

NCDOT OSFM Evaluation Services

Scope of NCDOT Evaluations: The purpose of this document is to provide guidelines to code enforcement officials, acting as an agent for an authority having jurisdiction, for clarification of code requirements or for consideration when presented with a method or material not prescriptively addressed by the building codes. This evaluation contains the performance characteristics given by the code to determine if the method or material meets the intent in accordance with Section 105 of the 2009 North Carolina Administrative Code and Policies.

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Product Group: **Spray Polyurethane Foam Insulation in Attic, Crawl Space, and Roofing Applications (Regulated by the North Carolina State Residential Code)**

Code Editions: 2009 NC Residential Code, 2009 NC Energy Conservation Code, 2009 NC Mechanical Code

Checklist of Documentation Suggested for Compliance

- Specific Approval Evaluation Report** (See Sections 4.0, 5.0A, 6.0A, 7.0B, 7.0D, 7.0G, 7.0K, Appendix A and Appendix B)
- SPFI Manufacturer's Specifications** (See Sections 5.0(all), 6.0B, 7.0B, 7.0I, and 7.0J)
- SPFI Manufacturer's QA/QC Program** (Optional) (See Sections 5.0A, 6.0A, 6.0F, 7.0D, and 7.0H)
- SPFI Manufacturer's Installation Instructions** (See Sections 5.0(all), 6.0F, 7.0B, 7.0D, 7.0G, 7.0H, 7.0J, and 7.0K)
- Product Labeling** (See Sections 5.0A, 6.0E, and 7.0B)
- SPFI Installer's Qualifications** (See Sections 5.0A, 5.0F, 5.0G, 6.0A, 7.0D, and 7.0H)
- Certification by the Installer** (See Sections 5.0A, 5.0F, 5.0G, 6.0A, 6.0C, 6.0F, 6.0G, 7.0D, and 7.0H)

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2.0 Intent

This report is intended to assist inspectors on subjects that may not be clear or methods that cannot be easily compared side-by-side with the language of the code. The report does not provide an evaluation of any vendor’s specific product, nor does this report imply that the local inspector must approve a specific material or method based on this material. The user of this document should exercise his judgment in the application of recommendations contained herein.

3.0 Scope

Increasingly challenging energy conservation requirements dictated by building codes in response to ever rising energy costs demand increasingly creative solutions for

constructing the thermal envelope of buildings in general and residences in particular. Spray Polyurethane Foam Insulations (SPFI) offer many advantages consistent with energy efficiency.

The wide variation in physical properties from product to product creates a tremendous potential for misapplication of SPFI products. Fire resistance characteristics vary from product to product, and some products may be appropriately used to limit air infiltration, while others may provide little resistance to air infiltration. SPFI products designed to retard moisture vapor flow must be installed only where a vapor retarder is appropriate or in appropriate thicknesses to control dew point locations; otherwise, a condensation problem may result in material deterioration and the growth of mold in the assembly.

This document provides guidance to the homeowner, the contractor and the local building official by clarifying current Residential Code requirements for SPFI. In addition, recommendations stated are intended to aid the end user in evaluating compliance of an installation with the requirements of the Residential Code.

4.0 Definitions

- **Attic** – The unfinished space between the ceiling joists of the top story and the roof rafters.
- **Attic Accessed for Utility Service Only** – Unfinished space between the ceiling joists of the top story and the roof rafters occupied only during the service of mechanical equipment, electrical wiring, fans, plumbing, gas or electric hot water heaters, or gas or electric furnaces. Attic flooring is limited to a service access walkway from the attic entry to the equipment not less than 24” wide or more than 48” wide. A service platform at the front or service side of the equipment not less than 30” deep or greater than 48” deep shall be permitted. The service platform shall be a minimum of 30” wide and not greater than 48” wide unless the appliance manufacturer requires a greater width. The floored area shall be permanently labeled at the attic access opening “NOT FOR STORAGE” in letters not less than 2” high.
- **Air Barrier** – A material or membrane within a wall, ceiling, or roof assembly designed and constructed to control air leakage between a conditioned space and an unconditioned space. In accordance with ASTM E 283 or ASTM E 2178, an air barrier is a material classified as “air-impermeable” if the tested air permeance is less than 0.02 L/s-m² at 75 Pa pressure differential.
- **Air Impermeable Insulation** – Insulation material having an air permeance less than 0.02 L/s-m² at 75 Pa pressure differential when tested in accordance with ASTM E 283 or ASTM E 2178. (See 2009 IRC.)
- **Ignition Barrier** - A material, which limits combustive damage, burning and charring, to the immediate area of fire exposure when tested in accordance with NFPA 286 or UL 1715 as modified by Appendix A or Appendix X of ICC-ES evaluation criteria AC377. Prescriptive ignition barriers specified in the Residential Code are:
 - 1 ½” thick mineral fiber insulation
 - ¼” thick wood structural panels (plywood or OSB)
 - 3/8” thick particleboard

- 3/8" thick gypsum board
- Corrosion resistant steel having a base metal thickness of 0.016"

A number of SPFI products are tested under Specific Approval exposed or with intumescent coatings as an alternative to the code prescribed ignition barriers.

- **Thermal Barrier** – A material that will limit the average temperature rise on the unexposed surface to no more than 250° F after 15 minutes of fire exposure complying with the ASTM E 119 standard time temperature curve. According to Section R314.4 of the Residential Code, ½" gypsum wallboard qualifies as a prescriptive solution for a thermal barrier.
- **Crawl Space** – Unfinished space enclosed by foundation walls between the bottom of the floor joists of the lowest supported floor and the ground surface below.
- **Closed Crawl Space** – A foundation without wall vents that uses air sealed walls, ground and foundation moisture control, and mechanical drying potential to control crawl space moisture. Insulation may be located at the supported floor level or at the exterior walls of the crawl space. Conditioned crawl spaces, defined below, are a special case of closed crawl spaces. Not all closed crawl spaces are conditioned. See Section 5.0C of this document for further explanation.
- **Conditioned Crawl Space** – A foundation without wall vents that encloses an intentionally heated or cooled space below the lowest supported floor. Insulation is located at the exterior walls of the crawl space. "Intentionally heated or cooled" means air is both supplied to the crawl space and returned from the crawl space by the equipment serving the dwelling. Closed crawl spaces become plenums when the crawl space is used as a means to distribute supply air from the equipment serving the dwelling to other spaces in the dwelling or as a means to return air from other spaces in the dwelling to equipment serving the dwelling.
- **Wall Vented Crawl Space** – A foundation that uses foundation wall vents as a primary means to control crawl space moisture. Insulation is located at the supported floor level.
- **Crawl Space Accessed for Utility Service Only** – A crawl space, vented or closed, occupied only during the service of mechanical equipment, electrical wiring, fans, plumbing, gas or electric water heaters, or gas or electric furnaces. The inside of the crawl space access door shall be permanently marked "NO STORAGE ALLOWED IN THE CRAWL SPACE" in letters no less than 2" high.
- **Fuel Burning Heat Producing Appliance** – A device that burns fuel, creating combustion in order to produce heat. Examples are natural gas or propane fueled furnaces or water heaters. Combustion air must be provided for heat producing appliances in unvented attics and crawl spaces. The crawl space cannot be the source for the combustion air.
- **Moisture Barrier** – A material, membrane, or coating designed to limit the intrusion of liquid water into a building envelope assembly.

- **R-Value (Thermal Resistance)** – The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area.
- **Roofing Application** – Roofing applications are those applications wherein the spray-applied polyurethane foam plastic is applied to the exterior of a roof substrate and provided with a liquid-applied, UV barrier coating complying with the code.
- **Specific Approval** – Performance based acceptance of a foam plastic insulation installation permitted by Section R314.6 of the Residential Code as an alternate to compliance with the prescriptive requirements of Sections R314.3 - R314.5. Typically, specific approval is used by the manufacturers to qualify a product for use without the thermal barrier prescribed by R314.4, for use without the ignition barrier prescribed by R315.5, or for use with an alternate ignition barrier, usually an intumescent coating. In order to qualify for specific approval, the material must be tested in accordance with one of the testing procedures specified by R314.6 (NFPA 286, NFPA 286M, FM 4480, UL 1040, or UL 1715) based on the actual end-use configuration of the product. Tests must be conducted on finished foam plastic assemblies in the maximum thickness intended for field application. Furthermore, test assemblies must include typical details indigenous to the installation of the product, seams, joints, and coatings for example. Specific Approval is intended as an alternate to either or both the prescriptive surface burning characteristics and the prescriptive thermal/ignition barrier requirements of the code. As a result, an ASTM E 84 test on the foam plastic and an ASTM E 119 test on the thermal/ignition barrier are not required for Specific Approval.
- **Vapor Retarder** – A material, membrane or coating, which limits the amount of moisture vapor that passes through a wall, ceiling, or floor assembly. Specifically, a material, membrane, or coating is considered to be a vapor retarder when testing in accordance with Procedure A of ASTM E 96 results in a permeance rating of 1 perm (5.7×10^{-11} kg/Pa*S*M²) or less at the applied thickness and density.

5.0 North Carolina Code References

A. Section R314 Foam Plastic, North Carolina Residential Code - specifies general requirements for the use of foam plastic products in residential construction:

1. Section R314.2 Labeling and identification – lists the information required on the labels for packages of SPFI components.
2. Section R314.3 Surface burning characteristics – specifies minimum flame spread and smoke developed indices for the spray foam material.
3. R314.4 Thermal barrier - requires a thermal barrier separating the interior of the building from SPFI unless otherwise tested for Specific Approval.
4. Section R314.5 Specific requirements – details requirements for specific applications.
 - a) Section R314.5.2 Roofing – allows deletion of thermal barriers in roofing applications (insulation installed above the sheathing) where the roof sheathing is tongue-in-groove wood plank or 15/32” structural wood panels, Exposure 1, exterior glue. Edges of structural wood panels must be blocked or tongue-in-groove.

through the attic assembly, moisture flow through the attic, and associated condensation. Condition number two calls for an “air-impermeable” insulation (air barrier) to be applied to the interior side of the roof deck. Some, though not all, SPFI products are classified as air impermeable. Only products classified as air barriers are suited for application in conditioned attic assemblies. In warm humid counties, defined in Table N1101.2.1 of the Residential Code, condition 3.1 requires a vapor retarder (wording of condition 3.1 specifically requires ASTM E 96, Procedure B in lieu of Procedure A required in Chapter 2) **on the exterior of the roof deck**. The insulation should not be rated as a vapor retarder for this application, unless the manufacturer can produce evidence that moisture problems will not result.

- E. Section R905.14 Sprayed polyurethane foam roofing, North Carolina Residential Code** – addresses materials, roof geometry, and installation of SPFI used in roofing applications.
- F. Chapter 11 of the North Carolina State Residential Code** – establishes prescriptive criteria for energy efficiency in the form of prescribed R-values for wall, floor, and roof/ceiling assemblies for various climate zones throughout the state. This Chapter requires moisture control in building envelope assemblies.
- G. North Carolina State Energy Conservation Code** – provides both prescriptive and performance based alternatives to the prescriptive energy efficiency requirements of Chapter 11 of the Residential Code. REScheck 4.0.0 may be used to evaluate energy efficiency trade-offs between the wall assemblies, the roof/ceiling assemblies, and the floor assemblies of a building. Envelope requirements may not be traded off against the use of high efficiency heating and cooling equipment. Furthermore, REScheck is not capable of evaluating the effects of air infiltration and exfiltration, and R-values adjusted to include infiltration and exfiltration should not be used with this program. Analyses assessing the effects of high performance heating/cooling equipment and air infiltration/exfiltration must be conducted by a Registered Design Professional in accordance with Section 404, Simulated Performance Alternative, of the Energy Conservation Code.
- H. Section 306 of the North Carolina State Mechanical Code** – specifies the minimum access requirements for equipment located in an attic or a crawl space.

6.0 Checklist Documentation Suggested Content

- A. Specific Approval Evaluation Report** – Whenever Specific Approval is chosen over prescriptive surface burning characteristics, thermal barrier, or ignition barrier requirements of the code, an evaluation report documenting compliance with ICC-ES AC377 “Acceptance Criteria for Spray-Applied Foam Plastic Insulation” or an equivalent evaluation criteria should be submitted. Submittal should occur at any time in the permitting or construction process deemed appropriate by the Authority Having Jurisdiction. This criteria specifies the minimum product testing, conducted by an IAS certified independent testing agency, which the product must undergo to be considered for evaluation by the ICC Evaluation Service. The current edition of AC377 became effective July 1, 2009. Many products were evaluated under older editions of AC377, and some of these reports will be valid until December 31, 2010. Limitations imposed on

the product may be a function of the edition of AC377 under which the product was evaluated. As a minimum, based on the requirements AC 377, the report should include the following information:

1. Installation by contractors certified by the report holder should be required in the report.
2. Applications for which the product was evaluated should be stated in the report.
3. R-values should be provided at mean test temperature of $75^{\circ}\text{F} \pm 5^{\circ}\text{F}$ for a 1" insulation thickness and at the maximum insulation thickness permitted by the applicable test procedure, but no less than 3.5". Since R-value is not necessarily a linear function of insulation thickness, selected thicknesses of insulation, other than 1" and the maximum, should also be included in the testing as necessary to establish the relationship between R-value and insulation thickness. See comments on R-value in Appendix B. Note: The total R-value for a particular assembly, wall, floor, or roof, may, as supplemental information, be stated for the actual thickness of foam being installed in that assembly, based on the tested R-value as listed in Table 1 of the ICC-ES report.
4. Thermal barriers and ignition barriers should be addressed in the report. Specifically, the report should state under what conditions code prescribed thermal barriers or ignition barriers may be deleted or state alternate materials or coatings that may be substituted for code prescribed thermal barriers or ignition barriers. If no mention of thermal or ignition barriers is contained in the report, then the prescriptive requirements of the code are applicable.
5. Types of construction for which the product was evaluated should be stated in the report.
6. If evaluated as a vapor retarder, the report shall state the minimum thickness and the required density of the foam necessary for the product to act as a vapor retarder.
7. Conditions for use of the product in vented and unvented attics or crawl spaces and/or roofing applications should be addressed in the report.

B. SPFI Manufacturer's Specifications – Regardless of whether the product is used according to prescriptive requirements of the code or under Specific Approval, product cut sheets published by the manufacturer should be submitted to the local building official at a time deemed appropriate by the Authority Having Jurisdiction. The local building official should compare the information on the cut sheets with the evaluation report submitted and with the code requirements. All of the following information should be included on the cut sheets:

1. Summarize all testing work conducted on the product, and all standards with which the product complies. The summary may consist of a table listing the tests conducted and a few words describing the results of each test. Detailed test data may be requested at the option of the Authority Having Jurisdiction.
2. State flame spread and smoke developed in accordance with ASTM E 84. Test sample size under the ASTM E 84 protocol is limited to 4" in thickness. Consequently, installations thicker than 4" require specific approval under one of the test protocols specified in Section R314.6 of the Residential Code. Specific approval would also be required for any product with a flame spread or smoke developed exceeding the limitations of Section R314.3. Conversely, an ASTM E 84 test is not required for any product passing one of the test protocols required for Specific Approval.

3. R-values for various test thicknesses, one inch thickness to maximum application thickness, should be stated. The test protocol under which the R-values were determined should be indicated.
4. Indicate appropriate applications of the product and limitations associated with each application. Applications indicated as appropriate should be supported by the summary of independent testing described in item 1 above and listing of the product specifically for the use indicated.
5. Indicate if use as an air impermeable insulation is appropriate and support the assertion with a description of the results of the ASTM E 283 or ASTM E 2178 test included in the summary table..
6. Indicate if use as a vapor retarder is appropriate, and support the assertion with a summary of the ASTM E 96 data. State allowable thickness range required to control condensation in unvented attic applications for climate zones 3, 4, and 5. State any precautions related to moisture control in all applications, including any applications where a material classified as a vapor barrier may not be appropriate.
7. State any health risks associated in handling the product, health risks associated with installing the product, and health risks associated with toxicity under fire conditions.

C. SPFI Manufacturer's QA/QC Program (Optional) – SPFI products shall be manufactured under an approved quality program. The program shall be approved, monitored, and inspected by an inspection agency accredited by the International Accreditation Service (IAS). Upon request by the local building official, the manufacturer shall submit evidence of an in-place quality control program complying with ICC-ES AC10 "Acceptance Criteria for Quality Documentation." In addition, upon request, the manufacturer shall submit a detailed summary of the product installer certification program to the local building official for review. The summary shall include curriculum, method of determining installer competence, follow-up requirements for maintaining certification, and conditions under which certification may be revoked.

D. SPFI Manufacturer's Installation Instructions – A copy of the SPFI manufacturer's written installation instructions should be submitted to the local building official at any time deemed appropriate by the Authority Having Jurisdiction. A copy should also be available at the jobsite.

1. State all health related warnings and precautions required for handling and installation of the product.
2. State all fire related warnings and precautions required for handling and installation of the product.
3. State minimum required qualifications for installers.
4. State all product components required to complete the installation, including intumescent coatings. Component mix ratios should be included, as well as application rate and minimum dry film thickness of coatings.
5. Provide detailed installation procedures required to produce a serviceable end product, to comply with the Residential Code, and to comply with all federal and state health and safety regulations.

E. SPFI Product Labeling – As required by Section R314.2, product containers must bear the label of an IAS approved agency. Information displayed on the label must include the manufacturer's name, the product listing, product identification, and information sufficient to determine that the end use will comply with the Residential Code

requirements. See items 6.0B and 6.0D above. A building inspector may confirm materials actually used by inspecting the labels on product containers on site during installation, or the inspector may request copies of the labels from the materials actually used.

F. SPFI Installer's Qualifications – According to AC377, installers must be certified as competent by the manufacturer of the SPFI product. Only the person on-site who is responsible for supervising the installation in the field is required to be certified. Certification of each crew member on the installer's crew is not necessary. At any time deemed appropriate by the Authority Having Jurisdiction, the installer's qualifications shall be submitted to the local building official. Credentials shall include a certificate from the manufacturer stating the name of the certificate holder, the date issued, the nature of the work for which the certificate holder is qualified, and the date of expiration. The certificate shall bear the signature of the manufacturer's representative responsible for administering the product installer certification program. Where all of the information indicated does not appear on the certificate, a supplemental letter from the manufacturer providing the missing information is acceptable.

G. Certification by the Installer – Section 1101.4 of the Residential Code requires certification of the insulation installation by the installer. Below is the information necessary to verify compliance that should be included in the certification.

1. Name, address, and phone number of the company employing the installer shall appear on the certification document.
2. The manufacturer certified installer responsible for supervising the SPFI installation must sign the certification document.
3. Thickness of the insulation installed, coverage area, installed density, installed thickness and associated R-value for each assembly in which SPFI is installed shall appear on the certification document. If REScheck was used to calculate envelope R-value trade-offs, then so indicate on the certification, and attach the REScheck output summary. Installed thickness shall also be marked in attics in accordance with Section N1101.4.1 of the Residential Code.
4. A statement attesting to installation in accordance with the manufacturer's written instructions and in accordance with the evaluation report submitted for the product shall be included in the certification document.
5. The document shall attest that all thermal or ignition barriers comply with either Section R314.5 or R314.6 of the Residential Code. If coatings are required for compliance, the application rate and installed dry film thickness of the coating shall be stated. Further, the service life of the coating should appear on the certification document.
6. A copy of the certification document shall be submitted to the local building official prior to or during the insulation inspection, a copy shall be provided to the homeowner at closing, and a copy shall be posted in a prominent place in the attic, in the crawl space of the home, or adhered to the primary HVAC unit.

7.0 Field Issues - Commentary and Recommendations

A. File of Alternate Materials and Methods – In lieu of collecting the same information on the same products for every project, the Authority Having Jurisdiction may consider maintaining a file of alternate materials and methods the jurisdiction has approved in the past. A list of the projects on which the system was allowed could be kept in the file

accompanied by the conditions under which the system was allowed. The jurisdiction could, then, request supplemental information to suit the conditions of individual projects on a case by case basis, and a notation could be inserted in the project file. Space required for file storage may be minimized by using this system or creating a similar system.

- B. Applications for which the product has not been tested or evaluated** – Often there are requests to use a product for some purpose for which it has not been tested or evaluated. Only applications for which the product has been tested or evaluated should be permitted. Furthermore, the product should only be permitted in types of construction indicated in the evaluation report, stated in the manufacturer’s specifications, or warranted as appropriate by the manufacturer in a letter of certification to the Authority Having Jurisdiction.
- C. Confusion associated with thermal barriers, ignition barriers, and specific approval** – Fire resistance properties of SPFI products vary considerably depending on formulation of the foam. In an apparent effort to accommodate the variety of fire resistance properties for different formulations and different applications for which the foam is used, the Residential Code has constructed a confusing maze of requirements for protecting SPFI products. Section 4.0 of this document offers definitions intended to help clarify the code requirements. In addition, Section 5.0 of this document summarizes the various sections in the Residential Code specifying fire protection for or fire resistant properties of SPFI products. Finally, the flowchart in Appendix A of this document is intended as an aid in navigating the code requirements related to thermal and ignition barriers. Some of the more recent ICC-ES evaluation reports contain multiple options for intumescent coatings along with an option to use the bare foam with no coating. Unfortunately, these reports do not adequately explain under what circumstances the coating may be deleted. When in receipt of a report worded in this manner, NCDOL recommends the code enforcement official request the manufacturer provide a letter from ICC-ES clarifying the intent of the report. In the absence of this letter, an intumescent coating should be applied to the SPFI.
- D. Intumescent coatings applied as alternates to thermal and ignition barriers** – Intumescent coatings applied as alternates to thermal and ignition barriers are to be used only with specific approval under Section R314.6 of the Residential Code. Intumescent coatings specified in product specific evaluation reports as alternates to thermal or ignition barriers may be translucent or transparent upon curing. As a result, visually verifying that the coating has been properly applied, or applied at all in some cases, may be difficult for the building inspector once the coating has cured. Consequently, some means of verifying application, other than visual examination, is essential to the inspector.

This paper promulgates certification by the installer as the primary means of verification. In cases where the installer is properly credentialed, financially stable, and past experience has shown him to be reliable, certification by the installer may be sufficient for verification that the installation is compliant. Requesting a copy of the manufacturer’s certification program (See item 6.0C) may be helpful in evaluating the installer’s credibility. A rigorous manufacturer’s certification program should speak well for the installer. In some cases, other means of verification may be necessary. Other means of verification available to the inspector include but are not limited to:

1. The building inspector may spot check during the application of the coating to verify the coating is applied. In this case, an application schedule should be submitted to the inspection department at least one week prior to commencement of application. Random times during the application should be chosen for spot checks.
2. Spot checking during the application by an approved testing laboratory may be required by authority of Section 105.2 of the North Carolina Administrative Code and Policies. In this case the contractor should notify the testing laboratory of the application schedule at least 48 hours prior to commencement of application.
3. The building inspector may request a manufacturer's representative be onsite during the application. Once installed, the manufacturer's representative should certify that the material has been installed in an appropriate application and in accordance with his written instructions and the product listing. This solution may be particularly appealing for the first installation of a new product in a jurisdiction.
4. Core samples may be obtained and tested by an approved testing laboratory by authority of Section 105.2 of the North Carolina Administrative Code and Policies.

When choosing a method of verification the inspector should consider cost to the owner and project schedule, as well as risk to the public.

E. Separation of attics and crawl spaces accessed for utility service only from other spaces

– Provisions in Sections R314.5.3 and R314.5.4 of the Residential Code envision a single crawl space or attic space occupied solely for the purpose of servicing equipment or utilities housed in the space. Specific definitions for these spaces are provided in Section 4.0 of this document. In practice, there may be multiple communicating crawl or attic spaces, some of which are intended to be accessed only for utility service, some of which are accessed for other purposes. A reasonable solution, depending on the configuration of the spaces, may be to separate spaces intended solely for service access from other spaces with a 15 minute thermal barrier. For instance an attic or crawl space storage room may be enclosed with partitions constructed of ½" gypsum board on the interior side of the supporting structure. Space outside of the storage room accessed only for utility service would then require only a prescriptive ignition barrier, unless the evaluation report stated otherwise. Under specific approval, the evaluation report may allow deletion of the ignition barrier, or the report may require an intumescent coating as an ignition barrier.

F. Fuel Burning Heat producing appliances and specific approval

– Appendix C contains a letter dated September 2008 stating ICC-ES's position on fuel burning heat producing appliances in proximity to foam plastic insulations. Heat producing appliances are fuel burning devices creating combustion in order to produce heat. Examples are natural gas or propane fueled furnaces or water heaters. Electric furnaces or water heaters are not classified as fuel burning heat producing appliances, because they are not fuel burning devices. According to the ICC-ES letter, evaluation reports for SPFI products tested under comparative protocols may exclude heat producing appliances from the attic or crawl space as a condition of omission of code prescriptive thermal or ignition barriers. NCDOL issued an interpretation dated February 16, 2009 allowing the heat producing appliance to be located in an enclosure constructed of ½" gypsum board on the interior side of the supporting structure as an alternate to providing the code prescribed ignition barrier on a product otherwise allowing deletion of the ignition barrier. Combustion air must be provided to the appliance from an exterior source.

G. Commentary on evaluation reports – Evaluation reports vary in content and completeness from product to product. Section 6.0A of this document lists the minimum information required in the report for a local building inspector to credibly evaluate compliance. When evaluated by an agency other than ICC-ES, the evaluation criteria must include the same elements as AC377 in order to be considered equivalent. The same minimum testing must be provided as the testing required by AC377; in particular, the testing required by Appendix X of AC377 must be provided. In addition, the criteria must address in-plant quality control in a similar fashion to AC377. The manufacturer's specifications should address any information omitted from the evaluation report. Information submitted must be verified by an IAS accredited testing laboratory. Under Section 105 of the North Carolina Administrative Code and Policies, the building official has the right to request any information necessary to determine compliance with the code. The manufacturer should respect any request for information.

Many evaluation reports are difficult to interpret. Appendix D of this document contains information useful in interpreting evaluation reports specific to SPFI products. ICC has a posting on their website detailing the general organization of an evaluation report, which may prove somewhat helpful. This posting may be found at http://www.icc-es.org/Evaluation_Reports/read.shtml. Finally, a thorough reading of AC377 may prove useful in understanding the content of a report on SPFI products.

H. Commentary on certification by installer - Certification of the insulation installation by the installer is currently required as verification of compliance with the energy efficiency requirements in Chapter 11 of the Residential Code. The suggested documentation in section 6.0G of this document builds on this requirement to provide assurance that adequate fire protection has been provided for the SPFI products. Detailed contact information required for the installer is intended to provide assurance that the homeowner can identify and contact a representative of the company responsible for the installation. Posting of the certification is intended to ensure that the homeowner or any future entity evaluating the installation has access to the information required to verify compliance.

I. Moisture control – Moisture control in buildings is a complex topic subject to much debate in the Building Science community. In the case of SPFI products, the complexity of the subject increases due to the flexibility of the product. SPFI products can be formulated to perform multiple functions within the building envelope, insulation, air barrier, vapor retarder, and/or moisture barrier. The manufacturer should be specific as to which functions his product is intended to perform and any moisture related problems associated with misuse of the product. Under the current edition of the Residential Code, vapor retarders are required on the warm-winter side of an envelope assembly only in six counties in the northwest portion of the state classified as Zone 5. Throughout the remainder of the state, products classified as vapor retarders should only be allowed when the manufacturer's literature expressly indicates there will be no moisture related problems with his product in the specific application/location.

J. Electrical wiring, conduit, piping and ductwork embedded in SPFI – Conduit, piping, and ductwork should only be embedded in SPFI when the manufacturer's literature indicates compatibility with the material from which the embedded items are constructed. Electrical wiring should be embedded in spray foam insulation only when the manufacturer's literature indicates there is no hazard associated with embedding electrical wiring in the insulation.

- K. Vertical Surfaces** - Some older evaluation reports require that intumescent coatings be applied on vertical surfaces only. The reports do not define vertical surfaces. In addition, the corner tests on which these reports are based do not realistically assess the effects of inclined roof surfaces on fire performance, because these test are conducted with a horizontal ceiling assembly elevated eight feet above the floor supported on walls with no inclination. In other words, the test is not indicative of the actual end use for an attic. ICC-ES has addressed the sloped roof issue in the current revision to AC377. Any product evaluated under the 2009 edition of AC377 will require intumescent coatings to be applied equally to horizontal and vertical surfaces. As of December 31, 2010, the older evaluation reports will expire. Consequently, it is recommended from the issue date of this document forward that whenever required by an evaluation report, the intumescent coating be applied to all surfaces, horizontal, inclined, and vertical.
- L. Converting Wall Vented Crawl Spaces to Closed Crawl Spaces** – When wall vented crawl spaces are converted to closed crawl spaces, vents may be permanently closed and sealed by any durable method that will exclude moisture, rodents, and termites from the crawl space.
- M. Installations Predating this Report** - Installations that were installed in accordance with a valid compliance report and accepted at the insulation inspection phase, but have not yet received a Certificate of Occupancy, should, at the discretion of the Authority Having Jurisdiction, remain acceptable.

8.0 Reference Standards

Tests are required to be performed by an approved and certified independent testing agency. Acceptance of test data is subject to the approval by the jurisdiction in accordance with Section 105 of the NC Administrative and Polices Code.

- **ASTM C 177-99**, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
- **ASTM C 518-91**, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- **ASTM C 1029-02**, Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation.
- **ASTM C 1363** – Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
- **ASTM D 1621-00**, Test Method for Compressive Properties of Rigid Cellular Plastics.
- **ASTM D 1622-98**, Test Method for Determining Apparent Density of Rigid Cellular Plastics.
- **ASTM D1623-78 (1995)**, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellar Plastics (Type B Specimen).

- **ASTM D 2126-98**, Test Method for Response of Rigid Cellular Plastics Thermal and Humid Aging.
- **ASTM D 2856-94 (1998)**, Standard Test Method for Open-Cell Content of Rigid Cellular Plastics by the Air Pycnometer.
- **ASTM E 84-04**, Test Methods for Surface Burning Characteristics of Building Materials.
- **ASTM E 96-00**, Test Method for Water Vapor Transmission of Materials.
- **ASTM E 119-00**, Test Methods for Fire Tests of Building Construction and Materials.
- **ASTM E 283-04**, Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen.
- **ASTM E 2178-03**, Standard Test Method for Air Permeance of Building Materials.
- **ICC-ES AC377**, Acceptance Criteria for Spray-Applied Foam Plastic Insulation.
- **FM 4480-(2001)**, American National Standard for Evaluating Insulated Wall or Wall and Roof/Ceiling Assemblies, Plastic Interior Finish Materials, Plastic Exterior Building Panels, Wall/Ceiling Coating Systems, Interior or Exterior Finish Systems.
- **NFPA 259-04**, Test Method for Potential Heat of Building Materials.
- **NFPA 286-00**, Standard Method of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.
- **UL 790-98**, Tests for Fire Resistance for Roof Covering Materials, with revisions through July 1998.
- **UL 1256-02**, Fire Tests of Roof Deck Construction.
- **UL 1040-96**, Fire Tests of Insulated Wall Construction, with revisions through June 2001.
- **UL 1715-97**, Fire Tests of Interior Finish Material, with revisions through March 2004.

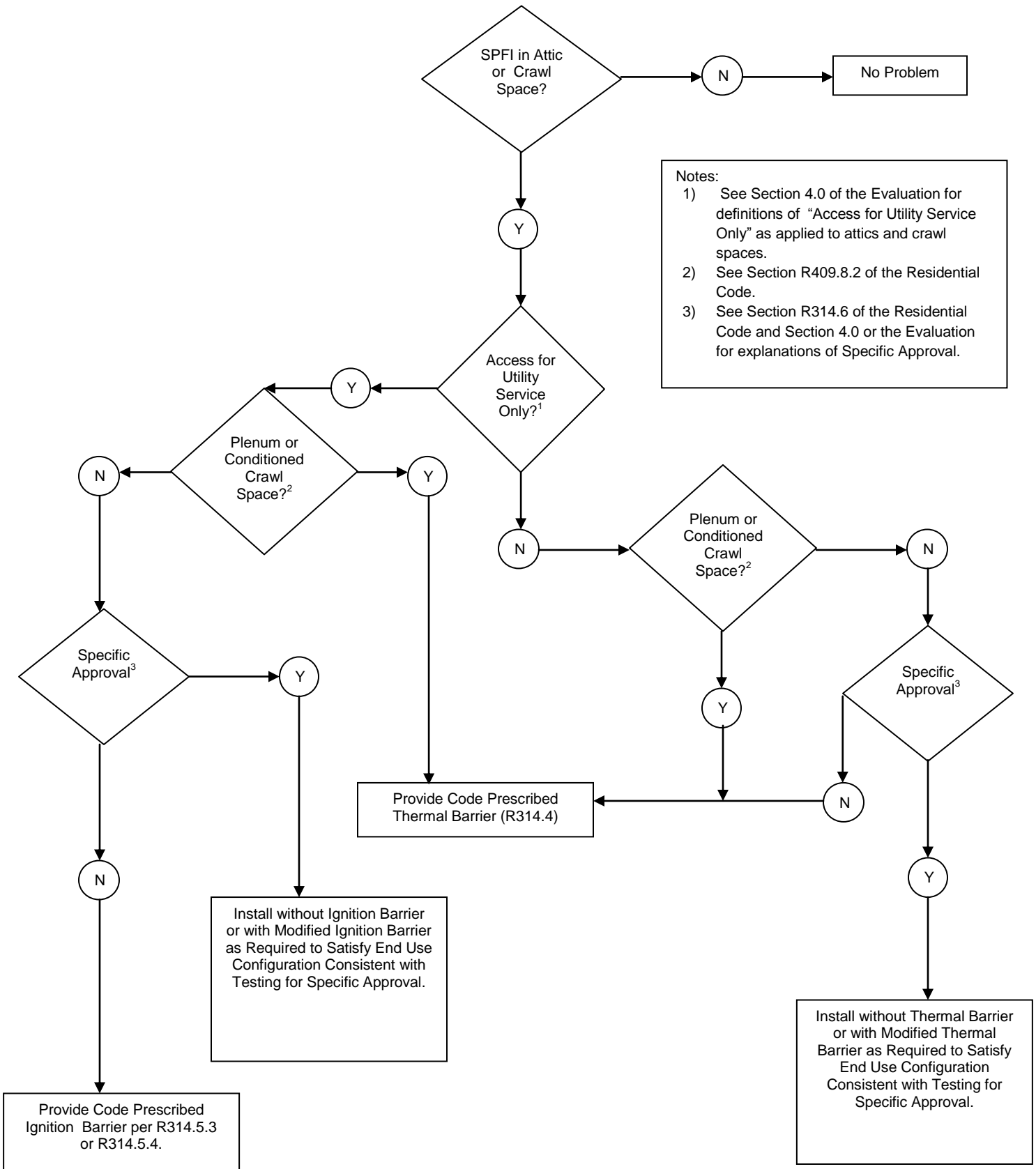
9.0 Technical References

- “Spray Foam Insulation,” Journal of Light Construction, August 2003, Hanley-Wood, LLC.
- AY-126 “Thermal Barriers for the Spray Polyurethane Foam Industry,” Spray Polyurethane Foam Alliance, Fairfax, Virginia, 2005.
- AX-230 “Fire Safety Guidelines for the Use of Rigid Polyurethane and Polyisocyanurate Foam Insulation in Building Construction,” March 2003, Alliance for the Polyurethanes Industry, Arlington, Virginia.

- “Working with MDI,” July 2003, Alliance for the Polyurethanes Industry, Arlington, Virginia.
- “Working with TDI,” January 2001, Alliance for the Polyurethanes Industry, Arlington, Virginia.
- “Commentary on the Toxicity Classification of PMDI in the International Fire Code,” October 2002, Alliance for the Polyurethanes Industry, Arlington, Virginia.
- “Vapor Barriers,” Joseph Lstiburek, Ph.D., PE, Building Science Corporation, Westford, MA, 2004.

This document does not constitute an evaluation of any vendor’s specific product, nor does this document imply that the local AHJ is obligated to approve any specific method or material.

Appendix A: Flow Chart for Determining Requirements for Thermal and Ignition Barriers



Appendix B: Reading an ICC-ES Report on SPFI

The first document contained in this appendix was contributed by Mr. Randy Nicklas of Icynene Corporation and is reprinted with his permission. NCDOT wishes to thank Mr. Nicklas for his input. The information in Appendix B is believed to be generic. Inclusion of this document is not intended as an endorsement of any specific product, nor is the information intended to be used to exclude the products of any manufacturer from consideration on any project. There is a correction under "Evidence Submitted (6.0): "AC 12" should read "AC377."

The second document, contributed by Mr. Tim Gull of the Wake County Inspections Department, offers a procedure for validating that an ICC-ES report is current.

READING AN ICC-ES REPORT FOR SPRAY-APPLIED FOAM INSULATION

The ICC Evaluation Service (ES) provides an important service by providing a report with information on whether a product complies with certain code requirements and limitations that might be applicable to use of that product. While the report format has varied somewhat over the years, the summary below follows the format of the more recent reports.

Report Number, Date, and Applicable Product

The ICC-ES report number and date are listed in the top right-hand corner. This usually consists of the letters "ER," "ESR," or "NER," followed by three to four digits.

Immediately below the report number will be the date of issue and potential expiration of the report. For example: "Issued January 1, 2006," "This report is subject to re-examination within one year."

One of the first entries in the left column will be the "Evaluation Subject," which will list the product name of the product being evaluated.

Evaluation Scope (1.0)

The first portion of this section will list the codes that compliance has been evaluated against, for example: "2006 International Building Code," "2006 International Residential Code," "2006 International Energy Conservation Code." If the report does not list the current codes and only lists previous codes, check to make sure that you have the latest report for that product. If this is the latest report, call ICC staff at (562) 699-0543 to see if the applicable code requirements in the current code are different from the applicable requirements in the code that the report is based on. Ask whether the report is considered valid for the current code.

The second portion of this section will list the properties evaluated, for example: "Physical Properties," "Surface-burning Characteristics," "Thermal Transmission," "Attic and Crawlspace Installation." Some reports do not list all properties such as "Thermal Transmission" (R-value).

Description (3.0)

General (3.1)

This section contains a simple description of the product. Sometimes, but not always, the description specifies whether the product is open-cell or closed-cell. It may also contain conditions for storage of materials prior to use. Examples include:

- "Having a maximum thickness of 2 inches."
- "Components shall be stored at temperatures between 60°F and 90°F."

Surface-burning Characteristics (3.2)

This section lists flame-spread index and smoke-developed index.

Thermal Transmission (3.3)

This section details R-value. Be very careful reviewing this section.

While most reports show the R-value for the standard 1-inch thickness, this is not always the case. One report, for example, shows the R-value for a 1.6-inch thickness. (R-5.7 at 1.6-inch thickness = R-3.56/inch.)

Also, be aware that not all spray foam insulation products have a consistent R-value per inch regardless of thickness. Another report shows the following values:

- (a) "R-3.83 at a 1-inch thickness" (= R-3.83/inch)
- (b) "R-6.77 at a 2-inch thickness" (= R-3.39/inch)
- (c) "R-13.0 at a 4-inch thickness" (= R-3.25/inch)

Note that the R-value per inch decreases as the thickness increases.

The difference is important:

R-3.83/inch x 5.5 inches = R-21.07, whereas

R-3.25/inch x 5.5 inches = R-17.88, 15% less.

Even that R-17.88 may be an overestimate as the ICC-ES report does not show whether the insulation R-value per inch continues to decline through 5.5 inches thickness.

If the report does not show the R-value associated with a particular thickness, always look for the thickness that is closest to the installed thickness and calculate adjustments from that point.

Installation (4.0)

General (4.1)

Virtually all of the reports specify that a copy of the manufacturer's installation instructions be available at all times on the jobsite during installation. Sometimes this section specifies storage conditions. An example:

- "Component shall not be stored at temperatures below 65°F or above 85°F."

Application (4.2)

This section will indicate whether there are any limitations on conditions for storage and installation. Examples of some of these conditions include:

- "shall not be stored, before installation, at temperatures below 59°F or above 86°F"
- "shall not be applied in areas that are exposed to a maximum ambient temperature greater than 180°F"
- "shall not be applied in electrical outlet or junction boxes"
- "shall not be applied in direct contact with water or soil"

One of the key limitations is related to maximum thickness. Here are examples of text from the ICC-ES reports addressing maximum thickness:

- "shall not exceed a maximum thickness of 6 inches"
- "in attics and crawlspaces...the thickness of the foam plastic...must not exceed 10 inches...foam plastic applied to vertical wall surfaces in attics and crawlspaces must not exceed 5.5 inches in thickness"
- "shall not have a thickness exceeding 5½ inches...a nominal thickness of 6 inches is permitted in attics and crawlspaces described in section..."

As noted above, the combination of the R-value per inch and these limitations on maximum thickness mean that most of these spray-applied foam insulation products do not comply with the prescriptive requirements in the Energy Code, and thus must use the Target UA or annual energy analysis options for compliance. However, spray-applied foam insulation may be installed with additional insulation products, like rigid foam sheathing, to attain the necessary minimum R-value.

Thermal Barrier (4.2)

In some situations a thermal barrier (e.g. ½-inch gypsum board) is required to separate the spray-applied foam insulation from the interior of the structure.

Conditions of Use (5.0)

This section contains the limitations on use of the product as evaluated by ICC-ES. Examples include limits on construction types, application, maximum thickness, weather exposure, installers, and identification of aspects that are beyond the scope of the report.

Limits on construction types. Most products are limited to construction types typically seen in simpler, smaller buildings. Examples include:

- "insulation shall be limited to interior use in Type V-B construction under the IBC...and to structures constructed in accordance with the IRC."
- "has not been evaluated for use with exterior walls of buildings of non-combustible construction"

Limits on the application. Most products are not allowed to be installed on the exterior or in contact with the ground. An example:

- "the insulation shall not be installed on the exterior of foundation walls or below floor slabs on grade or in contact with the soil"

Limits on thickness. There is usually a reference back to the specific limits in Section 4.

Limits on weather exposure. Some reports explicitly require protection of the finished product. An example:

- "required to be protected from the weather after application"

Limits on the installers. Most reports require that application be done by certified installers. Examples include:

- "spray foam insulation shall be applied by contractors certified by..."

Limits on the report scope. Most reports identify some aspects that are not addressed. Examples include:

- "the use of the spray-applied foam insulation as fire-blocking or draft stopping has not been evaluated and is outside the scope of this report"
- "has not been evaluated for use as a fire-stopping material or through-penetration system"

Evidence Submitted (6.0)

This section indicates what version of AC12 the evidence was submitted under (e.g. June 2006), but does not usually provide any details about that evidence. Sometimes there is mention of the manufacturer's published installation instructions, and the manufacturer's quality control manual.

Identification (7.0)

All of the reports require that component materials be labeled. Most require that the inspection agency for the manufacturer be listed. Examples of material identification requirements include:

- "The insulation shall be packaged in 55-gallon drums that identify the manufacturer's name"
- "Each package of components for the...spray foam insulation is identified with the manufacturer's name...and the name of the inspection agency"

Procedure for Validating an ICC-ES Evaluation Report

From time to time we need ICC Evaluation Reports to guide us in our inspections. When presented to us we typically check the date in the upper right hand corner and the "subject reexamination" requirement to determine its validity date wise. We must do one more thing. Some reports are valid beyond what the dates on the report may indicate. The only way to check these will be to go to the ICC web site. All current ESR reports are listed on the ICC Evaluation Service web site. When a report becomes invalid it is immediately removed from the list. I recommend that you all bookmark the ICC web site and do the following:

- Go to icc-es.org and bookmark.
- Click on "Evaluation Reports".
- Read the paragraph that starts with "Please Note" for an explanation of the above.
- Click on "List Reports".
- At the drop down list click on " ICC-ES Reports" for a complete list of current valid ES reports.

Tim Gull
Chief Building Inspector
Wake County Inspections Department
Mobile 919-524-4633
Fax 919-404-3957

Appendix C: ICC-ES Letter Regarding Heat Producing Appliances

Appendix C contains a letter from Mr. Michael Beaton, P.E. of ICC-ES to Mr. Roger V. Morrison, P.E. of NCFI Polyurethanes dated September 16, 2008. The letter defines ICC's perception of heat producing appliances and summarizes ICC's position on heat producing appliances in proximity to foam plastic insulations.



September 16, 2008

Roger V. Morrison, P.E., R.R.C.
Senior Staff Engineer
NCFI Polyurethanes
Post Office Box 1528
Mount Airy, North Carolina 27030-1528

Dear Mr. Morrison:

This is in response to your e-mail request for clarification of ICC-ES's position on the use of heat-producing appliances in attics and crawl spaces when foam plastic insulation is installed without the ignition barrier required *International Building Code* (IBC) Section 2603.4.1.6 and *International Residential Code* (IRC) Sections R304.5.3 and R304.5.4.

Section 3.4.4 of the ICC-ES Acceptance Criteria for Spray-applied Foam Plastic Insulation (AC377), dated May 2008, details requirements for foam plastic used in attics and crawl spaces. When testing is based on comparative diversified fire tests, ICC-ES evaluation reports will include a limitation that entry to the attic or crawl space is only to service utilities and no storage is permitted. Sections 3.4.4, A1.1 (attics) and A2.1 (crawl spaces) of AC377 define utilities to include mechanical equipment, electrical wiring, fans, plumbing, gas or electric hot water heaters, and gas or electric furnaces. Products such as recessed lights and fans would be included within the definition of utilities, as defined in AC377.

The foregoing describes the requirements of the current edition of AC377. Prior to May 2008, ICC-ES followed a policy of recognizing the use of foam plastic insulation without an ignition barrier in attics and crawl spaces based on comparative diversified tests. Evaluation reports that are based on this policy contain a limitation that no heat-producing appliances are permitted in the attic or crawl space. The term "heat-producing appliances," when used in this context, was intended to identify appliances that generated products of combustion. Products such as recessed lights, fans and electrical appliances, which do not generate products of combustion, were not included in this definition and would be acceptable if located within the attic or crawl space.

I trust this explanation is satisfactory for your needs. If you have any questions, please feel free to contact me by telephone at (800) 423-6587, extension 3289, or by e-mail at mbeaton@icc-es.org.

Sincerely,

A handwritten signature in black ink that reads "Michael Beaton". The signature is written in a cursive style with a large initial "M".

Michael Beaton, P.E.
Vice President - Whittier Operations

MB/cm

Appendix D: Links to Useful Information

“Air Barrier Association of America” (ABAA) (www.airbarrier.org)

1600 Boston-Providence Hwy

Walpole, MA 02081

P) 1-866-956-5888

F) 1-866-956-5819

“Spray Polyurethane Foam Association” (SPFA) (www.sprayfoam.org)

4400 Fair Lakes Court,

Suite 105

Fairfax, VA 22033

Tel: (800) 523-6154

Fax: (703) 222-5816

Alliance for the Polyurethanes Industry (API) (www.polyurethanes.org) (www.plastics.org)

A Business Unit of the American Plastics Council

1300 Wilson Boulevard

Arlington, VA 22209

703.741.5656

Polyisocyanurate Insulation Manufacturers Association (PIMA) (www.pima.org)

Suite 420

515 King Street

Alexandria, VA 22314

703.684.1136

Spray Foam Insulation Community Portal and Guide (www.sprayfoam.com)