SPF Proves Its Worth

A Look at the Real-world Performance of Spray Polyurethane Foam Roofing Systems

By Tom Harris

SPF manufacturers, equipment manufacturers and trade groups have made a commitment to quality control through training and education in the SPF industry, including hands-on and theoretical training programs.

Spray Polyurethane Foam (SPF) roofing systems have been around since the 1960s. Yet as recently as the late 1980s, the technology was considered "alternative" and far outside the mainstream of roofing.

Today, the "alternative" label has been shed, and the National Roofing Contractors Association (NRCA) has accepted SPF as a viable system and includes it in its standards and manuals. However, the perception remains that SPF systems are problematic. One member of the Roofing Consultants Institute recently estimated that 50 percent of his peers "would go out of their way to avoid SPF." That attitude is reflected in SPF's market share: 1.3% in the new construction market and 2.8% for the retrofit roofing market.[1]

However, the real world performance of SPF roofing systems refutes the perceptions and market share numbers. Perhaps it is time for us to take another look at SPF.

Basic Performance

In the mid 1990s, the National Roofing Foundation commissioned Structural Research Inc. of Middleton, Wisconsin, to perform an independent field and laborato-

ry assessment of SPF roof systems to establish and verify existing performance attributes.

The study included the inspection of 140 SPF roofs with acrylic, silicone, and urethane coatings, ranging in age from 6 months to 27 years (median age 10.5 years, average age 11 years). Four climates were included in the study: hot, humid summers with moderate winters (Texas); hot, dry summers with wet, cool winters (California); moderate to hot summers with very cold winter temperatures and heavy snow and ice (Illinois and Wisconsin); and moderate to hot summers, cold and damp winters (New York). Key findings include:[2]

- **Compressive Strength (determined using ASTM D 1621) –** the average compressive strength for all samples was 404 kPa (58.6 psi); highest compressive strength was 685 kPa (99.3 psi) from a New York location installed in 1975 with silicone coating. Minimum required compressive strength for SPF roofs is 276 kPa (40 psi).[3]
- **Apparent Core Density (determined using ASTM D 1622) –** the average apparent core density was 51.6 kg/m^3 (3.22 pcf) for all samples; highest apparent core density was 78.0 kg/m^3 (4.87 pcf) from a location in northwestern Wisconsin installed in 1974; the lowest apparent core density was 30.1 kg/m^3 (1.88 pcf). Dr. René M. Dupuis of Structural Research Inc. noted in his report that recommended minimum foam densities had risen over the years, to a minimum of 44.9 kg/m^3 (2.8 pcf) in the 1990s. The newest SPF roof in the study had a core density of 64.1 kg/m^3 (4.0 pcf) with a compressive strength of 448 kPa (65 psi). The oldest had a density of 56.4 kg/m^3 (3.52 pcf), with a compressive strength of 685 kPa (99.3 psi).
- **Moisture Content Values (determined by oven-drying samples at 50˚C [122(F]) –** average moisture content was 1.02 percent by weight. Dr. Dupuis noted that the physical properties of the evaluated roofs were positive regardless of the age of the installation and that these properties point to the durability of SPF.

The Human Factor

No roofing system – regardless of the technology involved – will provide long-term performance unless it is installed properly. The construction industry is one of the riskiest endeavors in the United States in terms of business failures. From 1990-1997, over 80,000 contractors failed, leaving behind $21.8 billion in liabilities.[4]

A possible reason for this high failure rate among contractors is found in a survey conducted by *Engineering News Record (ENR)*: 42% of the projects surveyed finished late, 33% were over budget, 13% had pending claims, and only 53% of the owners would ever use the same contractor again.[5]

Low-bid awarding of contracts, poor workmanship, poor-quality or insufficient training, and minimal attention to customer service can all take partial blame for this abysmal showing by the contractor community in this study.

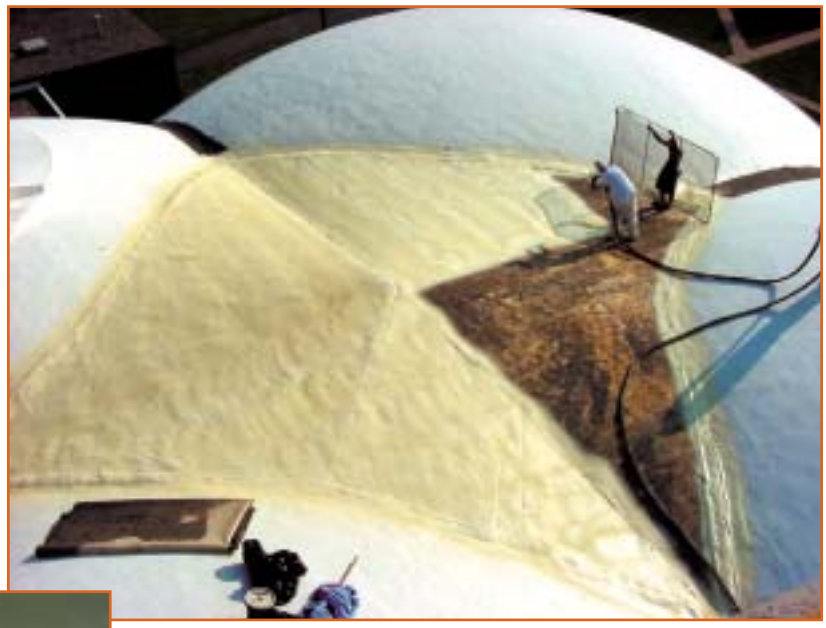
SPF manufacturers, equipment manufacturers, NRCA, RCI, the Society for Protective Coatings, and the Spray Polyurethane Foam Alliance (SPFA, www.sprayfoam.org) have all made a commitment to quality control through training and education in the SPF industry. The SPFA Accreditation Program provides the industry with up-to-date training in the application of spray polyurethane foams, coatings, and good business practices.

State-of-the-art training facilities (such as the SPF Center in Hudson Falls, New York) offer hands-on and theoretical training programs from the history of SPF roofing to final inspection of a new roof, including chemicals, safety, equipment, construction details, application techniques, and maintenance.

The joint training efforts of trade groups, associations, and manufacturers have contributed to a reduction of over 60% in the typical failure modes of early SPF roofs.

Another contributing factor to quality control is third-party inspection of installed roofs. Independent inspectors measure new installations against minimum standards: surface texture, foam thickness and consistency, coating thickness and consistency, and evidence of ponding (< 10 x 10 feet of ponded water, 48 hours+ after rainfall). Deviations are subtracted from the score.

One major SPF manufacturer currently shows 3,076 roofs with an inspection score of 10 out of 10 in its warranty database. Analysis of the same manufacturer's warranty database indicates current failure modes such as blistering have dropped by over 60%



Above: One leading SPF manufacturer reports that its system has been installed directly on top of existing substrate in 95 out of 100 reroofing projects, eliminating costly tear-off, landfill fees, interior exposure, and down time.

Left: SPF roofs are seamless and self-flashing for improved resistance to lifting and peeling failure during high wind events. The SPFA reports that SPF's wind uplift resistance exceeded the capacity of UL's equipment during testing.

New application technologies, such as the RoboRoofer (left and below), have contributed to a reduction of familiar failure modes such as blistering and cracking at edge details.

and cracking at edge details has been reduced by over 80% in recent years.

The ALPHA System

The Performance Based Studies Research Group (PBSRG, www.pbsrg.com) was developed by Dr. Dean Kashiwagi at Arizona State University's Del E. Webb School of Construction in 1994. The PBSRG, a non-profit research group, developed the ALPHA Research Project to analyze performance information and identify high performance roofing systems, specialty contractors, and facility systems in the construction industry.

For the purposes of the ALPHA project, an "ALPHA Roof System" is defined as any low-slope roofing system with a documented performance that meets or exceeds that of a conventional, 20-year life-expectancy, low-slope, built-up roof (BUR) assembly.

The program is open to all roofing systems. Any manufacturer, product, or group of contractors that can demonstrate – when randomly sampled by PBSRG every other year – that 98% of its customers are satisfied with their roofs, 98% of their roofs don't leak, and are willing to have all newly installed roofs over 5,000ft^2 surveyed yearly, qualifies for inclusion in the program.

Since its inception in 1996, only one system has qualified for ALPHA: Spray Polyurethane Foam.

There are ten ALPHA contractors across the United States. To date:

- 484 roofs have been inspected.
- 341 customer responses have been received.
- The oldest installation is 30 years old.
- The average installation is 10 years old.
- 99% of the jobs are completed on time.
- 99% of the roofs do not leak.
- 99% of the customers are satisfied.
- The average contractor performance rating is 9.7 out of 10.

The ALPHA system offers a 15-year warranty with almost no exclusions.

In the mid 1990s, a National Roofing Foundation-commissioned independent field and laboratory assessment of SPF roof systems showed that the physical properties of the evaluated roofs were positive, regardless of age, and that these properties point to the durability of SPF.

Storm Warning

Inclement weather is the toughest test for any roof system. Underwriters Laboratories (UL) and FM Global test various roofing systems for wind uplift performance and then publish the results in their directories. Designers can then look for systems that meet the UL designations class 30, class 60, and class 90 or FM1-60, FM1-90, or higher where needed.

The SPFA reports that, during laboratory testing of SPF systems, SPF's wind uplift resistance exceeded the capacity of UL's equipment. UL also observed that SPF roofs applied over BUR and metal increased the wind uplift resistance of those roof coverings. FM Global testing showed similar results over concrete, metal, and wood.

In addition to high wind uplift resistance, SPF roof systems are resistant to progressive peeling failure due to missile impact, deck failure, or a

SPF is the only system that has qualified for ALPHA –the Performance Based Studies Research Group at Arizona State University's research project to analyze performance information and identify high performance roofing systems and contractors.

lifting and peeling failure at the roof edge, along with the ability to resist water infiltration after being impacted by missiles.[6]

Hail resistance field testing and documentation have shown proven service periods of over 20 years and proven hail resistance for the entire 20-year service period. Testing results show the ALPHA system exceeds the warranted FM-SH performance, accommodating 2.75-inch hailstones without breaking the coating.[7]

More than Marketing Hype

In addition to long service life and high performance indicators – including 99% leak-free and a commitment to customer service and contractor certification – SPF roofing offers other factors often regarded as mere marketing buzz, but in actuality, they are documented benefits.

- **Energy Efficiency –** The main campus of Texas A&M University boasts over 7 million square feet of SPF roofing. In 1985, Gerald Scott, PE, monitored energy savings on 27 different buildings on the campus that had received an SPF roof from 1980 to 1984. The results showed the university was able to cover the complete cost of the roof application through energy savings in an average of 4.5 years.[8]
- **Low Cost Reroofing –** One leading SPF manufacturer reports that its system has been installed directly on top of an existing substrate in 95 out of 100 reroofing projects, eliminating costly tear-off, landfill fees, interior exposure, and down time.
- **Lowest Lifecycle Cost –** When factors such as life cycle performance, maintenance cost, ecological footprint, energy and raw material consumption, health effect potential, risk potential, emissions, and evaluation of land use and transportation fuel usage are taken into consideration, SPF is shown to be one of the lowest lifecycle cost systems available today.[9]
- **Environmentally Responsible –** Prior to 1992, most high-density SPF used CFC 11 as the main blowing agent. For the past 10 years, HCFC 141b has been used, for a 92% reduc-

tion in SPF's global warming potential. The current move to zero-ozone depleting blowing agents such as HFC-245fa and VOC-free coatings also increases SPF's environmental responsibility.

CONCLUSION

Independent, third-party field and laboratory studies show that SPF is a viable roofing system deserving of consideration from roof consultants. The numbers prove the SPF industry's commitment to providing a high-quality system installed by highly trained and skilled professional applicators. ■

Footnotes:

1 *National Roofing Contractors Association 2000-2001 Annual Market Survey.*
2 Dupuis, René M., "Field and Laboratory Assessment of SPF Roof Systems," *Proceedings of the Fourth International Symposium on Roofing Technology,* 1996.
3 *National Roofing Contractors Association Roofing and Waterproofing Manual - Fourth Edition.*
4 "Why Do Contractors Fail? Surety Bonds Provide Prevention and Protection," SIO Surety Information Office, 2003.
5 Post, N., "Building Teams Get High Marks," *Engineering News Record,* 240 (19), 1998.
6 Smith, T.L., "How Did PUF Roofs Perform During Hurricane Andrew?" *Professional Roofing,* (20-25), January 1993.
7 Kashiwagi, D., and J.A. Savicky, "20 Year ALPHA Roof System Hail Performance," Arizona State University, Performance Based Studies Research Group, 2003.
8 Cohen, S., "A Comparison of Built-Up and Foam Roofing Systems," Texas A&M University, 1993.
9 Wall, C., *Eco-Efficiency Analysis, Roof Insulation Systems,* BASF Corporation, 2003.

About the Author

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Tom Harris is currently the product manager for BASF's Spray Foam Group in the United States. Over his 20-year career in the polyurethane systems business, he's chaired eight technical committees within the SPI, Canadian General Standards Board, National Research Council of Canada, and the Canadian Urethane Foam Contractors Association. Tom is currently contributing to two ASTM committees, one NRCA committee, and the SPFA's Building Envelope Committee. He also represents BASF as a founding member of the Air Barrier Association of America. Tom is originally from Canada and is a chemical engineering graduate of Ryerson Polytechnical University.