NAIMA CANADA

# Building Insulation

## A Performance Comparison for Today's Environmental Home Builder & Renovation Project

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

*Making a World of Difference*

www.naimacanada.ca

# The Most Sustainable Energy is Saved Energy

Insulation—when installed into a home, commercial, institutional or industrial building— provides an environment where you can live, work and play in comfort, all while reducing your energy consumption. This is especially important considering our varied and sometimes extreme weather conditions across Canada.

## RESIDENTIAL

Insulation is one of the most important, cost-effective, energy-saving building materials in a home. In fact, without the insulation, some of the other energy-efficient components in a home won't perform as intended.

Insulation is used as a thermal and acoustical solution in the walls, ceilings, floors, and attics of a home or every part of the building envelope.

Insulation keeps your home cooler in the summer and warmer in the winter. Insulation in a home saves energy and is perhaps the most cost-effective way to lower energy bills. Insulation reduces noise and adds to the quality and comfort of your home.

Whether you're building a new home, renovating a room, cottage, basement, attic or entire home, select an insulation that is 'installer friendly' — one that anyone can do safely.

## COMMERCIAL

Insulation systems are used extensively in commercial, institutional and metal buildings as a solution to reduce the rate of heat transfer through the roofs and sidewalls.

Board, blanket and batt insulation also installed on and within the interior walls, reduces the transmission of room-to-room noise. Insulation is used on chilled water piping, HVAC ducts and equipment for thermal, sound, condensation and process control.

Insulating saves energy and helps reduce greenhouse gas emissions.

## INDUSTRIAL

Insulation is used to insulate HVAC ducts and equipment, process piping, industrial equipment, tanks and vessels found in power plants, petrochemical plants, refineries and other industrial applications.

These insulation systems are carefully specified to reduce energy costs, enhance process performance, reduce greenhouse gas emissions, protect personnel, control condensation, reduce noise levels and to maximize a return on investment.

## Why We Insulate Our Homes

One of the most important and cost-effective energy saving materials in our home is the insulation. It quietly performs some remarkable functions despite the fact most of us never see it, or know that it is working day in and day out saving us energy and keeping us comfortable.

Insulation keeps our homes warm in winter and cool in summer. In fact, it works so well that comfort is something that many now take for granted. The insulation system also helps the heating and cooling equipment perform better and more efficiently. It keeps our homes quieter, it provides a healthier environment, and insulation keeps our energy bills down.

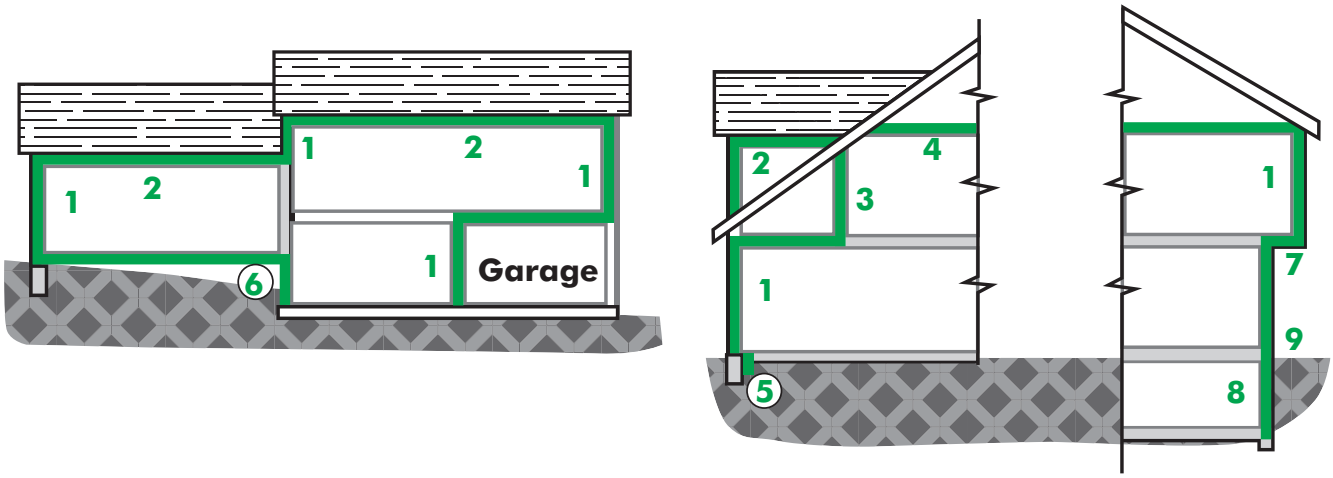
Reducing energy costs is one of the top reasons homeowners are reassessing the insulation in their homes. Whether building a new home, or renovating your current one, the selection of your insulation system warrants some serious attention.

Adding insulation can offer you a lifetime of energy savings while improving the energy efficiency and comfort to your home.

*Insulation will bring you comfort and savings for the life of the home.*

## Where We Should Insulate

Generally insulation is installed between the framing members in the home. Walls, ceilings, floors around the perimeter, basements, attics and even interior rooms of the home.




1. Exterior walls. Sections sometimes overlooked are walls between living spaces and unheated garages or storage rooms, dormer walls, and the portions of walls above ceilings of adjacent lowers sections of split-level homes.
2. Ceilings with cold spaces above, including dormer ceilings.
3. Knee walls of attic spaces finished as living quarters.
4. Sloped walls and ceilings of attic spaces finished as living quarters.
5. Perimeters of slabs on grade.
6. Floors above vented crawlspaces. Insulation may also be placed on crawlspace floors and walls.
7. Floors over unheated or open spaces such as over garages or porches. Floors over unheated basements. The cantilevered portions of floors.
8. Basement walls.
9. Band or header joists, the wall sections at floor levels.
10. Interior walls, ceilings and floors where sound control is desired, (not shown).

# Selecting the Right Insulation

While some insulation products lend themselves better to the do-it-yourselfer, it is generally recommended that a professional or certified insulation contractor perform the insulation work. As the consumer, however, you need to be informed about the types of insulation available, their rated thermal performance, their ease of application, the impact the installation will have on your family while the work is being done and of course, their value. You should also consider the overall lifetime performance of the insulation, its environmental features, and any safety-related considerations.

## Fibre Glass Insulation – Batts, Rolls or Blown-in

Fibre glass batts or rolls are made from sand and glass and then melted and spun into wool-like fibres. They are then manufactured into batt or roll insulation that is supplied either with or without facings. Fibre glass loose-fill (blown-in) insulation is available in two forms – either processed from a by-product of manufacturing batts or rolls, or from "prime" fibres produced especially for blowing applications. It is applied through pneumatic means using a mechanical blowing machine. Fibre glass insulation is naturally non-combustible.

**Application:**
Fibre glass batts are available in pre-cut sizes that fit standard wall cavities. They can also be easily cut to fit any size cavity and small spaces. Installing batts requires nothing more than a cutting tool, staples and a hammer. For comfort, some may choose to use personal protection equipment such as gloves, long sleeves, and a dust mask. Fibre glass blown-in insulation is applied through pneumatic means using a mechanical blowing machine. There is no curing or drying time needed. Other trades or homeowners do not need to leave the premises during installation.

## Rock Wool and Slag Wool Insulation

Rock wool and slag wool insulation is comprised of basically the same raw materials but in different proportions, and are produced in the same ways. Manufacturers use a mechanized process to spin a molten composition of rock and slag into high temperature-resistant fibres. Their similar properties also produce fairly similar performance attributes. The major difference is in the specific volumes of the various raw materials used to make each product.

Rock wool insulation is composed principally of fibres manufactured from a combination of aluminosilicate rock (usually basalt), blast furnace slag and limestone or dolomite. Slag is a byproduct from steel production that would otherwise wind up in landfills. Binders may or may not be used, depending on the product. Typically, rock wool insulation is comprised of a minimum of 70-75% natural rock.

Slag wool insulation is composed principally from fibres manufactured by melting blast furnace slag, with a combination of inorganic additives, with or without binders, depending on the product. Some natural rock is also used. Typically, slag wool insulation uses a minimum of 70 - 85 percent blast furnace slag, with the remaining volume of raw materials being natural rock.

**Application:**
Rock and slag wook batts are available in pre-cut sizes that fit standard wall cavities and wall heights. They can also be easily cut to fit any size cavity and small spaces. Installing batts requires nothing more than a cutting tool. Rock and slag wool can be either blown-in using a mechanical blowing machine, or poured in place. There is no curing or drying time needed. Other trades or homeowners do not need to leave the premises during installation.

## Cellulose Insulation

Cellulose insulation is made of ground-up or shredded newspaper that is naturally combustible. In fact, cellulose insulation is regulated as a potential fire hazard by the Consumer Product Safety Commission (CPSC).[1] To protect against fire hazards, cellulose insulation is heavily treated with fire-retardant chemicals prior to installation.[2]

**Application:**
Dry loose-fill cellulose insulation is installed in attics and walls with pneumatic blowing machines. Existing walls may be insulated by blowing insulation in through access holes. Cellulose insulation spray-applied in wet form is a self-supporting material. It relies on water, adhesive, or a combination of both to build bond strength to a "substrate and within itself". Spray-on products may be used in wall cavities (fully open and dried before covering) or on other suitable exposed wall or overhead surfaces.[3] A critical factor in using wet spray insulation is allowing proper drying time after installation. Ideally, the wall cavity should be completely dry before installing drywall. Industry and manufacturer guidelines often note a normal drying time of 24-48 hours. However, actual drying time can take significantly more time.[4]

## Spray Foam Insulation (SPF)

Most spray polyurethane foam plastic insulations are "two-component" foams. Basically, the two ingredients are mixed onsite using special equipment. Heated hoses convey the components to a mixing gun that then sprays the chemicals on the surfaces to be insulated. A chemical reaction begins as soon as the chemical are mixed. The liquid mixture forms, expands and eventually solidifies in place. Removal of the insulation once it is in place is considered difficult.

**Application:**
Spray polyurethane foam is usually installed by a specialty spray-foam contractor equipped with a truck or trailer to carry the necessary chemicals and spray equipment. When the foam insulation is sprayed, it coats the surface and quickly expands as it solidifies. Excess insulation, from over expansion, must be then trimmed, sawed or cut away to fit the cavities.

The curing time (complete reaction) varies depending on the type of SPF product, product formulation, applicator technique, foam thickness, temperature, humidity and other factors, which will impact re-occupancy time. Cutting or trimming foam before it is fully cured may cause exposure to unreacted SPF chemicals. Homeowners and other decision-makers should get clear guidance from contractors, system houses, and product manufacturers on the appropriate time of year to install SPF in your area or weather conditions that may impact the installation of SPF. Temperature and humidity play a critical role in the curing of SPF ingredients.[5]

**Air Sealing is a Must!**
Prior to insulating, caulk and seal all sill plates, band joists, penetrations, joints and other areas where air infiltration might occur. Research shows that an effective air barrier is essential to achieving an efficient building envelope regardless of insulation type.

Insulation alone is no substitute for proper sealing and the prevention of air infiltration.

1 16 C.F.R. Part 1209 and 16 C.F.R. Part 1404.

2 Donald W. Belles and Associates, Inc., "Loose-Fill Cellulose Insulation – An Aging Problem," *J. Applied Fire Science*, Vol. 30, 295-303, 1993-94; Mark McLees, "'Going Green' May Make You 'See Red,'" *Firehouse*, June 2008.

3 CIMA Technical Bulletin #1: Cellulose Insulation: Codes, Regulations & Specifications

4 ZIP System® Wall Technical Bulletin: ZIP System Wall Panels and Wet Sprayed Cellulose Insulation, Mikael Salonvaara, Huber Engineered Woods, R&D, Building Science.

5 Design for the Environment, An EPA Partnership Program: Spray Polyurethane Foam (SPF) Home: Curing Rates of SPF Affect Re-Entry Times: http://www.epa.gov/dfe/pubs/projects/spf/exposure_potential.html#curingrates

# Building Insulation — A Performance Comparison for Today's Environmental Home Builder and Renovation Project

| Features | Fibre 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 Performance**[1]<br>***R-value ranges - Batts***<br>**2 x 4 wall (3.5")**<br>**2 x 6 wall (5.5")** | <br><br>R-12 to R-15[4]<br>R-12 to R-24[4] | <br><br>N/A<br>N/A |
| **Thermal Performance**<br>***R-value ranges - Blown-In***<br>**2 x 4 wall (3.5")**<br>**2 x 6 wall (5.5")** | <br><br>R-13 to R-15<br>R-20 to R-23 | <br><br>R-12 to R-13[14]<br>R-19 to R-20[14] |
| **Settling** | Batts: No settling<br>Blown-In:<br>Virtually no settling.<br>Does not impact R value.[5] | Batts: N/A<br>Blown-In: (Dry)<br>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**<br>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.<br>Absorbed moisture can wash away the applied fire retardant.<br>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 fibre glass. | Dry application: Do it yourself.<br>Wet application: Professionally installed using a blowing machine to add water.<br>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. |
| **Reuse**[3] | Yes. | No. |
| **Major Raw Material Components** | Recycled glass and sand, a renewable and abundant resource.[11] | Newspapers or wood fibre treated 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-12 to R-15[24]<br>R-12 to R-24[24] | R-13[34]<br>R-19 to R-21[34] | N/A<br>N/A | N/A<br>N/A |
| R-14.5<br>R-23 | N/A<br>N/A | R-12 to R-13[42]<br>R-19 to R-20[42] | R-19 to R-22[51]<br>R-32 to R-35[51] |
| Batts: No settling.<br>Blown-In:<br>Virtually no settling.[25]<br>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]<br>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. Some grades can be poured, as opposed to blown. | Do it yourself.[38]<br>Difficult to cut without a motorized cutting tool.[39] | Requires professional installation.<br>A fire extinguisher should be close at hand during installation.[47] | Requires professional installation.<br>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 saftey testing. | No known health and saftey 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.

## Fibre Glass Insulation

4 Thermal performance ranges for fibre 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 Fibreglass 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. Fibreglass 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 fibre glass insulation products will not require any drying time. Certain spray applied fibre glass products may require drying. Consult manufacturer's installation instructions.

10 NAIMA has established work practices for installation of fibre 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, fibre 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 fibres: 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 Customer 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 CPCS, 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 date 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 fibres [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. Fibreglass 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.

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 fibre 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 fibres are significantly tougher than glass fibres, 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. 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.

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

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Fibre glass, rock wool, and slag wool insulation provides excellent environmental benefits making them the leading choice for sustainable construction. Their fibrous composition provides superior insulating performance, design flexibility and product versatility not found in any other type of insulation in the market today — making them the product of choice for a wide variety of residential, commercial and industrial applications.

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### Fibre Glass, Rock Wool & Slag Wool Insulation
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1 "Since the development of fibre glass in the 1930s it has been used in 90% of homes in the U.S. that contain insulation" Glen Wilkinson, "Beyond R-Value: Insulating for the Environment," *Environmental, Design and Construction Magazine* (January-February 1999):28.

2 "Air Infiltration of Wood Frame Walls," *NAHB Research Center*, p. 10 May 2009.

## NAIMA CANADA

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

### For more information, contact us at:

150 Laurier Ave. W., Suite 500
Ottawa ON K1P 5J4
Phone: 613-232-8093 • Fax: 613-232-9149
contact@naimacanada.ca

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