USE OF COVER BOARDS OVER POLYISOCYANURATE ROOF INSULATION

BULLETIN 2000-3, MARCH 2000

NRCA has received a significant number of reports of problems associated with the use of polyisocyanurate roof insulation, although it is important to note that the vast majority of roof assemblies that include polyisocyanurate insulation have performed successfully. However, the reported problems often involve large roof areas, where remedies can be quite expensive. The majority of the reported problems have occurred in low-slope membrane roof assemblies where a cover board layer of insulation was not included in the design.

According to the Polyisocyanurate Insulation Manufacturers Association (PIMA), more than 4.5 billion board feet of polyisocyanurate foam insulation were produced in the United States in 1999. A reasonable estimate is that at least 2.5 billion board feet were installed in low-slope membrane roof assemblies, which represents, according to NRCA market survey data, about 55 percent of the market for insulation used in low-slope membrane roof systems.

Polyisocyanurate roof insulation can exhibit problems in several different ways. These include:

- Facer-sheet delamination
- Edge cavitation
- Cupping or bowing
- Shrinkage
- Crushing or powdering

These characteristics are discussed more fully in an attachment to this bulletin.

NRCA has previously recommended the use of cover boards over polyisocyanurate insulation where hot-applied bituminous membranes are installed. This recommendation is included in *The NRCA Roofing and Waterproofing Manual, Fourth Edition*, and was the subject of NRCA Technical Bulletin 9, "NRCA Statement on Polyisocyanurate, Polyurethane and Phenolic Foam Roof Insulations," dated September 1988. NRCA is now expanding its recommendation for the use of cover boards to include all other low-slope membrane roof assemblies, including thermoset and thermoplastic single-ply roof assemblies in ballasted, mechanically attached and fully adhered configurations.

In addition, NRCA has separately reported (in a report issued May 24, 1999) concerns with the U.S. material standard for polyisocyanurate roof insulation, ASTM C 1289, "Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board." For example, the standard does not establish a requirement for curing time prior to shipment, and NRCA believes that improperly cured polyisocyanurate insulation is more prone to experience problems. Similarly, NRCA has recommended changes in the standard's values for compressive strength, dimensional stability and R-value determination.

NRCA has had a number of discussions with polyisocyanurate insulation manufacturers and PIMA addressing these issues. NRCA has also been actively working to improve ASTM C 1289, and intends to continue to do so, by working, where appropriate, in cooperation with individual polyisocyanurate insulation manufacturers and with PIMA.

Given NRCA's concerns with shortcomings in ASTM C 1289 and reported problems experienced in the field, NRCA recommends that designers specify a suitable cover board over polyisocyanurate insulation in all low-slope membrane roof systems. The use of a cover board should help to reduce problems whether directly related to the manufacturing process or due to other causes.

Further, polyisocyanurate roof insulation is often specified because of its fire-resistance properties. There are occasions, however, when the use of a cover board may be required to achieve a fire-resistance classification for a roof assembly, and the use of certain types of cover boards can generally improve the fire-resistance properties of roof assemblies that include polyisocyanurate insulation.

Insulation cover boards should be a minimum ½" (13 mm) thick and be composed of any of the following:

- glass-faced siliconized gypsum board
- perlite board
- wood-fiber board
- glass-fiber board
- mineral-fiber board

When selecting a specific suitable cover board, designers should consider the characteristics of the specific roof assembly, and take into account the cover board's compatibility with the assembly.

Using a suitable cover board over polyisocyanurate insulation in low-slope membrane roof assemblies provides the following attributes:

- It separates the membrane from the polyisocyanurate insulation, reducing the possible effects of facer-sheet delamination, edge cavitation, cupping or bowing, shrinkage and crushing or powdering of the polyisocyanurate insulation.
- It allows for installation of the insulation board layers with staggered board joints, a practice known to reduce stresses on the membrane and improve a roof assembly's overall thermal performance.
- It may be required to achieve a fire-resistance classification for a roof assembly.

ATTACHMENT TO TECHNICAL BULLETIN 2000-3, MARCH 2000

CHARACTERISTICS OF PROBLEMS REPORTED WITH
POLYISOCYANURATE ROOF INSULATION

Facer-Sheet Delamination is the separation of the facer sheet, which is typically a roofing felt made with glass fibers or composite materials, from the polyisocyanurate foam core. This can result from the manufacturing process if the foam is off proper ratio; the foam cells can become elongated and therefore not as strong as cells produced with proper ratios. Facer-sheet delamination can also result from concentrated and/or repetitive traffic on the insulation's surface. Facer-sheet delamination caused by concentrated and/or repetitive traffic typically will exhibit crushed cells immediately below the interface of the foam and facer sheet. When facer-sheet delamination is caused by concentrated and/or repetitive traffic, the affected area generally will be limited to the traffic area(s) only and not other portions of the roof.

Edge Cavitation is a condition in which the exterior edges of insulation boards exhibit concave depressions. Edge cavitation is generally believed to be a manufacturing defect that once was associated most frequently with the change in blowing agents that occurred in the early 1990s; however, it is still reported occasionally.

Currently, edge cavitation is caused most often when a minor amount of water is used as an ingredient in the manufacturing process. Small amounts of water sometimes are added during the manufacturing process to generate carbon dioxide as a co-blowing agent. The carbon dioxide can be useful in improving some of the foam's physical properties. When changes were first made in the blowing agent, it was not known that the blowing agent (HCFC 141b) had a greater tendency to dissolve in the foam's polymer matrix than the previous blowing agent (CFC-11). If a significant amount of the blowing agent dissolves into the cell walls, the walls are weakened.

Also, the chemical reaction between the components in the production of foam produces heat, with the temperature within the foam reaching up to 300 F (149 C) during manufacturing and curing. The high reaction temperatures cause the gas pressure within the cells to be less than the ambient atmospheric pressure when the product cools. If carbon dioxide is present (e.g., as the result of using a small amount of water in the process), the carbon dioxide will diffuse out of the cells faster than the air components diffuse into the cells, magnifying the pressure differential between the foam cells and the environment.

The combination of weakened cell walls and great pressure differential creates elongated cells that are too weak for the board's thickness. This occurs most rapidly at the board's edges, resulting in poor foam structure and board edge cavitation.

Cupping or Bowing can be caused by an off-ratio mix, a manufacturing defect that creates distorted cell structures that are distributed unevenly within the foam's thickness. The uneven distribution of the cells creates inherent dimensional instability and will exhibit substantially different compressive strength values in the board's length, width and thickness. When placed under load, the board will resist the load differently, resulting in cupping or bowing.

Cupping or bowing also can occur when one of the board's facers gets wet. As the facer dries, that side of the board shrinks, which exerts unbalanced forces within the board. The top surface of the top board in a bundle also can become wet if the insulation is not properly protected from precipitation. When this happens, these boards may become cupped.

Cupping of boards as a result of exposure to precipitation typically is the result of inadequate packaging of the insulation bundles at the manufacturing site or inadequate material handling, storage or application. The cupped boards that result from wetness generally will appear in random locations throughout the roof. It would be unusual for all the boards in any bundle of insulation to be wet only on their top surfaces.

Shrinkage of insulation boards generally is associated with an off-ratio foam mix. However, ASTM C 1289 allows up to a 4 percent linear change, representing the product's dimensional stability when conditioned at 158 F (70 C) and 97 percent relative humidity for seven days.

The ASTM methodology involves small-scale tests. However, if the standard is applied to a typical 4-foot by 8-foot (1.2 x 2.4 m) polyisocyanurate insulation board, it would allow for shrinkage or expansion of up to 3.8 inches (97 mm) in the long dimension. Even modest shrinkage can result in relatively wide gaps between tightly-butted insulation boards, which can impact roof system performance.

Crushing or Powdering sometimes is attributable to an off-ratio mix that is too rich in isocyanate, resulting in foam that is too brittle. Even minor loads on the insulation's surface, including normal roof system installation traffic, can crush the foam and turn it to powder if the mix is off ratio. This also can cause the facer sheet to delaminate from the foam core.

Crushing or powdering also can be caused by concentrated and/or repetitive traffic on the insulation's or membrane's surface. This condition usually will be confined only to high traffic areas, rather than other portions of the roof.