of GSA Specification HH-I-530A, or another reliable procedure~~the appropriate consensus-based material specification.

(2) For loose-fill cellulose, the tests must be done at the settled density determined under paragraph 8 of ASTM C 739-03, “Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation.”

(3) For loose-fill mineral wool, self-supported, spray-applied cellulose, and stabilized cellulose, the tests must be done on samples that fully reflect the effect of settling on the product's R-value.

(4) For self-supported spray-applied cellulose, the tests must be done at the density determined pursuant to ASTM C 1149-02, “Standard Specification for Self-Supported Spray Applied Cellulosic Thermal Insulation.”

(5) For loose-fill insulations, the initial installed thickness for the product must be determined pursuant to ASTM C 1374-03, “Standard Test Method for Determination of Installed Thickness of Pneumatically Applied Loose-Fill Building Insulation,” for R-values of 13, 19, 22, 30, 38, 49 and any other R-values provided on the product's label pursuant to § 460.12.

(b) Single sheet systems of aluminum foil must be tested with ASTM E 408-71 (Reapproved 2002), “Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques,” or ASTM C 1371-04a, “Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.” This tests the emissivity of the foil—its power to radiate heat. To get the R-value for a specific emissivity level, air space, and direction of heat flow, use the tables in the most recent edition of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers' (ASHRAE) Fundamentals Handbook, if the product is intended for applications that meet the conditions specified in the tables. You must use the R-value shown for 50[degrees] Fahrenheit, with a temperature differential of 30[degrees] Fahrenheit.

(c) Aluminum foil systems with more than one sheet, and single sheet systems of aluminum foil that are intended for applications that do not meet the conditions specified in the tables in the most recent edition of the ASHRAE Fundamentals Handbook, must be tested with ASTM C 1363-97, “Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus,” in a test panel constructed according to ASTM C 1224-03, “Standard Specification for Reflective Insulation for Building Applications,” and under the test conditions specified in ASTM C 1224-03. To get the R-value from the results of those tests, use the formula specified in ASTM C 1224-03.

(d) For insulation materials with foil facings, you must test the R-value of the material alone (excluding any air spaces) under the methods listed in paragraph (a) of this section. You can also determine the R-value of the material in conjunction with an air space. You can use one of two methods to do this:

(1) You can test the system, with its air space, under ASTM C 1363-97, “Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus,” which is incorporated by reference in paragraph (a) of this section. If you do this, you must follow the rules in paragraph (a) of this section on temperature, aging and settled density.

(2) You can add up the tested R-value of the material and the R-value of the air space. To get the R-value for the air space, you must follow the rules in paragraph (b) of this section.

(e) The standards listed above are incorporated by reference into this section. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be inspected at the Federal Trade Commission, Consumer Response Center, Room 130, 600 Pennsylvania Avenue, NW., Washington, DC 20580, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741-6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. Copies of materials and standards incorporated by reference may be obtained from the issuing organizations listed in this section.

(1) The American Society of Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshocken, PA 19428-2959.

(i) ASTM C 177-04, “Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.”

(ii) ASTM C 518-04, “Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.”

(iii) ASTM C 739-03, “Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation.”

(iv) ASTM C 1045-01, “Standard Practice for Calculating Thermal Transmission Properties from Steady-State Conditions.”

(v) ASTM C 1114-00, “Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus.”

(vi) ASTM C 1149-02, “Standard Specification for Self-Supported Spray Applied Cellulosic Thermal Insulation.”

(vii) ASTM C 1224-03, “Standard Specification for Reflective Insulation for Building Applications.”

(viii) ASTM C 1363-97, “Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.”

(ix) ASTM C 1371-04a, “Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.”

(x) ASTM C 1374-03, “Standard Test Method for Determination of Installed Thickness of Pneumatically Applied Loose-Fill Building Insulation.”

(xi) ASTM E 408-71 (Reapproved 2002), “Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.”

~~(2) U.S. General Services Administration (GSA), 1800 F Street, NW., Washington, DC 20405.~~

~~(i) GSA Specification HH-I-530A, Federal Specification, Insulation Board, Thermal (Urethane), November 22, 1971.~~

(ii) [Reserved] [70 FR 31274, May 31, 2005]

§ 460.6 "Representative thickness" testing.

All tests except aluminum foil tests must be done at a representative thickness for every thickness shown in a label, fact sheet, ad, or other promotional material. "Representative thickness" means a thickness at which the R-value per unit will vary no more than plus or minus 2% with increases in thickness. However, if the thickness shown in your label, fact sheet, ad, or promotional material is less than the representative thickness, then you can test the insulation at the thickness shown.

§ 460.7 Which test version to use.

Use the version of the ASTM test method that was in effect when this regulation was promulgated. If ASTM changes a test method, the new version will automatically replace the old one in these rules 90 days after ASTM first publishes the change. However, the Commission's staff or a person affected by the change can petition the Commission during the 90-day period not to adopt the change or to reopen the proceeding to consider it further.

§ 460.8 R-value tolerances.

If you are a manufacturer of home insulation, no individual specimen of the insulation you sell can have an R-value more than 10% below the R-value shown in a label, fact sheet, ad, or other promotional material for that insulation. If you are not a manufacturer, you can rely on the R-value data given to you by the manufacturer, unless you know or should know that the data is false or not based on the proper tests.

[70 FR 31275, May 31, 2005]

§ 460.9 What test records you must keep.

Manufacturers and testing labs must keep records of each item of information in the "Report" section of the ASTM test method that is used for a test. They must also keep the following records:

(a) The name and address of the testing lab that did each test.

(b) The date of each test.

(c) For manufacturers, the date each test report was received from a lab. For labs, the date each test report was sent to a manufacturer.

(d) For extruded polystyrene, polyurethane, and polyisocyanurate, the age (in days) of the specimen that was tested.

(e) For aluminum foil, the emissivity level that was found in the test.

Manufacturers who own their own testing labs need not keep records of the information in paragraph (c) of this section.

Keep these records for at least three years. If the documents show proof for your claims, the three years will begin again each time you make the claim. Federal Trade Commission staff members can check these records at any time, but they must give you reasonable notice first.

§ 460.10 How statements must be made.

All statements called for by this regulation must be made clearly and conspicuously. Among other things, you must follow the Commission's enforcement policy statement for clear and conspicuous disclosures in foreign language advertising and sales materials, 16 CFR 14.9.

[61 FR 13666, Mar. 28, 1996]

§ 460.11 Rounding off R-values.

R-values shown in labels, fact sheets, ads, or other promotional materials must be rounded to the nearest tenth. However, R-values of 10 or more may be rounded to the nearest whole number.

§ 460.12 Labels.

If you are a manufacturer, you must label all packages of your insulation. The labels must contain:

(a) The type of insulation.

(b) A chart showing these items:

(1) For batts and blankets of any type: the R-value, length, width, thickness, and square feet of insulation in the package.

(2) For all loose-fill insulation: the minimum settled thickness, initial installed thickness, maximum net coverage area, number of bags per 1,000 square feet, and minimum weight per square foot at R-values of 13, 19, 22, 30, 38, and 49. You must also give this information for any additional R-values you list on the chart. Labels for these products must state the minimum net weight of the insulation in the package. You must also provide information about the blowing machine and machine settings used to derive the initial installed thickness information.

(3) For boardstock: the R-value, length, width, and thickness of the boards in the package, and the square feet of insulation in the package.

(4) For aluminum foil: the number of foil sheets; the number and thickness of the air spaces; and the R-value provided by that system when the direction of heat flow is up, down, and horizontal. You can show the R-value for only one direction of heat flow if you clearly and conspicuously state that the foil can only be used in that application.

(5) For insulation materials with foil facings, you must follow the rule that applies to the material itself. For example, if you manufacture boardstock with a foil facing, follow paragraph (b)(3) of this section. You can also show the R-value of the insulation when it is installed in conjunction with an air space. This is its "system R-value." If you do this, you must clearly and conspicuously state the conditions under which the system R-value can be attained.

(6) For air duct insulation: the R-value, length, width, thickness, and square feet of insulation in the package.

(c) The following statement: "R means resistance to -heat flow in laboratory testing. ~~The h~~Higher ~~the~~ R-values can result in greater~~, the greater the~~ insulating power. As installed, other physical properties of insulation like air permeance, air sealing and quality of installation will impact performance."

(d) If installation instructions are included on the label or with the package, add this statement: “To get the marked R-value, it is essential that this insulation be installed properly. If you do it yourself, follow the instructions carefully.”

(e) If no instructions are included, add this statement: “To get the marked R-value, it is essential that this insulation be installed properly. If you do it yourself, get instructions and follow them carefully. Instructions do not come with this package.”

[70 FR 31276, May 31, 2005]

§ 460.13 Fact sheets.

If you are a manufacturer, you must give retailers and installers fact sheets for the insulation products you sell to them. Each sheet must contain what is listed here. You can add any disclosures that are required by federal laws, regulations, rules, or orders. You can add any disclosures that are required by State or local laws, rules, and orders, unless they are inconsistent with the provisions of this regulation. Do not add anything else.

Each fact sheet must contain these items:

(a) The name and address of the manufacturer. It can also include a logo or other symbol that the manufacturer uses.

(b) A heading: “This is ____ insulation.” Fill in the blank with the type and form of your insulation.

(c) The heading must be followed by a chart:

(1) If § 460.12(b) requires a chart for your product's label, you must use that chart. For foamed-in-place insulations, you must show the R-value of your product at 31/2 inches. You can also show R-values at other thicknesses.

(2) You can put the charts for similar products on the same fact sheet. For example, if you sell insulation boards or batts in three different thicknesses, you can put the label charts for all three products on one fact sheet. If you sell loose-fill insulation in two different bag sizes, you can put both coverage charts on one fact sheet, as long as you state which coverage chart applies to each bag size.

(d) For ~~air duct~~fibrous insulation, the chart must be followed by this statement: “The R-value of this insulation varies depending on how much it is compressed during installation.”

(e) After the chart and any statement dealing with the specific type of insulation, ALL fact sheets must carry this statement, boxed, in 12-point type:

READ THIS BEFORE YOU BUY

WHAT YOU SHOULD KNOW ABOUT R-VALUES

THE CHART SHOWS THE R-VALUE OF THIS INSULATION. R MEANS RESISTANCE TO HEAT FLOW IN LABORATORY TESTING. ~~THE~~ HIGHER ~~THE~~ R-VALUES CAN RESULT IN, ~~THE~~ GREATER ~~THE~~ INSULATING POWER. ~~COMPARE INSULATION R-VALUES BEFORE YOU BUY.~~

HOWEVER, THERE ARE OTHER FACTORS TO CONSIDER. THE AMOUNT OF INSULATION YOU NEED DEPENDS MAINLY ON THE CLIMATE YOU LIVE IN. ALSO, YOUR FUEL SAVINGS FROM INSULATION WILL DEPEND UPON THE CLIMATE, THE TYPE AND SIZE OF YOUR HOUSE, THE AMOUNT OF INSULATION ALREADY IN YOUR HOUSE, AND YOUR FUEL USE PATTERNS AND FAMILY SIZE. AS INSTALLED, OTHER PHYSICAL PROPERTIES OF INSULATION LIKE AIR PERMEANCE, AIR SEALING AND QUALITY OF INSTALLATION WILL IMPACT PERFORMANCE. IF YOU BUY TOO MUCH INSULATION, IT WILL COST YOU MORE THAN WHAT YOU'LL SAVE ON FUEL.

TO GET THE MARKED R-VALUE, IT IS ESSENTIAL THAT THIS INSULATION BE INSTALLED PROPERLY.

[44 FR 50242, Aug. 27, 1979, as amended at 45 FR 68928, Oct. 17, 1980; 70 FR 31276, May 31, 2005]

§ 460.14 How retailers must handle fact sheets.

If you sell insulation to do-it-yourself customers, you must have fact sheets for the insulation products you sell. You must make the fact sheets available to your customers. You can decide how to do this, as long as your insulation customers are likely to notice them. For example, you can put them in a display, and let customers take copies of them. You can keep them in a binder at a counter or service desk, and have a sign telling customers where the fact sheets are. You need not make the fact sheets available to customers if you display insulation packages on the sales floor where your insulation customers are likely to notice them and each individual insulation package offered for sale contains all package label and fact sheet disclosures required by §§ 460.12 and 460.13.

[70 FR 31276, May 31, 2005]

§ 460.15 How installers must handle fact sheets.

If you are an installer, you must have fact sheets for the insulation products you sell. Before customers agree to buy insulation from you, you must show them the fact sheet(s) for the type(s) of insulation they want. You can decide how to do this. For example, you can give each customer a copy of the fact sheet(s). You can keep the fact sheets in a binder, and show customers the binder before they agree to buy.

§ 460.16 What new home sellers must tell new home buyers.

If you are a new home seller, you must put the following information in every sales contract: The type, thickness, and R-value of the insulation that will be installed in each part of the house. There is an exception to this rule. If the buyer signs a sales contract before you know what type of insulation will be put in the house, or if there is a change in the contract, you can give the buyer a receipt stating this information as soon as you find out.

§ 460.17 What installers must tell their customers.

If you are an installer, you must give your customers a contract or receipt for the insulation you install. For all insulation except loose-fill and aluminum foil, the receipt must show the coverage area, thickness, and R-value of the insulation you installed. The receipt must be dated and signed by the installer. To figure out the R-value of the insulation, use the data that the manufacturer gives you. If you put insulation in more than one part of the house, put the data for each part on the receipt. You can do this on one receipt, as long as you do not add up the coverage areas or R-values for different parts of the house. Do not

multiply the R-value for one inch by the number of inches you installed. For loose-fill, the receipt must show the coverage area, initial installed thickness, minimum settled thickness, R-value, and the number of bags used. For aluminum foil, the receipt must show the number and thickness of the air spaces, the direction of heat flow, and the R-value.

[70 FR 31276, May 31, 2005]

§ 460.18 Insulation ads.

(a) If your ad gives an R-value, you must give the type of insulation and the thickness needed to get that R-value. Also, add this statement explaining R-values: "~~The h~~Higher ~~the~~ R-values can result in~~, the~~ greater ~~the~~ insulating power. Ask your seller for the fact sheet on R-values and information on other physical properties like air permeance, air sealing and quality of installation that will impact installed performance."

(b) If your ad gives a price, you must give the type of insulation, the R-value at a specific thickness, the statement explaining R-values in paragraph (a) of this section, and the coverage area for that thickness. If you give the price per square foot, you do not have to give the coverage area.

(c) If your ad gives the thickness of your insulation, you must give its R-value at that thickness and the statement explaining R-values in paragraph (a) of this section.

(d) If your ad compares one type of insulation to another, the comparison must be based on the same coverage areas. You must give the R-value at a specific thickness for each insulation, and the statement explaining R-values in paragraph (a) of this section. If you give the price of each insulation, you must also give the coverage area for the price and thickness shown. However, if you give the price per square foot, you do not have to give the coverage area.

(e) The affirmative disclosure requirements in § 460.18 do not apply to ads on television or radio.

[44 FR 50242, Aug. 27, 1979, as amended at 51 FR 39651, Oct. 30, 1986; 70 FR 31276, May 31, 2005]

§ 460.19 Savings claims.

(a) If you say or imply in your ads, labels, or other promotional materials that insulation can cut fuel bills or fuel use, you must have a reasonable basis for the claim. For example, if you say that insulation can "slash" or "lower" fuel bills, or that insulation "saves money," you must have a reasonable basis for the claim. Also, if you say that insulation can "cut fuel use in half," or "lower fuel bills by 30%," you must have a reasonable basis for the claim.

(b) If you say or imply in your ads, labels, or other promotional materials that insulation can cut fuel bills or fuel use, you must make this statement about savings: "Savings vary. Find out why in the seller's fact sheet on R-values. Higher R-values can mean greater insulating power. As installed, other physical properties of insulation like air permeance, air sealing and quality of installation will impact performance."

(c) If you say or imply that a combination of products can cut fuel bills or use, you must have a reasonable basis for the claim. You must make the statement about savings in paragraph (b) of this section. Also, you must list the combination of products used. They may be two or more types of insulation; one or more types of insulation and one or more other insulating products, like storm windows or siding; or insulation for two or more parts of the house, like the attic and walls. You must say how much of the savings came from each product or location. If you cannot give exact or approximate figures, you must give a ranking. For instance, if your ad says that insulation and storm doors combined to cut fuel use by 50%, you must say which one saved more.

(d) If your ad or other promotional material is covered by § 460.18 (a), (b), (c), or (d), and also makes a savings claim, you must follow the rules in §§ 460.18 and 460.19. However, you need not make the statement explaining R-value in § 460.18(a).

(e) Manufacturers are liable if they do not have a reasonable basis for their savings claims before the claim is made. If you are not a manufacturer, you are liable only if you know or should know that the manufacturer does not have a reasonable basis for the claim.

(f) Keep records of all data on savings claims for at least three years. For the records showing proof for claims, the three years will begin again each time you make the claim. Federal Trade Commission staff members can check these records at any time, but they must give you reasonable notice first.

(g) The affirmative disclosure requirements in § 460.19 do not apply to ads on television or radio.

[44 FR 50242, Aug. 27, 1979, as amended at 51 FR 39651, Oct. 30, 1986; 70 FR 31276, May 31, 2005]

§ 460.20 R-value per inch claims.

In labels, fact sheets, ads, or other promotional materials, do not give the R-value for one inch or the “R-value per inch” of your product. There are two exceptions:

(a) If an outstanding FTC Cease and Desist Order applies to you but differs from the rules given here, you can petition to amend the order.

(b) You can do this if actual test results prove that the R-values per inch of your product does not drop as it gets thicker.

You can list a range of R-value per inch. If you do, you must say exactly how much the R-value drops with greater thickness. You must also add this statement: “The R-value per inch of this insulation varies with thickness. The thicker the insulation, the lower the R-value per inch.”

[44 FR 50242, Aug. 27, 1979, as amended at 70 FR 31276, May 31, 2005]

§ 460.21 Government claims.

Do not say or imply that a government agency uses, certifies, recommends, or otherwise favors your product unless it is true. Do not say or imply that your insulation complies with a governmental standard or specification unless it is true.

§ 460.22 Tax claims.

Do not say or imply that your product qualifies for a tax benefit unless it is true.

§ 460.23 Other laws, rules, and orders.

(a) If an outstanding FTC Cease and Desist Order applies to you but differs from the rules given here, you can petition to amend to order.

(b) State and local laws and regulations that are inconsistent with, or frustrate the purposes of, the provisions of this regulation are preempted. However, a State or local government may petition the Commission, for good cause, to permit the enforcement of any part of a State or local law or regulation that would be preempted by this section.

(c) The Commission's three-day cooling-off rule stays in force.

[44 FR 50242, Aug. 27, 1979, as amended at 70 FR 31276, May 31, 2005]

§ 460.24 Stayed or invalid parts.

If any part of this regulation is stayed or held invalid, the rest of it will stay in force.

Pt. 460, App.

Appendix to Part 460—Exemptions

Section 18(g)(2) of the Federal Trade Commission Act, 15 U.S.C. 57a(g)(2), authorizes the Commission to exempt a person or class of persons from all or part of a trade regulation rule if the Commission finds that application of the rule is not necessary to prevent the unfair or deceptive acts or practices to which the rule relates. In response to petitions from industry representatives, the Commission has granted exemptions from specific requirements of 16 CFR part 460 to certain classes of sellers. Some of these exemptions are conditioned upon the performance of alternative actions. The exemptions are limited to specific sections of part 460. All other requirements of part 460 apply to these sellers. The exemptions are summarized below. For an explanation of the scope and application of the exemptions, see the formal Commission decisions in the **Federal Register** cited at the end of each exemption.

(a) Manufacturers of perlite insulation products that have an inverse relationship between R-value and density or weight per square foot are exempted from the requirements in §§ 460.12(b)(2) and 460.13(c)(1) that they disclose minimum weight per square foot for R-values listed on labels and fact sheets. This exemption is conditioned upon the alternative disclosure in labels and fact sheets of the maximum weight per square foot for each R-value required to be listed. 46 FR 22179 (1981).

(b) Manufacturers of rigid, flat-roof insulation products used in flat, built-up roofs are exempted from the requirements in § 460.12 that they label these home insulation products. 46 FR 22180 (1981).

(c) New home sellers are exempted from:

(1) the requirement in § 460.18(a) that they disclose the type and thickness of the insulation when they make a representation in an advertisement or other promotional material about the R-value of the insulation in a new home;

(2) the requirement that they disclose in an advertisement or other promotional material the R-value explanatory statement specified in § 460.18(a) or the savings explanatory statement specified in § 460.19(b), conditioned upon the new home sellers alternatively disclosing the appropriate explanatory statement in the sales contract along with the disclosures required by § 460.16;

(3) the requirement that they make the disclosures specified in § 460.19(c) if they claim that insulation, along with other products in a new home, will cut fuel bills or fuel use; and

(4) the requirement that they include the reference to fact sheets when they must disclose the R-value explanatory statement or the savings claim explanatory statement under § 460.18(a) or § 460.19(b), respectively.

The exemptions for new home sellers also apply to home insulation sellers other than new home sellers when they participate with a new home seller to advertise and promote the sale of new homes, provided that the primary thrust of the advertisement or other promotional material is the promotion of new homes, and not the promotion of the insulation product. 48 FR 31192 (1983).

[61 FR 1366, Mar. 28, 1996]

Exhibit B

October 2015 Presentation to ASTM Committee C16 on Thermal Insulation:

Summary of Closed-Cell Spray Polyurethane Foam Long-Term Thermal Performance Research Project

Thermal Aging Issues

- Some members of ASTM 16.22 asking for C1303 thermal testing procedure in ASTM C1029

- ASTM C1303 is a long-term thermal resistance (LTTR) test method used to predict 5-year thermal performance of closed-cell foam insulation
  - Uses thin-slice method
  - It could neglect benefits of skins/substrates, field thickness as well as non-homogeneity of SPF
  - Will likely under-predict field thermal performance of MD-SPF

Thermal Aging Project

- SFC commissioned a study in July 2012 to measure effects of skins/substrates and specimen thickness on aged thermal performance

PHASE I (July 2012)
- Core and skin/substrate samples
- Two thicknesses (1" and 3.5")
- THREE commercial MD-SPF products: A, B and C
- Include aging times of 90d, 180d, 1yr, 2yr and 5yr
- Two commercial labs perform C518 testing
- Two commercial labs perform C1303 testing

PHASE II (Aug 2013)
- Core and skin/substrate samples
- Two thicknesses (1" and 3.5")
- FOUR commercial MD-SPF products: A, B, D and E
- Include aging times of 90d, 180d, 1yr, 2yr and 5yr
- Manufacturers perform C518 testing
- One commercial lab performs C1303 testing

Thermal Aging Project

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

Spray sample

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

Pre-Aging Preparation

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

Aging Time

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

Post-Aging Preparation

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

Why

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

Triplicate Specimens

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

Specimen Visual
Sprayed vs. Aged

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

14 test configurations

White: control
Light Green: 1” S&S
Dark Green: 3.5” S&S
Light Violet: 1” core
Dark Violet: 3.5” core
Orange: C1303 thin slice

Thermal Aging Project

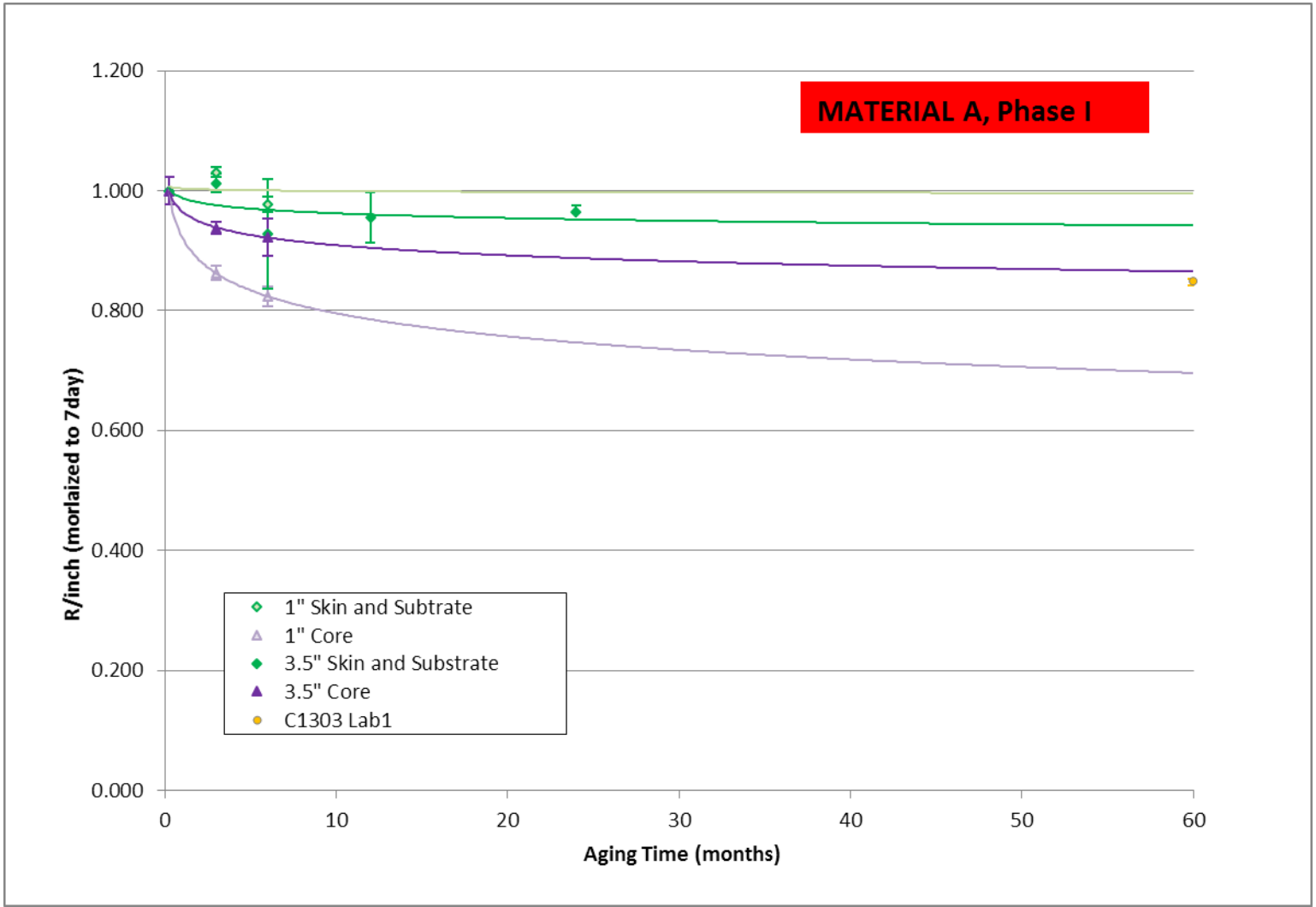
Spray sample | Pre-Aging Preparation | Aging Time | Post-Aging Preparation | Why | Triplicate Specimens | Specimen Visual Sprayed vs. Aged

TEST	Nominal Thk.	Subst.	Spray Thk.	SPF pass	Pre-Aging Prep	Aging Period	Post-Aging Prep	Purpose	Specimen Identification*			Sprayed Geometry	Aged Geometry
1	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness; perform thermal test without aging	<7d	None	Control	WX011	WX012	WX013		
2	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 1" thickness	1" 90d with S&S	WX021	WX022	WX023		
3	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	90d	None	1" 90d core	WX031	WX032	WX033		
4	1"	3/4" PW	1.5	1	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 1" thickness	1" 180d with S&S	WX041	WX042	WX043		
5	1"	PE	1.5	1	Remove PE Substrate and top skin and cut to 1" thickness	180d	None	1" 180d core	WX051	WX052	WX053		
6	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	90d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 90d with S&S	WX061	WX062	WX063		
7	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	90d	None	3.5" 90d core	WX071	WX072	WX073		
8	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	180d	Remove PW Substrate and top skin and cut to 3.5" thickness	3.5" 180d with S&S	WX081	WX082	WX083		
9	3.5"	PE	4	2	Remove PE Substrate and top skin and cut to 3.5" thickness	180d	None	3.5" 180d core	WX091	WX092	WX093		
10	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	1yr	None	3.5" 1yr with S&S	WX101	WX102	WX103		
11	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	2yr	None	3.5" 2yr with S&S	WX111	WX112	WX113		
12	3.5"	3/4" PW	4	2	None - age with Substrate and top skin in place	5yr	None	3.5" 5 yr with S&S	WX121	WX122	WX123		
13	2.75"	PE	3	4	Perform ASTM C1303 Speciment prep and aging	n/a	n/a	C1303	WX131 WX134	WX132 WX135	WX133 WX136		NA
14	2-4"	??	3	4	Perform ASTM C518 on In-Situ Material (5 yr)	n/a	n/a	C518	WX141 WX144	WX142 WX145	WX143 WX146	???	NA

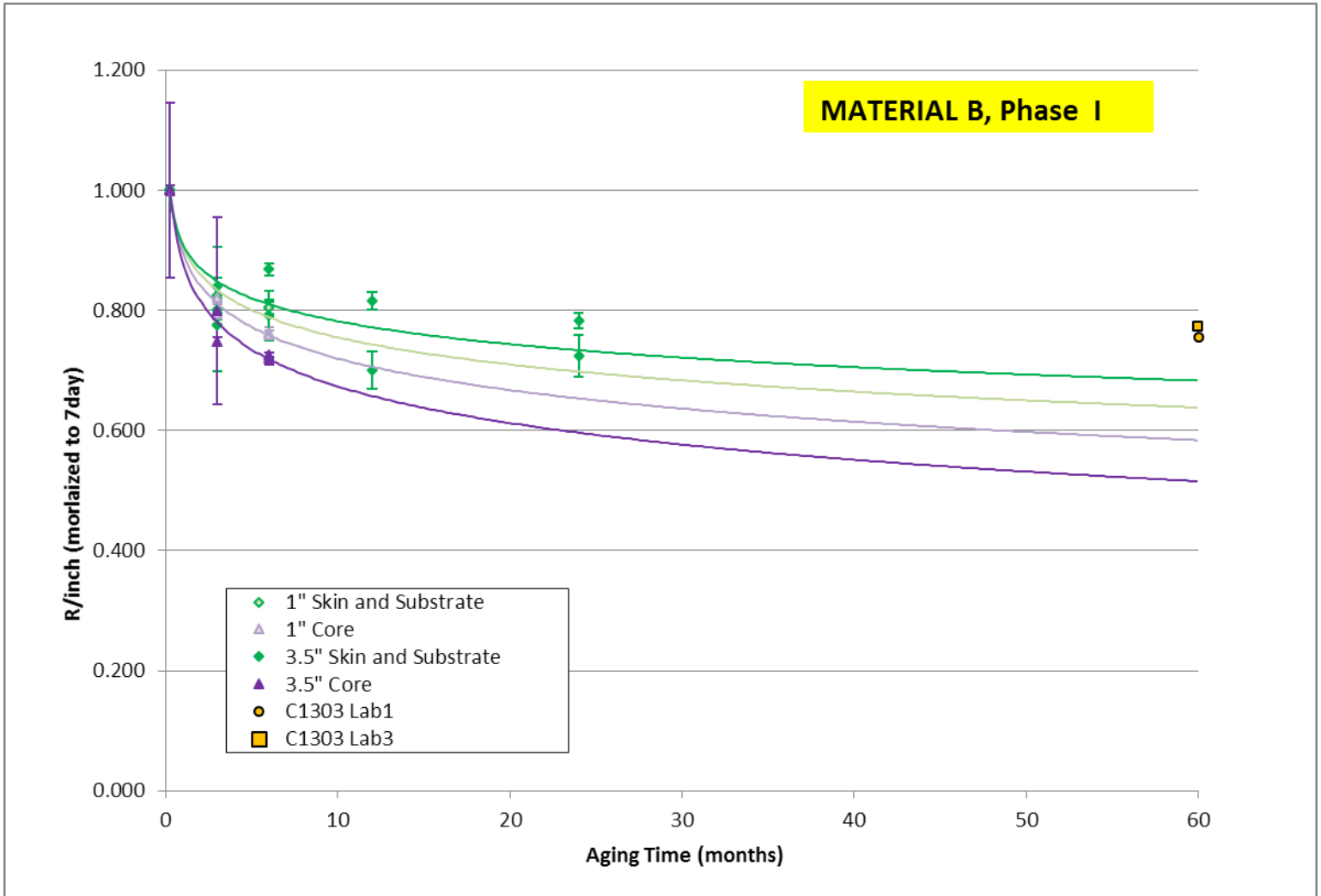
Phase I Thermal Aging Results

	time (mo)	A		B1		B2		C	
		mean	sd	mean	sd	mean	sd	mean	sd
1" core	0.25	1	0.023	1	0.146	1	0.009	1	0.005
1" skin and substrate	3	1.031	0.008	0.825	0.029	0.802	0.018	0.945	0.013
1" core	3	0.863	0.011	0.794	0.016	0.821	0.003	0.855	0.003
3.5" skin and substrate	3	1.012	0.016	0.840	0.065	0.776	0.078	0.980	0.003
3.5" core	3	0.938	0.010	0.800	0.156	0.748	0.008	0.943	0.003
1" skin and substrate	6	0.977	0.012	0.804	0.010	0.804	0.014	0.879	0.041
1" core	6	0.823	0.016	0.763	0.009	0.759	0.007	0.802	0.008
3.5" skin and substrate	6	0.927	0.092	0.791	0.042	0.868	0.010	0.978	0.006
3.5" core	6	0.922	0.031	0.720	0.009	0.726	0.004	0.914	0.008
3.5" skin and substrate	12	0.956	0.042	0.700	0.031	0.815	0.014	0.947	0.014
3.5" skin and substrate	24	0.964	0.012	0.724	0.036	0.784	0.013	0.905	0.008
3.5" skin and substrate	60								
C1303 (Lab 1)	60	0.847	0.006	0.756	0.004			0.791	0.003
C1303 (Lab 3)	60					0.773	0.009	0.813	0.013

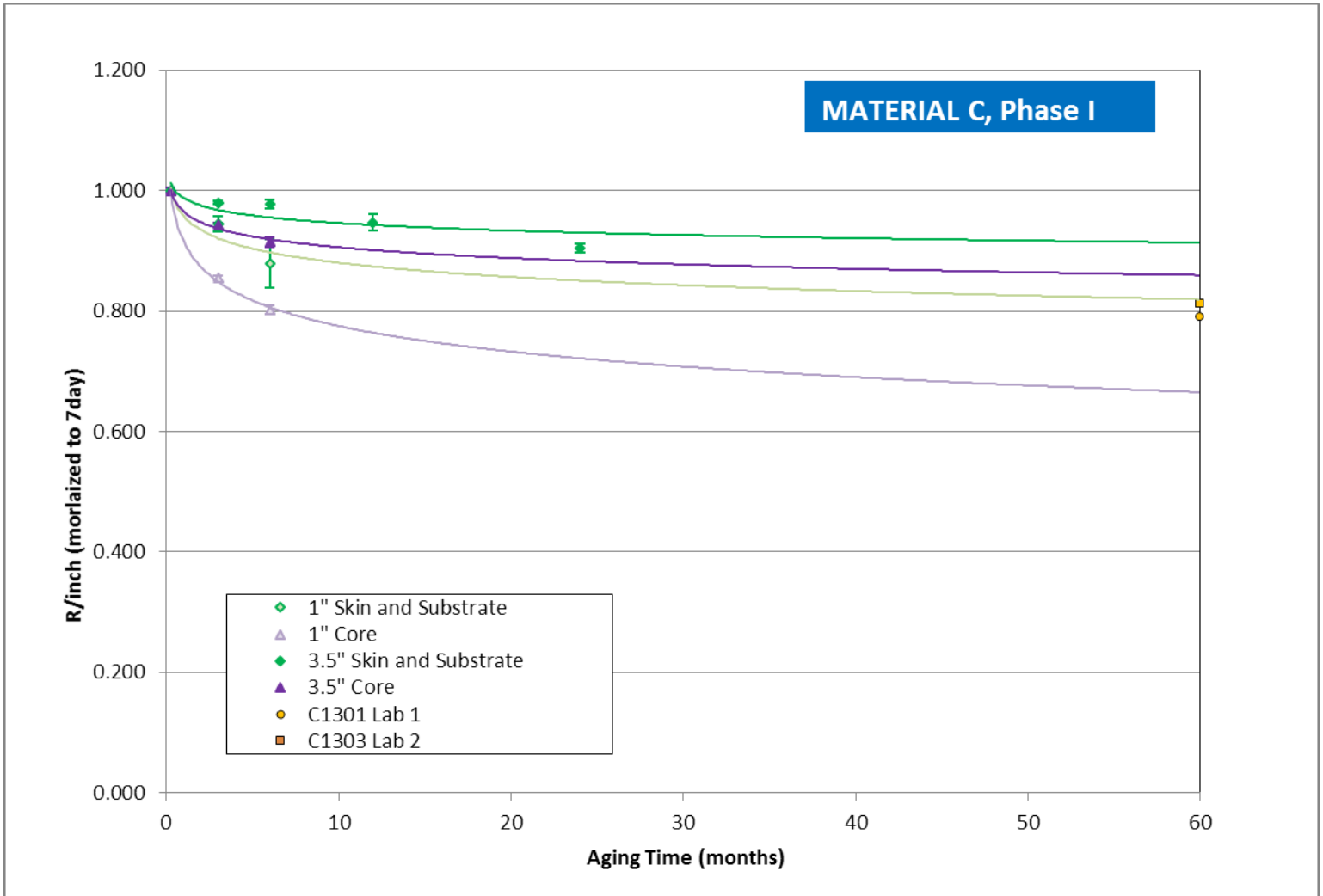
Phase I Thermal Aging Results



Phase I Thermal Aging Results



Phase I Thermal Aging Results



Phase I Thermal Aging Results

	time (mo)	A		B1		B2		C	
		mean	sd	mean	sd	mean	sd	mean	sd
1" core	0.25	1	0.023	1	0.146	1	0.009	1	0.005
1" skin and substrate	3	1.031	0.008	0.825	0.029	0.802	0.018	0.945	0.013
1" core	3	0.863	0.011	0.794	0.016	0.821	0.003	0.855	0.003
3.5" skin and substrate	3	1.012	0.016	0.840	0.065	0.776	0.078	0.980	0.003
3.5" core	3	0.938	0.010	0.800	0.156	0.748	0.008	0.943	0.003
1" skin and substrate	6	0.977	0.012	0.804	0.010	0.804	0.014	0.879	0.041
1" core	6	0.823	0.016	0.763	0.009	0.759	0.007	0.802	0.008
3.5" skin and substrate	6	0.927	0.092	0.791	0.042	0.868	0.010	0.978	0.006
3.5" core	6	0.922	0.031	0.720	0.009	0.726	0.004	0.914	0.008
3.5" skin and substrate	12	0.956	0.042	0.700	0.031	0.815	0.014	0.947	0.014
3.5" skin and substrate	24	0.964	0.012	0.724	0.036	0.784	0.013	0.905	0.008
3.5" skin and substrate	60								
C1303 (Lab 1)	60	0.847	0.006	0.756	0.004			0.791	0.003
C1303 (Lab 3)	60					0.773	0.009	0.813	0.013

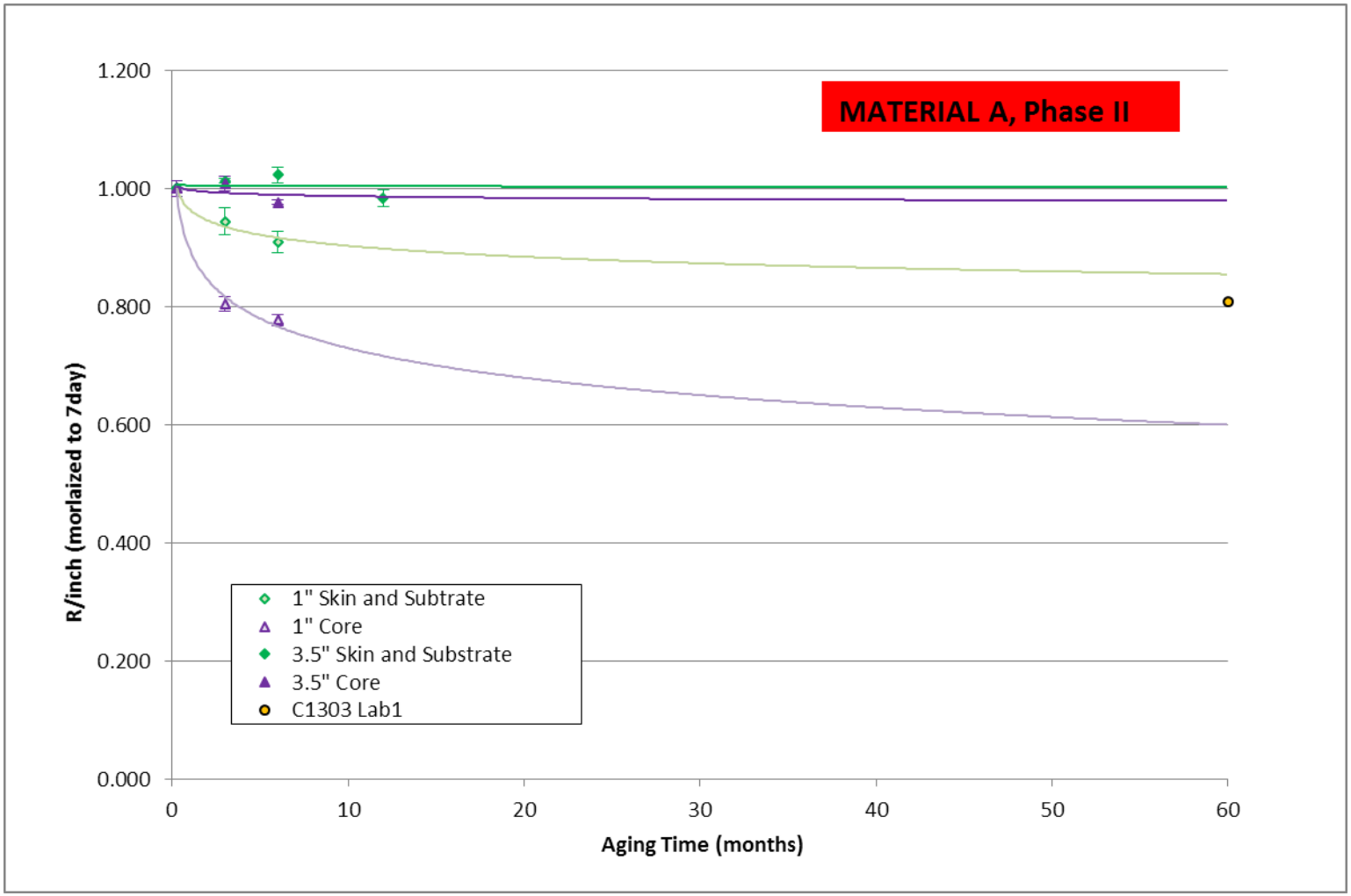
INTERIM PHASE I OBSERVATIONS

- R/inch (resistivity) decreases with time for all specimens, but at a higher rate for thin specimens aged without skins and substrates
- Core samples have lower aged resistivity that samples with skins and substrates …at all aging intervals
- Thin samples have lower aged resistivity that thick samples…at all aging intervals
- C1303 values close to 1” core aged samples after 180 days
- C1303 values close to field-aged materials (not from same lot)
- C1303 values 10-15% lower than 3.5” thick samples aged for 1 year with skin and substrates. Need to wait for 5-year data (specimen 12).

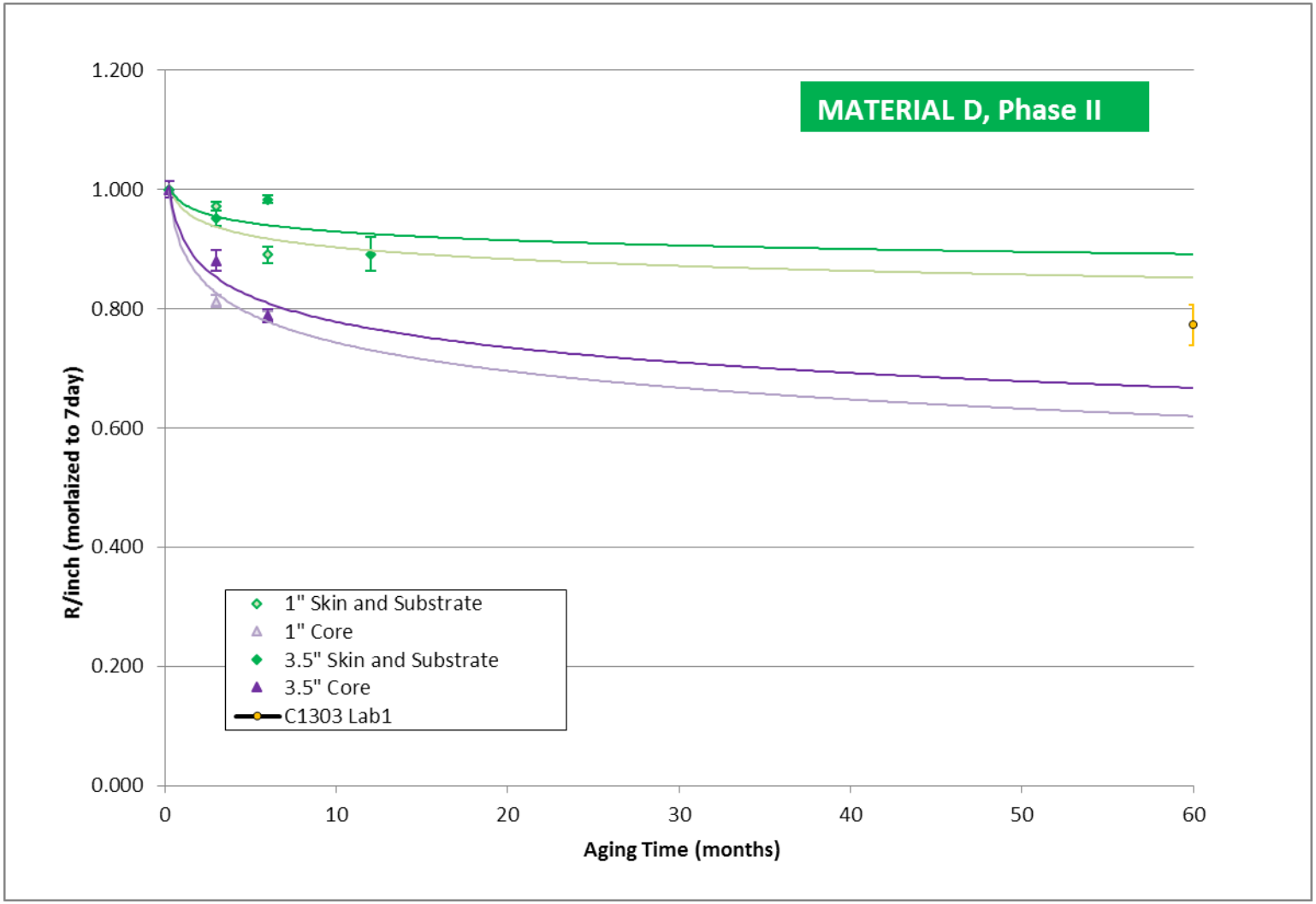
Phase II Thermal Aging Results

	time (mo)	A		B		D		E	
		mean	sd	mean	sd	mean	sd	mean	sd
1" core	0.25	1.000	0.007	1.000	0.127	1.000	0.008	1.000	0.013
1" skin and substrate	3	0.965	0.028			0.969	0.006	0.972	0.007
1" core	3	0.803	0.008			0.835	0.006	0.812	0.010
3.5" skin and substrate	3	1.018	0.004			0.932	0.008	0.952	0.012
3.5" core	3	1.014	0.012			0.903	0.005	0.880	0.017
1" skin and substrate	6	0.914	0.018			0.933	0.002	0.890	0.014
1" core	6	0.781	0.009			0.811	0.012	0.789	0.007
3.5" skin and substrate	6	1.018	0.004			0.931	0.013	0.983	0.007
3.5" core	6	0.982	0.004			0.857	0.011	0.788	0.011
3.5" skin and substrate	12	1.000	0.007			0.891	0.028	0.935	0.007
3.5" skin and substrate	24							0.913	0.012
3.5" skin and substrate	60								
C1303 (Lab 1)	60	0.813	0.009	0.826	0.002	0.765	0.007	0.772	0.033

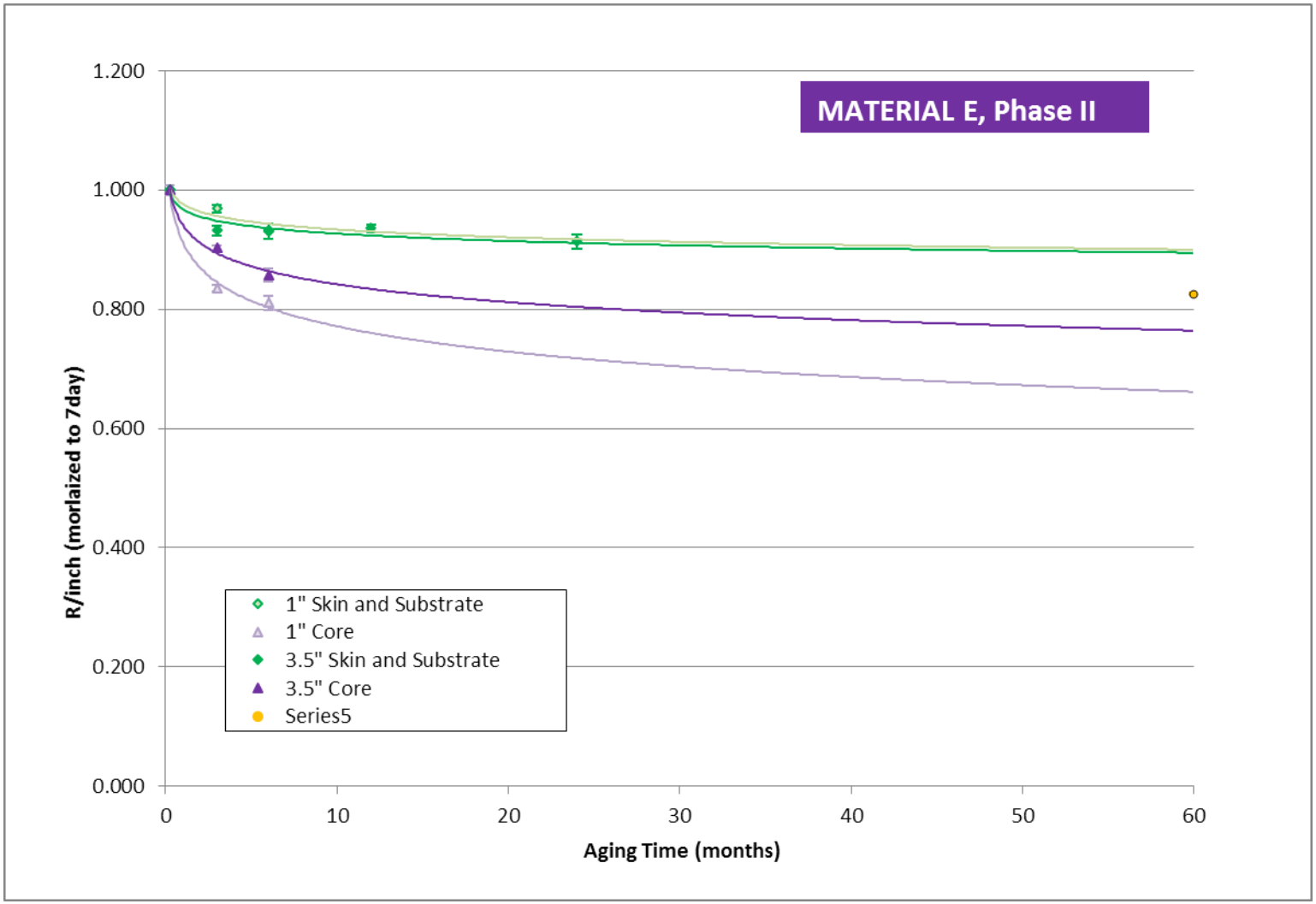
Phase II Thermal Aging Results



Phase II Thermal Aging Results



Phase II Thermal Aging Results



Phase II Thermal Aging Results

	time (mo)	A		B		D		E	
		mean	sd	mean	sd	mean	sd	mean	sd
1" core	0.25	1.000	0.007	1.000	0.127	1.000	0.008	1.000	0.013
1" skin and substrate	3	0.965	0.028			0.969	0.006	0.972	0.007
1" core	3	0.803	0.008			0.835	0.006	0.812	0.010
3.5" skin and substrate	3	1.018	0.004			0.932	0.008	0.952	0.012
3.5" core	3	1.014	0.012			0.903	0.005	0.880	0.017
1" skin and substrate	6	0.914	0.018			0.933	0.002	0.890	0.014
1" core	6	0.781	0.009			0.811	0.012	0.789	0.007
3.5" skin and substrate	6	1.018	0.004			0.931	0.013	0.983	0.007
3.5" core	6	0.982	0.004			0.857	0.011	0.788	0.011
3.5" skin and substrate	12	1.000	0.007			0.891	0.028	0.935	0.007
3.5" skin and substrate	24							0.913	0.012
3.5" skin and substrate	60								
C1303 (Lab 1)	60	0.813	0.009	0.826	0.002	0.765	0.007	0.772	0.033

INTERIM PHASE II OBSERVATIONS

- Replicate materials A and B and new materials D and E exhibit similar results to Materials A, B and C
- R/inch (resistivity) decreases with time for all specimens, but at a higher rate for thin specimens aged without skins and substrates
- Core samples have lower aged resistivity that samples with skins and substrates …at 90 and 180 days
- Thin samples have lower aged resistivity that thick samples…at at 90 and 180
- C1303 values close to 1” core aged samples after 90 days
- C1303 values 15-20% lower than 3.5” thick samples aged for 90 days with skin and substrates. Need to wait for 5-year data (specimen 12)

Exhibit C

Spray Polyurethane Foam Open-Cell (Low-Density) Thermal Aging Study Report

American Chemistry Council | Spray Foam Coalition

Spray Polyurethane Foam Open-Cell (Low-Density) Thermal Aging Study Report

Published: May 2016

Prepared by: Richard Duncan, Duncan Engineering

1. Introduction

Industry standards require insulation manufacturers to test the thermal resistance (or R-value) of products under specific conditions. Foam plastic insulations are aged prior to conducting this thermal testing. The Spray Foam Coalition[1] of the American Chemistry Council's Center for the Polyurethanes Industry (CPI) created and undertook a study of open-cell spray polyurethane foam (SPF) products to determine an appropriate aging period for thermal resistance testing. Specifically, thermal testing on four commercially-available open-cell SPF products was conducted at regular intervals during an extended aging process. The results and conclusion from the study are presented in this report.

2. Background

Foam plastic insulations with closed-cell structures use captive blowing agents to increase thermal performance. For these foams, hydrocarbon (HC) gases such as pentane or butane may be used for boardstock foams manufactured in a plant facility. These flammable blowing agents are not safe for field-manufactured foam plastics like spray polyurethane foams (SPF), which typically use fluorine gases (F-gas) such as hydrofluorocarbons (HFCs) or hydrofluoroolefins (HFOs). Both HFC and F-gas blowing agents have lower thermal conductivities than air, and provide increased thermal performance for the closed-cell insulation products.

It is well understood that captive blowing agents in closed-cell foam plastic insulations diffuse from the cells near the exposed surfaces of the material, which can slightly lower thermal performance. For this reason, ASTM thermal test protocols for closed-cell foam insulations involve aging prior to thermal testing.[2] Aging of foams prior to testing is typically done at room temperature for 180 days; an accelerated aging procedure at 104°F for 90 days may also be used prior to thermal testing.

Polyurethane (PU) foam insulations with an open-cell structure are typically expanded using $C0_2$ gas, which is a byproduct of the reaction between water and isocyanate. Open-cell PU foams over-expand the cells, bursting the cell walls to create a network of struts as the PU cures. Initially, these open-cells contain CO_2, but this gas diffuses from the foam within a short period of time and is replaced by air from the ambient environment. Once the CO_2 is replaced by air, open-cell foams will reach a terminal R-value.

The current thermal test requirements for all SPF insulation products, regardless of cell structure, require 180-day room temperature aging or 90-day accelerated aging. Manufacturer test data collected for this report demonstrates that these extended aging times are not needed for open-cell foams, as the CO_2 gas in these foams is rapidly replaced by air within 30 days.

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[1] The Spray Foam Coalition (SFC) champions the use of spray polyurethane foam in U.S. building and construction applications and promotes its economic, environmental and societal benefits while supporting the safe manufacture, transport, and application of spray polyurethane foam. SFC consists of manufacturers of spray polyurethane foam systems as well as suppliers of raw materials and machinery used to apply the foam.

[2] ASTM test protocols may vary by product type. For example, certain foam plastic insulation is tested in accordance with ASTM C1303, which uses thin-slice methods to extrapolate long-term thermal performance (LTTR). The required test protocols may also vary by jurisdiction.

3. Objective of Thermal Aging Study

The research project was undertaken to determine an appropriate time period for room temperature aging prior to thermal performance measurement of open-cell SPF. The project used the standardized thermal resistance test (ASTM C518) to measure R-value as a function of aging time over a 180-day period. Using this test procedure, the open-cell SPF samples were aged to determine the time period within which samples reached a terminal R-value. This abbreviated thermal aging time can be used to update acceptance criteria (ICC-ES AC-377) and material test standards (ASTM WK30150, CAN/ULC 712.1, etc.) for open-cell SPF products.

4. Procedure

A. Materials

For this study, four commercially-available open-cell SPF products with a density of 0.4 to 0.7 pounds per cubic feet (PCF) were tested. Density was measured per ASTM D1622. Open-cell content was measured for each product per ASTM D 6226 to assure an open-cell content of greater than 85%. All products used in this study have current evaluation reports (e.g., ICC-ES Evaluation Service Report or equivalent).

B. Sample Preparation

Samples of the test materials were aged and studied under different aging conditions and specimen geometries. The effects of core versus as-sprayed (skins and substrates intact) were investigated. The effects of room temperature versus accelerated thermal aging were also evaluated.

In this study, all specimens were sprayed by the respective manufacturers using a single pass. Application was performed consistent with manufacturer recommendations, including: temperature of liquid components, ambient temperature, and temperature of substrate, as well as type and operation of spray equipment. Under the spray conditions used to prepare the specimens, the ambient substrate temperature was 75° ± 5° F (24° ± 3° C) and the relative ambient humidity did not exceed 80%.

The sprayed thickness of the specimens with skins and substrate intact was approximately 4” to 5”, as shown in **Figure 1**. The core specimen thickness, as shown in **Figure 1**, was trimmed to a nominal thickness of 3.5” to simulate open-cell foam installed in a typical wall cavity constructed with 2” x 4” wood studs.

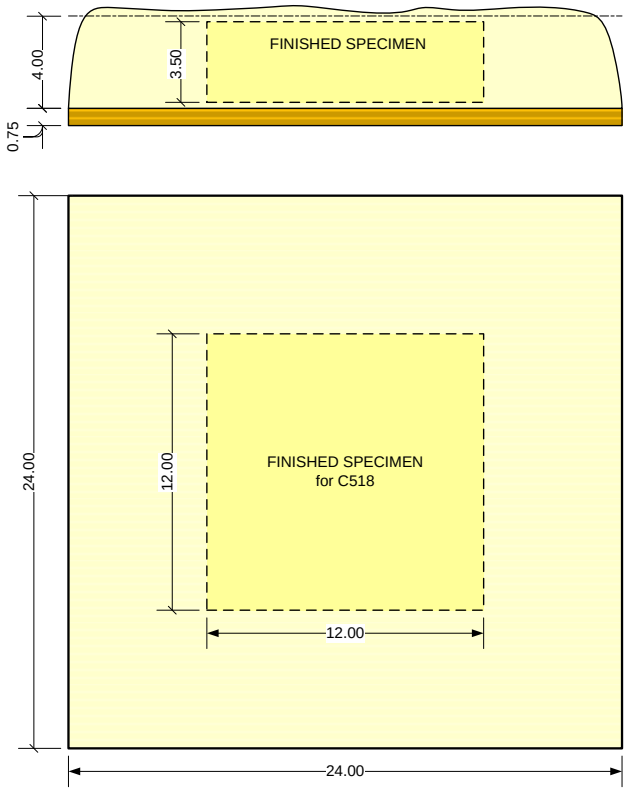

Figure 1 – Thermal Specimen Dimensions[3]

Samples aged with skins and substrates were sprayed on 2' x 2' sheet of plywood (Exterior CDX Grade ¾" unfinished both sides). These plywood panels were tested for moisture content via Delmhorst or Trammex Meter to assure a maximum allowable moisture content of 18%. Samples aged as a core material were sprayed onto 6 mil polyethylene film.

The following information to document spray conditions was recorded:

- Date sprayed;
- Temperature of components in containers;
- Environmental conditions (location, temperature, relative humidity);
- Type of equipment used and settings; and
- Picture taken at time of receipt from the field.

C. Aging Conditions

A total of three test panels were trimmed to 3.5" thick and aged at room temperature conditions (75°F/50% RH) prior to thermal testing per ASTM C518. Three additional test panels were trimmed to 3.5" thick and aged under accelerated aging conditions (140°F/dry) prior to thermal testing. A total of 24 specimens were aged at room temperature conditions with skins and substrates intact; these skins and substrates were removed just prior to thermal testing.

[3] The 12"x12"x3.5" thermal specimen should be weighed in order to determine apparent density each time a thermal resistance measurement is taken.

The specimen configuration, aging conditions, and identification scheme are provided in **Table 1**. Each yellow cell of **Table 1** indicates a separate test panel. Note that panels for aging with skins and substrates cannot be reused after initial testing, since the skins and substrates are removed for thermal testing. However, panels aged as cores can be reused after thermal testing, provided they are placed back into the aging chambers after thermal testing. Thermal testing was performed just after spraying (<2 days), and then again at 7, 14, 21, 30, 60, 90 and 180 day intervals.

The procedures used for core-aged specimens prior to testing per ASTM C518 were as follows:

- Lab cut the core-aged test specimens per **Figure 1** within 24 hours of receipt to begin conditioning process;
- Core specimens designated for room-temperature aging were exposed to 73° ±2° F (23° ±1° C) and 50% ±5 % relative humidity for the required duration (see ASTM C1029) prior to thermal testing per ASTM C 518; and
- Core specimens designated for accelerated aging were exposed to 140° ±2° F (60° ±1° C) and dry conditions for the required duration (*see* ASTM C1029 for accelerated aging) prior to thermal testing.

Specimens designated for aging with skins and substrate intact (as-sprayed specimens) were conditioned prior to thermal testing as follows:

- Un-cut, as-sprayed test specimens were exposed to at 73° ±2° F (23° ± 1° C) and 50% ± 5 % relative humidity for the required duration; and
- Lab cut test specimens per **Figure 1** within 24 hours after aging was completed.

	Aging time (days) prior to thermal testing per ASTM C518							
Aging	<2	7	14	21	30	60	90	180
73F/50 %RH Skin and PW Substrate	X-73S-002-1	X-73S-007-1	X-73S-014-1	X-73S-021-1	X-73S-030-1	X-73S-060-1	X-73S-090-1	X-73S-180-1
	X-73S-002-2	X-73S-007-2	X-73S-014-2	X-73S-021-2	X-73S-030-2	X-73S-060-2	X-73S-090-2	X-73S-180-2
	X-73S-002-3	X-73S-007-3	X-73S-014-3	X-73S-021-3	X-73S-030-3	X-73S-060-3	X-73S-090-3	X-73S-180-3
73F/50 %RH Core	X-73C-002-1	X-73C-007-1	X-73C-014-1	X-73C-021-1	X-73C-030-1	X-73C-060-1	X-73C-090-1	X-73C-180-1
	X-73C-002-2	X-73C-007-2	X-73C-014-2	X-73C-021-2	X-73C-030-2	X-73C-060-2	X-73C-090-2	X-73C-180-2
	X-73C-002-3	X-73C-007-3	X-73C-014-3	X-73C-021-3	X-73C-030-3	X-73C-060-3	X-73C-090-3	X-73C-180-3
140F/dry Core	X-140C-002-1	X-140C-007-1	X-140C-014-1	X-140C-021-1	X-140C-030-1	X-140C-060-1	X-140C-090-1	X-140C-180-1
	X-140C-002-2	X-140C-007-2	X-140C-014-2	X-140C-021-2	X-140C-030-2	X-140C-060-2	X-140C-090-2	X-140C-180-2
	X-140C-002-3	X-140C-007-3	X-140C-014-3	X-140C-021-3	X-140C-030-3	X-140C-060-3	X-140C-090-3	X-140C-180-3

Table 1: Test Panel/Data Identification (X was replaced by A, B, C and D to identify product used)

D. Referenced Test Methods:

- ASTM C 518 *Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*
- ASTM D 1622 *Test Method for Apparent Density of Rigid Cellular Plastics*
- ASTM D 6226 *Test Method for Open-Cell Content of Rigid Cellular Plastics*

5. Results

All specimen preparation, aging, and thermal testing were performed by each product manufacturer at their respective laboratory facilities.

A total of four different open-cell SPF products were tested. Three of the four products (A, B and D) were tested under all conditions and aging times per the matrix of **Table 1**. A fourth product (C) was partially tested without accelerated aging and no aging beyond 30 days.

The thermal test results were measured in R-value per inch (thermal resistivity). For each product, the thermal resistivity was normalized by the average thermal resistivity measured within 2 days of spraying. These normalized results were averaged along with variance (standard deviation) for each group of three specimens for each aging condition and time. The normalized data is provided in **Table 2**.

Figures 2-5 show the normalized thermal resistivity (R-value per inch) versus aging time for each product. For each data point, error-bars indicate the normalized standard deviation for the three thermal samples. The dashed horizontal line shows the average normalized standard deviation for all specimens measured for a given product.

	time (d)	A		B		C		D	
		mean	sd	mean	sd	mean	sd	mean	sd
3.5" S&S, 73F 50%RH	2	1.000	0.030	1.000	0.009	1.000	0.013	1.000	0.011
3.5"core, 73F 50%RH	2	1.000	0.026	1.000	0.040	1.000	0.014	1.000	0.003
3.5" core, 140F dry	2	1.000	0.018	1.000	0.025			1.000	0.005
3.5" S&S, 73F 50%RH	7	0.980	0.014	1.019	0.020	1.027	0.017	0.990	0.009
3.5"core, 73F 50%RH	7	1.000	0.027	0.993	0.034	1.007	0.020	0.995	0.003
3.5" core, 140F dry	7	0.995	0.018	0.996	0.020			1.004	0.013
3.5" S&S, 73F 50%RH	14	0.979	0.019	1.000	0.021	0.977	0.025	0.978	0.004
3.5"core, 73F 50%RH	14	1.000	0.027	0.985	0.024	1.004	0.024	0.986	0.002
3.5" core, 140F dry	14	0.996	0.017	0.983	0.014			0.999	0.011
3.5" S&S, 73F 50%RH	21	0.972	0.005	1.009	0.004	0.995	0.014	0.975	0.005
3.5"core, 73F 50%RH	21	0.989	0.026	0.970	0.030	1.006	0.021	0.981	0.006
3.5" core, 140F dry	21	0.978	0.025	0.983	0.032			0.988	0.011
3.5" S&S, 73F 50%RH	30	0.961	0.009	1.004	0.017	1.003	0.029	0.979	0.004
3.5"core, 73F 50%RH	30	0.989	0.025	0.994	0.005	1.008	0.022	0.977	0.009
3.5" core, 140F dry	30	0.978	0.025	0.982	0.010			0.995	0.017
3.5" S&S, 73F 50%RH	60	0.972	0.013	0.993	0.010			0.974	0.006
3.5"core, 73F 50%RH	60	1.001	0.024	0.988	0.007			0.962	0.004
3.5" core, 140F dry	60	0.998	0.017	0.992	0.003			1.014	0.007
3.5" S&S, 73F 50%RH	90	0.967	0.005	0.991	0.004	1.010	0.087	0.986	0.005
3.5"core, 73F 50%RH	90	0.999	0.025	0.995	0.002	1.001	0.047	0.985	0.013
3.5" core, 140F dry	90	0.997	0.018	0.988	0.007			0.997	0.024
3.5" S&S, 73F 50%RH	180	0.966	0.023	0.991	0.006			0.983	0.005
3.5"core, 73F 50%RH	180	1.003	0.028	0.971	0.006			0.990	0.010
3.5" core, 140F dry	180	0.998	0.018	0.989	0.007			0.998	0.012

Table 2 – Normalized R/inch Versus Aging Conditions and Aging Duration

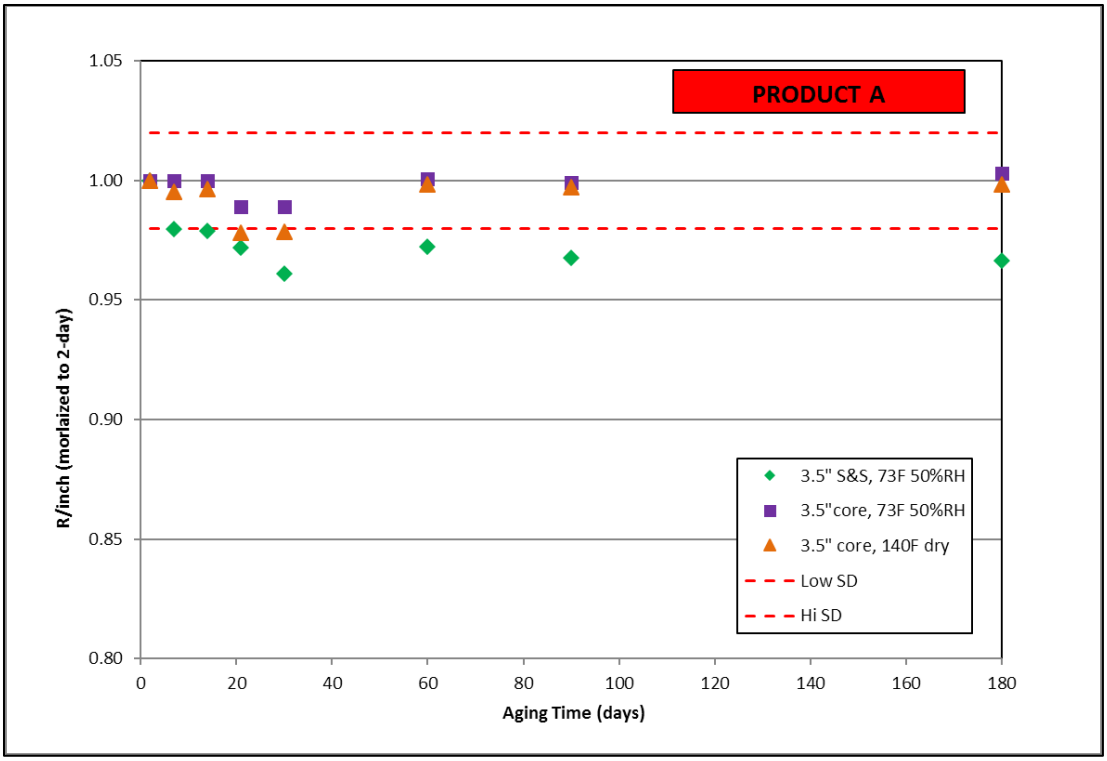

Figure 2 - Normalized R/inch versus Aging Time for Product A

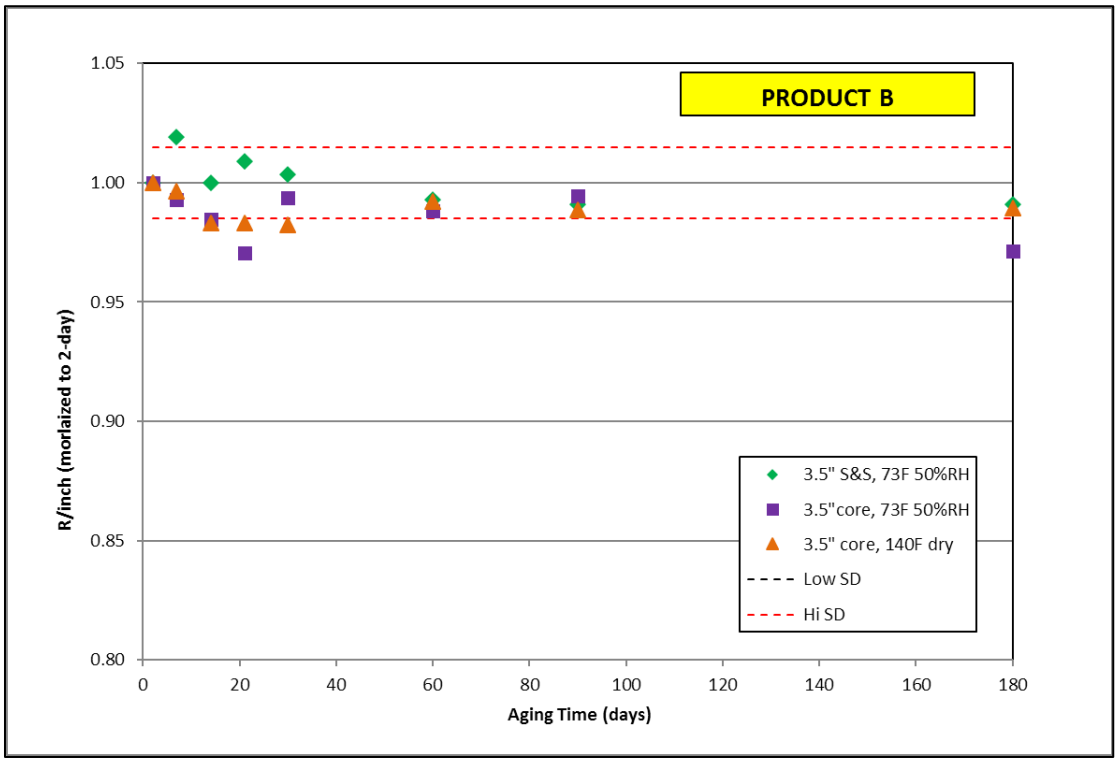

Figure 3 - Normalized R/inch versus Aging Time for Product B

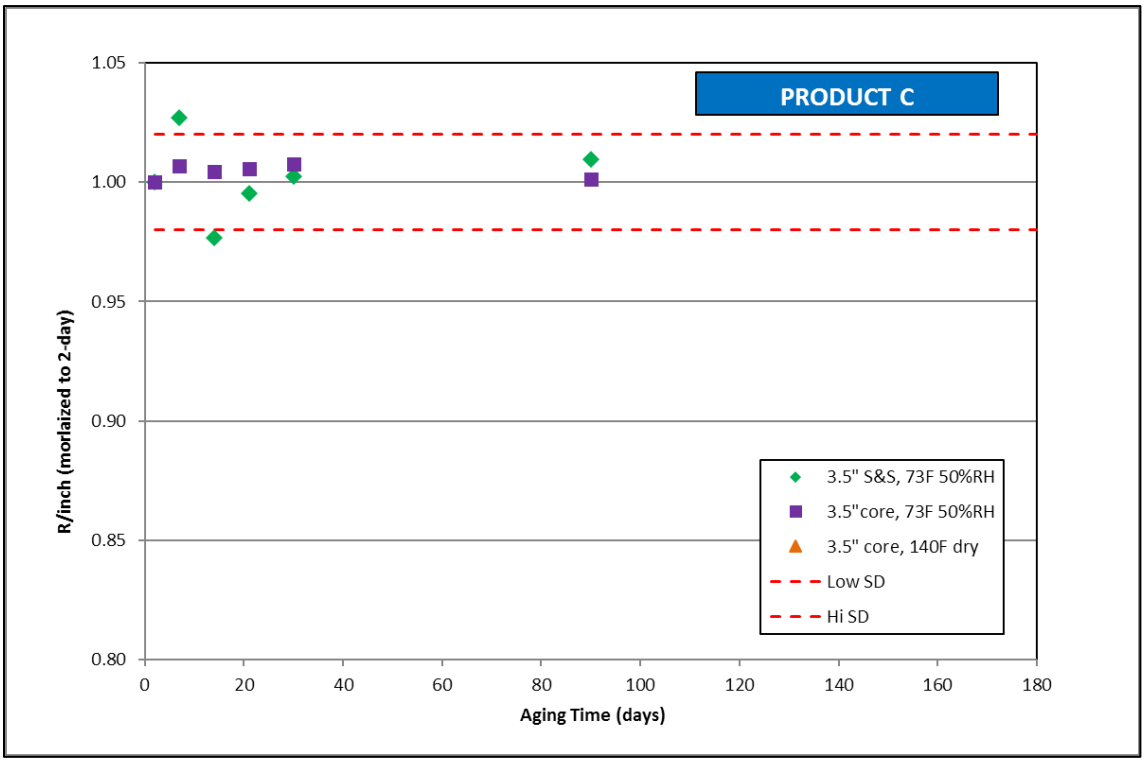

Figure 4 - Normalized R/inch versus Aging Time for Product C

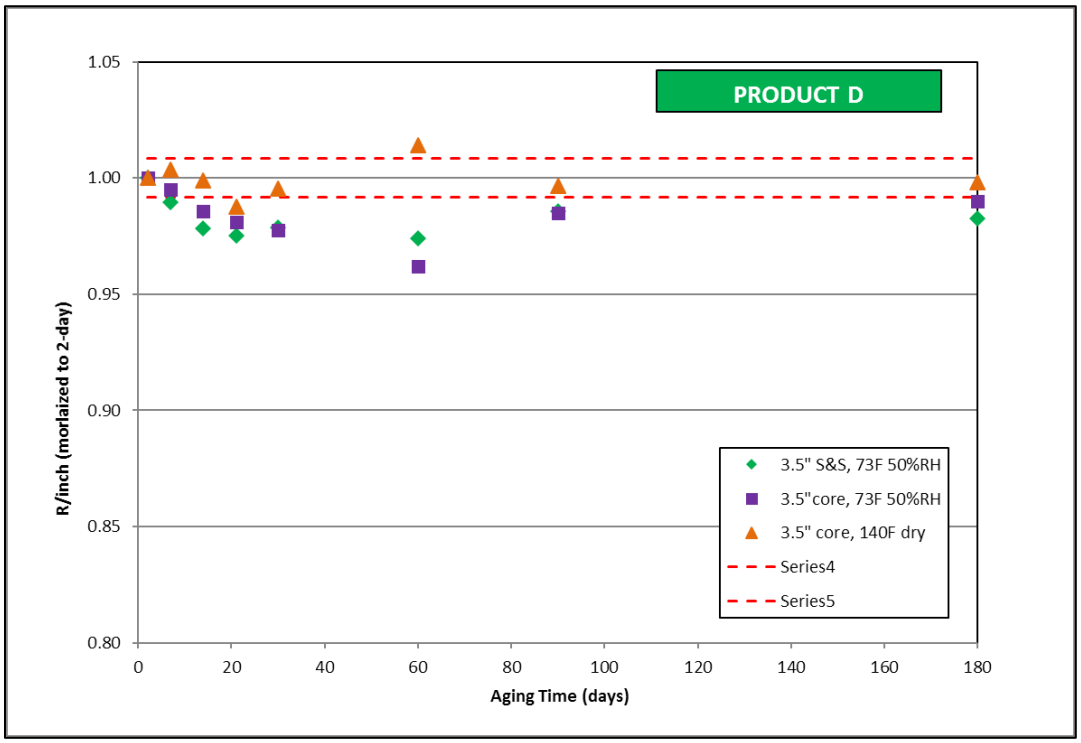

Figure 5 - Normalized R/inch versus Aging Time for Product D

6. Discussion

Based on the results of **Table 2** and **Figures 2-5**:

- The data from Products A, B, and C indicate a terminal (180-day) thermal resistivity value is reached in 30 days of aging, regardless of specimen configuration (skins-substrates or core specimens), or aging conditions. The data from all four products does indicate a slight reduction in thermal performance within the first 30 days after spray.
- Within the variance of the data, there appears to be little, if any, influence of specimen configuration or aging conditions.

7. Conclusion

Open-cell SPF may be tested 30 days after aging, with or without skins and substrates, to obtain a terminal thermal resistance (R-value).