

Building Insulation

A Performance Comparison for Today's Environmental Home Builder



Today's home builder is striving to construct a home that will minimize impact on the environment and provide comfort, convenience and cost savings for the home owner.

Insulation saves energy. Insulation provides added comfort. Insulation requires no maintenance.

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Features	Fiber Glass	Cellulose
Installed Cost	A sustainable insulation product must also be cost effective. In fact, weigh those costs against the benefits. The key is to install the most	
Thermal Performance¹ <i>R-value ranges - Batts</i> 2 x 4 wall (3.5") 2 x 6 wall (5.5")	R-13 to R-15 ⁴ R-19 to R-21 ⁴	N/A N/A
Thermal Performance <i>R-value ranges - Blown-In</i> 2 x 4 wall (3.5") 2 x 6 wall (5.5")	R-13 to R-15 R-20 to R-23	R-12 to R-13 ¹⁴ R-19 to R-20 ¹⁴
Settling	Batts: No settling Blown-In: Virtually no settling. Does not impact R value. ⁵	Batts: N/A Blown-In: (Dry) In attics, can settle up to 20% - losing R-value. ¹⁵
Fire Performance	Naturally fire resistant. ⁶	Naturally flammable. Cellulose insulation manufacturers must apply 20 to 23 percent, by weight, of fire retardants to reduce flammability. ^{16, 17}
Corrosiveness	Non-corrosive. ⁷	When chemical fire retardants are used, it can lead to corrosion. ¹⁸
Moisture Absorption Building codes require vapor retarders to be installed on the "warm-in-winter" side of most walls in cold climates. ²	Will not absorb and retain moisture. ⁸	Will absorb moisture and "mat down," losing R-value. Absorbed moisture can wash away the applied fire retardant. Will absorb moisture and hold it until drying conditions occur. ¹⁹
Drying Time Required (Blown-In Applications)	No. ⁹	Yes. ²⁰
Installation Considerations	For blown-in, professional installation is recommended. The installer must use a machine capable of installing fiber glass.	Dry application: Do it yourself. Wet application: Professionally installed using a blowing machine to add water. To prevent fires, heaters and recessed light fixtures must not come in contact with product. ²¹
Recommended Work Practices	For batt and blown-in installations, manufacturers have established recommended work practices. ¹⁰	Industry lacks recommended work practices. NIOSH recommends personal protective equipment.
Reuse³	Yes.	No.
Major Raw Material Components	Recycled glass and sand, a renew- able and abundant resource. ¹¹	Newspapers or wood fiber treat- ed with chemical fire retardant. ²²
Product Testing for Health Safety	Thoroughly tested product. ¹²	Very limited health and safety testing.
Recycled Content	Yes. ¹³	Yes. ²³

Rock/Slag Wool (Mineral Wool)	Cotton	Spray Foams Open Cell	Spray Foams Closed Cell
cost is as important a factor as the other performance attributes listed below. Installed insulation costs vary and the builder will need to cost-effective, high performing, sustainable insulation product to improve the energy and environmental performance of the home.			
R-13 to R-15 ²⁴ R-22 to R-23 ²⁴	R-13 ³⁴ R-19 to R-21 ³⁴	N/A N/A	N/A N/A
R-14.5 R-23	N/A N/A	R-12 to R-13 ⁴² R-19 to R-20 ⁴²	R-19 to R-22 ⁵¹ R-32 to R-35 ⁵¹
Batts: No settling. Blown-In: Virtually no settling. ²⁵ Does not impact R-value.	Batts: No settling.	Shrinkage may occur over time. ⁴³	Shrinkage may occur over time. ⁵²
Naturally fire resistant. ²⁶	Flammable. Must be treated with fire retardants. ³⁵	Can be consumed by flame. Exposed foam should be protected using a 15-minute thermal barrier required when installed in a habitable area. ⁴⁴	Can be consumed by flame. Exposed foam should be protected using a 15-minute thermal barrier required when installed in a habitable area. ⁵³
Non-corrosive. ²⁷	Fire retardant chemicals can cause corrosion. ³⁶	Non-corrosive.	Non-corrosive.
Will not absorb and retain moisture. ²⁸	Can hold up to 15% moisture. Repeated wetting and drying can cause borate treatment to leach out and mold to grow. ³⁷	Can absorb, but not retain moisture. ⁴⁵	Will not absorb and retain moisture. ⁵⁴ Closed cell foams of sufficient thickness do not need vapor retarders.
No. ²⁹	No.	A drying or curing time is required. ⁴⁶	A drying or curing time is required. ⁵⁵
For blown-in, professional installation is recommended. The installer must use a machine capable of installing rock wool. Blows at high speeds.	Do it yourself. ³⁸ Difficult to cut without a motorized cutting tool. ³⁹	Requires professional installation. A fire extinguisher should be close at hand during installation. ⁴⁷	Requires professional installation. A fire extinguisher should be close at hand during installation. ⁵⁶
For batt and blown-in installations, manufacturers have established recommended work practices. ³⁰	Industry lacks recommended work practices available. Use of fire retardants would dictate use of personal protective equipment.	Some manufacturers have recommended work practices. Significant risks dictate use of a full-face air respirator, coveralls with hood, boot covers, gloves for the applicator and the helpers working in the vicinity. ⁴⁸	Some manufacturers have recommended work practices. Significant risks dictate use of a full-face air respirator, coveralls with hood, boot covers, gloves for the applicator and the helpers working in the vicinity. ⁵⁷
Yes.	Yes.	No.	No.
Minerals like basalt or diabase and blast furnace slag. ³¹	Recycled or raw cotton treated with chemical fire retardants. ⁴⁰	Water, HFAs, MDIs, diisocyanates, polyol compounds. ⁴⁹	HCFC and HFA gases, CFCs, MDIs, diisocyanates, polyol resins. ⁵⁸
Thoroughly tested product. ³²	No known health and safety testing.	No known health and safety testing.	No known health and safety testing.
Yes. ³³	Yes. ⁴¹	No. ⁵⁰	No. ⁵⁹

References

General Features

- 1 *Thermal Performance*: Many insulation advertisements make R-value per inch claims. The R-value Rule specifically prohibits such claims with two exceptions: 1) an FTC Cease and Desist Order applies to you but differs from the Rule; and 2) you possess actual test results that prove the R-value per inch of your product does not drop as it gets thicker. R-values are not always linear, and, therefore, an insulation product's thermal resistance may not be accurately represented by reference to the R-value per inch. An advertiser may list a range of R-value per inch. If such a claim is made, the advertiser must state exactly how much the R-value drops with greater thickness and include specific language with the claim. 16 C.F.R § 460.20.
- 2 *Moisture Absorption*: Local building codes likely will require vapor retarders (or materials that retard vapor transmission like vapor retarder paints) to be installed on the "warm-in-winter" side of walls in cold climates except on basement walls, the part of any wall below grade and any wall where moisture or freezing will not damage the materials. Refer to local building codes for specific vapor retarder requirements as they may not be the same as the model building codes.
- 3 *Reuse*: Wet or damaged insulation of any type should not be reused.

Fiber Glass Insulation

- 4 Thermal performance ranges for fiber glass batt insulation in 2x4 and 2x6 walls found in manufacturers data and submittal sheets (2008, 2009).
- 5 U.S. Department of Energy, Energy Efficiency and Renewable Energy, "A Consumer's Guide to Energy Efficiency and Renewable Energy: Loose-Fill Insulation," http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic+11650; Bengt Svennerstedt, "Field Data on Settling in Loose-Fill Thermal Insulation," *Insulation Materials, Testing and Applications*, D.L.McElroy and J.F. Kimpflen, eds. (Philadelphia, PA: ASTM, 1990), pp.231-236.
- 6 Fiberglass is naturally fire resistant but faced insulation will contribute to flame spread unless flame-resistant materials are used. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 131.
- 7 K. Sheppard, R. Weil, and A. Desjarlais, "Corrosiveness of Residential Thermal Insulation Materials under Simulated Service Conditions," *Insulation Materials, Testing and Applications*, D.L. McElroy and J.F. Kimpflen, eds. (Philadelphia, PA: ASTM, 1990), pp. 634-654.
- 8 "Plastic foams, on the other hand, are not particularly liable to absorb moisture and neither are such materials as rock wool, glass fibre, etc.," R.M. E. Diamant, *Insulation of Buildings – Thermal and Acoustic*. (The Chapel River Press, Ltd. 1965), p. 106. Fiberglass and rock wool absorb less than 1 percent of their weight, whereas cellulose absorbs 5-20 percent of its weight. Richard T. Bynam, Jr., *Insulation Handbook* (New York McGraw-Hill, 2001), p. 78.
- 9 Typically fiber glass insulation products will not require any drying time. Certain spray applied fiber glass products may require drying. Consult manufacturer's installation instructions.
- 10 NAIMA has established work practices for installation of fiber glass products.
- 11 Richard T. Bynum, Jr., *Insulation Handbook* (New York McGraw-Hill, 2001), pp. 120. 144. Nelson Shaffer, "The Time of Sands; Quartz Sand Deposits as a Renewable Resource," University of Idaho; *Electronic Green Journal*, Winter 2006.
- 12 As the most thoroughly tested insulation products on the market, fiber glass and rock and slag wool insulation products are well known products and the industry stands behind them as safe to manufacture, install and use when work practices are followed. In contrast, there has been very limited health and safety research on other types of insulation, making the possibility of significant and unexpected health risks far greater as research develops. An inadequately tested or analyzed product should not be deemed safe or free from health risks simply because its manufacturer has refused or failed to test its product. Indeed, failure of a product to be adequately tested by its manufacturer should be a critical factor in determining that a product should NOT be considered for use. Dr. J.M.G. Davis of the Institute of Occupational Medicine Ltd. reaffirms this concept in the following statement: "It is disappointing to find that...some fibre products are being manufactured and promoted as safe when this really means they are untested. A current example of this concerns the increasing use of materials based on cellulose fibres." Davis' statement is equally applicable to all other types of insulation. JMG Davis, "The need for standardized testing procedures for all products capable of liberating respirable fibers: the example of materials based on cellulose," *British Journal of Industrial Medicine*, 1993: 50: 187-190. Fifteen years after this admonishment, cellulose insulation manufacturers have still not adequately tested their products.
- 13 U.S. EPA, "Comprehensive Procurement Guidelines," www.epa.gov/cpg/products/building.htm

Cellulose Insulation

- 14 Thermal performance ranges for cellulose blown-in insulation.
www.southface.org/web/resources&services/publications/factsheets/12insulation.pdf
- 15 U.S. Department of Energy, Energy Efficiency and Renewable Energy, "A Consumer's Guide to Energy Efficiency and Renewable Energy: Loose-Fill Insulation," http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic+11650; Bengt Svennerstedt, "Field Data on Settling in Loose-Fill Thermal Insulation," *Insulation Materials, Testing and Applications*, D.L.McElroy and J.F. Kimpflen, eds. (Philadelphia, PA: ASTM, 1990), pp.231-236.

- 16 Cellulose is naturally flammable. Cellulose insulation manufacturers must apply 20 to 23 percent, by weight, of fire retardants to reduce flammability. After discovering a high rate of failure of cellulose insulation products to pass the U.S. Consumer Product Safety Commission ("CPSC") fire tests (70 to 80 percent of the manufacturers), the CPSC issued a memorandum on a "Chemical Analysis of Cellulose Insulation for Fire Resistant Chemicals." In the "Findings/Conclusions" of the memorandum, the CPSC stated: "We believe that boric acid and borax at a 2 to 1 ratio, added at a rate of 20 to 23 percent by weight, would allow the vast majority of industry to pass the CPSC standard." United States Government Memorandum, "Chemical Analysis of Cellulose Insulation for Fire Retardant Chemicals," July 7, 1981 (emphasis added). Cellulosic thermal insulation materials are typically manufactured from ground waste paper, wood pulp, or waste cotton. These materials are recognized to be easily ignited and to have a potential for fire growth. This study was supported in part by the U.S. Department of Energy. J. Randall Lawson, "Environmental Cycling of Cellulosic Thermal Insulation and Its Influence on Fire Performance," U.S. Department of Commerce, National Bureau of Standards, National Engineering Laboratory, Center for Fire Research, Gaithersburg, MD, August 1984, p. 5.
- "After the materials were exposed to the various environmental cycles, they were tested for fire performance. Result from these tests show that environmental exposure can have a significant effect on the fire performance of cellulosic insulation materials and indicates that long term fire protection provided by fire retardant compounds be limited." Ibid. Cellulose is regulated by the CPSC. In 1978, due to rampant house fires connected to cellulose insulation, Congress enacted the Emergency Interim Consumer Product Safety Standard Act to require the CPSC to adopt an interim federal standard for cellulose insulation. Pub. L. 95-319 (codified at 5 U.S.C. § 2082). The CPSC promulgated regulations mandating labeling of cellulose insulation as a fire hazard, disclosure on cellulose insulation packages of a fire hazard, warning statements, fire testing, and prohibitions on installing the product near heat sources (electric wiring, etc.). See 16 CFR Part 1209.
- 17 According to the CPSC, cellulose fires "may result in serious injuries or death." 16 C.F.R. Part 1404.
- 18 Sarfraz A. Siddiqui, *A Handbook on Cellulose Insulation* (Malabar, Florida: Robert E. Krieger, 1989), p. 76; K. Sheppard, R. Weil, and A. Desjarlais, "Corrosiveness of Residential Thermal Insulation Materials under Simulated Service Conditions," *Insulation Materials, Testing and Applications*, D.L. McElroy and J.F. Kimpflen, eds. (Philadelphia, PA: ASTM, 1990), pp. 634-654.
- 19 Moisture absorption, ranging from 5-20% of its weight, is one disadvantage of cellulose insulation. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 83. <http://www.tntinsulation.ca>: Cellulose insulation is made of shredded newspaper and will absorb moisture. Also, if soaked, cellulose will 'mat' down and thermal performance can be permanently reduced. Assuming existing cellulose does dry after becoming wet, there is a concern that the fire retardant chemicals may 'wash away' leaving insulation materials insufficiently protected. In addition, studies conducted in Canada, New England and Ohio demonstrated that wet-spray applications of cellulose insulation do not achieve their advertised R-value until dry and may take as long as two months to dry. In many cases, wet-spray applications may need to remain uncovered until completely dry. <http://www.house-energy.com/Insulation/Cellulose.htm>: Cellulose insulation can absorb more moisture than most other types of insulation. If wall cavities aren't perfectly dry, or if there is a risk of wetting, then cellulose may favor mildew growth. Well-designed and implemented walls and attics are essential to the use of cellulose insulation. If this isn't possible, then you should look for other solutions.
- 20 "The disadvantage of needing a drying operation with the associated energy requirements should be balanced against the benefits of the process." Sarfraz A. Siddiqui, *A Handbook on Cellulose Insulation* (Malabar, Florida: Robert E. Krieger, 1989), p. 33. See pp. 32-35. ("...Spray insulation takes time to dry and may take as long as a week or more to completely dry out.") Ibid. at p. 34. www.buildernewsmag.com/viewsnews.pl?id=273: Cellulose can be sprayed into the wall cavity dry behind netting or with a fine water mist that allows the material to stick to cavity surfaces, eliminating the need for netting. "Typically it takes 24-48 hours to dry depending on time of year and location."
- 21 Requires pneumatic blowing machines. Heaters and recessed light fixtures must not come in contact with the cellulose insulation. See 16 C.F.R. Part 1404.
- 22 http://www.goodtobegreen.com/res_buildingguide_insulation.aspx: Made of newspaper, borates and ammonium sulfate.
- 23 U.S. EPA, "Comprehensive Procurement Guidelines," www.epa.gov/cpg/products/building.htm

Rock/Slag Wool (Mineral Wool) Insulation

- 24 Thermal performance ranges for rock wool and slag wool insulation in 2x4 and 2x6 walls found in manufacturers data and submittal sheets. (2008, 2009).
- 25 U.S. Department of Energy, Energy Efficiency and Renewable Energy, "A Consumer's Guide to Energy Efficiency and Renewable Energy: Loose-Fill Insulation," http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic+11650; Bengt Svennerstedt, "Field Data on Settling in Loose-Fill Thermal Insulation," *Insulation Materials, Testing and Applications*, D.L. McElroy and J.F. Kimpflen, eds. (Philadelphia, PA: ASTM, 1990), pp.231-236.
- 26 Naturally fire resistant. "The fibers [rock and slag wool] are noncombustible." Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 147.
- 27 K. Sheppard, R. Weil, and A. Desjarlais, "Corrosiveness of Residential Thermal Insulation Materials under Simulated Service Conditions," *Insulation Materials, Testing and Applications*, D.L. McElroy and J.F. Kimpflen, eds. (Philadelphia, PA: ASTM, 1990), pp. 634-654.

References

- 28 "Plastic foams, on the other hand, are not particularly liable to absorb moisture and neither are such materials as rock wool, glass fibre, etc", R.M.E. Diamant, *Insulation of Buildings – Thermal and Acoustic*, (The Chapel River Press, Ltd. 1965), p. 106. Fiberglass and rock wool absorb less than 1 percent of their weight, whereas cellulose absorbs 5-20 percent of its weight. Richard T. Bynum, Jr., *Insulation Handbook* (New York McGraw-Hill, 2001), p. 78.
- 29 Typically rock and slag wool insulation products will not require any drying time. Spray products intended for fireproofing would require drying time.
- 30 NAIMA has established work practices for installation of fiber glass products.
- 31 Slag wool insulation is produced from blast furnace slag, a waste material. Richard T. Bynum, Jr., *Insulation Handbook*; (New York: McGraw-Hill, 2001). p. 144.
- 32 Ibid., 12.
- 33 U.S. EPA, "Comprehensive Procurement Guidelines," www.epa.gov/cpg/products/building.htm

Cotton Insulation

- 34 http://www.coler.com/l4_4asp (02/07/09). <http://www.insulation4less.com/compare.asp> (02/07/09).
- 35 Cotton insulation must be treated with fire retardants. Cotton insulation is flammable. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 149.
- 36 Cotton insulation must be treated with the same type of fire retardants as cellulose insulation. These fire retardants can cause corrosion. Sarfraz A. Siddiqui, *A Handbook on Cellulose Insulation* (Malabar, Florida: Robert E. Krieger, 1989), p. 76. ("Cellulose by itself is non-corrosive. The fire retardant chemicals used with the wrong ration of chemical or if not buffered may be corrosive.") See also Flowserve Corporation, "Worcester Controls Corrosion Data," www.flowserve.com, Document #FCD WCATBOOO2-00 (C12-7).
- 37 Build It Green, "Cotton Insulation," Oct. 2005. www.builditgreen.org/webfm_send/64
- 38 Cotton fibers are significantly tougher than glass fibers, making cutting with a knife difficult. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 149.
- 39 Energy Design Update; "Problems Installing Cotton Insulation," Tristan Korthales Attes, August 2008.
- 40 http://www.goodtobegreen.com/res_buildingguide_insulation.aspx: Predominantly cotton insulation comes from post-industrial recycled cotton textiles, such as denim. http://www.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11560: Cotton insulation consists of recycled content that has been treated with chemical fire retardants.
- 41 U.S. EPA, "Comprehensive Procurement Guidelines," www.epa.gov/cpg/products/building.htm

Spray Foams Open Cell Insulation

- 42 Thermal performance ranges for open and closed cell foam spray-in insulation for 2x4 and 2x6 walls found in manufacturers data and submittal sheets (2009). In addition, calculations made by taking the R-value per inch value that is contained in the *ASHRAE Handbook of Fundamentals*, page 25.6 - 2005 edition. R-value table from www.coloradoenergy.org/procorner/stuff/r-values.htm
- 43 Foams are not UV stable and can be biodegraded by sunlight. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001) p. 195. Elastomeric coating is required to stop the foam from degrading. Degradation compromises the thermal performance. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 195. Foams tend to shrink over time. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), P. 199. Improper equipment use can cause shrinkage. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 200. Maximum shrinkage is 1/8 inch in a wall cavity. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 200.
- 44 Spray foam can be consumed by flame. Building codes require a 15-minute thermal barrier when spray foam is installed in a habitable area. Exposed foam is a potential risk and should be protected from open flames during construction. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), pp. 191, 195.
- 45 Statement made in several manufacturers data sheets.
- 46 "The disadvantage of needing a drying operation with the associated energy requirements should be balanced against the benefits of the process." Sarfraz A. Siddiqui, *A Handbook on Cellulose Insulation* (Malabar, Florida: Robert E. Krieger, 1989), p. 33. See pp. 32-35. ("...Spray insulation takes time to dry and may take as long as a week or more to completely dry out.") Ibid. at p. 34.

- 47 Spray foams can't be installed within 5° of the dew point; None of the surfaces can exhibit frost or water or thermal performance will be reduced; Poor mixing of chemicals and erratic spraying pattern results in uneven thickness which delivers inferior thermal performance; Equipment may clog and deliver inadequate spray pattern. Spraying too thick in a single application may cause the foam to char or result in a fire; Fire restraint tools should be available on the jobsite; During installation, there is a potential for the foam spray to ignite due to static electricity or other electrical sources; If the foam is sprayed too thick in one pass, the heat generation can result in combustion; A complex combination of equipment is required for applying spray foam insulation: Transfer pump – this sometimes requires a pressure tank with Nitrogen; Proportioning pump – 4 cylinders – 2 of which must move in unison to feed the heater system. Any imbalance in pressure or fluctuation of temperature will result in poor mixing and a product that does not deliver; All equipment must be cleaned and recalibrated after each use to insure quality installation of product. Truck hauling all this equipment must be partitioned in separate compartments with temperature controlled. SPFA Contractor Safety and Product Stewardship Program, Spray Polyurethane Foam Alliance, Fairfax, Virginia.
- 48 Brian F. Karlovich CIH, SSP, CPA/SPF Spray Polyurethane Foam Insulation Emissions Testing Project Update – Air Monitoring Investigation – SPF Installation in Residential Structures, presented a Spray Foam 2009, January 2009, Austin, TX.
- 49 Mason Knowles, "Learning the difference between ½-lb and 2-lb spray polyurethane foam," *Modern Materials*, Nov. 2004, pp 14-17. SPFs rely on HCFS (hydrochlorofluorocarbons) and HFCs (hydrofluorocarbons) as a blowing agent. OSHA Letter to NAIMA, September 15, 2008, Spray foam products contain MDIs (methylene bisphenyl isocyanates), according to OSHA, "occupational exposure to MDI can result in respiratory and skin sensitization as well as other deleterious effects." See NIOSH "Preventing Asthma and Death from Diisocyanate Exposure," <http://198.246.98.211/niosh/asthma.html>
- 50 U.S. EPA, "Comprehensive Procurement Guidelines," www.epa.gov/cpg/products/building.htm

Spray Foams Closed Cell Insulation

- 51 Thermal performance ranges for open and closed cell foam spray-in insulation for 2x4 and 2x6 walls found in manufacturers data and submittal sheets (2009). In addition, calculations made by taking the R-value per inch value that is contained in the *ASHRAE Handbook of Fundamentals*, page 25.6 - 2005 edition. R-value table from www.coloradoenergy.org/procorner/stuff/r-values.htm
- 52 Foams are not UV stable and can be biodegraded by sunlight. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001) p. 195. Elastomeric coating is required to stop the foam from degrading. Degradation compromises the thermal performance. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 195. Foams tend to shrink over time. Richard T. Bynam, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), P. 199. Improper equipment use can cause shrinkage. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 200. Maximum shrinkage is 1/8 inch in a wall cavity. Richard T. Bynam, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), p. 200.
- 53 Spray foam can be consumed by flame. Building codes require a 15-minute thermal barrier when spray foam is installed in a habitable area. Exposed foam is a potential risk and should be protected from open flames during construction. Richard T. Bynum, Jr., *Insulation Handbook* (New York: McGraw-Hill, 2001), pp. 191, 195.
- 54 Statement made in several manufacturers data sheets.
- 55 "The disadvantage of needing a drying operation with the associated energy requirements should be balanced against the benefits of the process." Sarfraz A. Siddiqui, *A Handbook on Cellulose Insulation* (Malabar, Florida: Robert E. Krieger, 1989), p. 33. See pp. 32-35. ("...Spray insulation takes time to dry and may take as long as a week or more to completely dry out.") Ibid. at p. 34.
- 56 Ibid., 48.
- 57 Ibid., 49.
- 58 Mason Knowles, "Learning the difference between ½-lb and 2-lb spray polyurethane foam," *Modern Materials*, Nov. 2004, pp 14-17. SPFs rely on HCFS (hydrochlorofluorocarbons) and HFCs (hydrofluorocarbons) as a blowing agent. OSHA Letter to NAIMA, September 15, 2008, Spray foam products contain MDIs (methylene bisphenyl isocyanates), according to OSHA, "occupational exposure to MDI can result in respiratory and skin sensitization as well as other deleterious effects." See NIOSH "Preventing Asthma and Death from Diisocyanate Exposure," <http://198.246.98.211/niosh/asthma.html>
- 59 U.S. EPA, "Comprehensive Procurement Guidelines," www.epa.gov/cpg/products/building.htm

About NAIMA

NAIMA is the association for North American manufacturers of fiber glass, rock wool, and slag wool insulation products. Its role is to promote energy efficiency and environmental preservation through the use of fiber glass, rock wool, and slag wool insulation, and to encourage the safe production and use of these materials.

NAIMA, continuing its members' commitment to safety has established a renewed Product Stewardship Program, which embodies the components of the earlier OSHA-NAIMA Health and Safety Partnership Program (HSPP). The HSPP was a comprehensive eight-year partnership with OSHA, which NAIMA completed in May 2007, and now NAIMA incorporates these safe work practices into NAIMA's Product Stewardship Program.

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