

**ACRYSHIELD PROTECTIVE COATING
FOR USE OVER
SPRAY POLYURETHANE FOAM ROOF INSULATIONS
IN RECOVER ROOF CONSTRUCTION
AND NEW CONSTRUCTION OVER STRUCTURAL CONCRETE ROOF DECKS**

FOR

**NATIONAL COATINGS CORPORATION
1201 CALLE SUERTE
CAMARILLO, CALIFORNIA 93012**

**J. I. 1B3A0.AM
STANDARD 4470**

September 27, 1996

Factory Mutual Research

1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, Massachusetts 02062

Factory Mutual Research

1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, Massachusetts 02062

J.I. 1B3A0.AM
Standard 4470

September 27, 1996

ACRYSHIELD PROTECTIVE COATING
FOR USE OVER
SPRAY POLYURETHANE FOAM ROOF INSULATIONS
IN RECOVER ROOF CONSTRUCTION
AND NEW CONSTRUCTION OVER STRUCTURAL CONCRETE ROOF DECKS

FOR

NATIONAL COATINGS CORPORATION
1201 CALLE SUERTE
CAMARILLO, CALIFORNIA 93012

I INTRODUCTION

1.1 National Coatings Corporation submitted their Acryshield Protective Coating for testing with polyurethane foam roof insulations to determine if they would meet the Approval requirements of Factory Mutual Research Corporation Standard 4470 for Class 1 Fire, Windstorm and Hail Classifications for use in recover construction over steel, wood and concrete deck roofs, insulated metal panel roofs and in new construction over structural concrete roof decks.

1.2 Examination included ASTM E108 (93) fire testing for potential exterior fire spread, simulated hail damage testing, water leakage testing, and resistance to foot traffic tests.

1.3 Testing of nine polyurethane spray foam roof insulations was completed in J.I. OZ3Q4.AM as part of a generic test program sponsored by The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division (SPI/SPFD). Tests completed by SPI/SPFD included calorimeter testing for potential interior fire spread, simulated wind uplift testing, ASTIVI E108 (93) fire testing for potential exterior fire spread, simulated hail damage testing and resistance to foot traffic tests.

1.4 Test results show that the Acryshield Protective Coating submitted for testing meets the Factory Mutual Research Corporation Standard 4470 Approval requirements for Class 1 Roof Covers when installed as described in the CONCLUSIONS of this report.

II MATERIALS TESTED

2.1 Acryshield Acrylic Elastomeric Roof Coating is a water based elastomeric coating, available in various colors. It is designed to protect sprayed rigid polyurethane foam. It is brush, roller or spray applied to the foam at an application rate of 4.00 gal/sq (1.7 l/m²), applied in three coats. The finished dry thickness is minimum 30 mil [0.030 in. (0.76 mm)].

2.2 Polyurethane foam is a sprayed in place insulation for use in roof construction. It consists of an A component (isocyanate) and a B component (polyol) which are shipped to the job site in separate containers and mixed on site using special spray equipment for application to the roof. The foam has an apparent overall density of 2.8 to 3.0 lb/ft³ (45 to 48 kg/m³) and requires that an Approved protective elastomeric coating be applied to its top surface.

2.2.1 The following polyurethane foams were submitted for testing as part of the SPI/SPFD program:

a. Burtin Corporation -	BUC 12~3.0
b. Foam Enterprises, Inc. -	FE 303-2.5
c. Gaco Western, Inc. -	Gaco Polyfoam 275
d. IPI, A Division of PMC, Inc. -	ISOFOAM SS-1570-3.0
e. North Carolina Foam Industries-	NCFI 591-2.8
f. Polythane Systems, Inc. -	OSI~H200-30
g. Resin Technology Company -	RT-2031-3.0
h. SWD Urethane Company -	SWD 525-3.0
i. Urethane Technologies -	UT 5100-2.7

III TESTS: CRITERIA AND PROCEDURES

3.1 Tests conducted were as required by the Factory Mutual Research Corporation Standard 4470 for Class 1 Roof Covers.

3.1.1 Additional tests were completed by SPI/SPFD under J.I. OZ3Q4.AM. This program included a series of preliminary screening tests to identify the critical foam products to evaluate according to Approval Standard 4470. The spray foams tested in J.I. OZ3Q4.AM were identified as Foam #1, Foam #2 through Foam #9.

3.2 FMRC Class 1 Fire Test - The fire tests were conducted using the FMRC Construction Materials Calorimeter which measures the maximum rate of fuel contribution by the sample roof cover/insulation combination, also expressed as the maximum heat release rate (HRR); e.g., for a Class 1 rating, the assembly must exhibit a 3 minute heat release rate (HRR) no greater than 410 BTU/ft²/min. (1111 kg-cal/dm²/min.) in any 3 minute time frame during the 30 minute fire exposure. Tests were completed in J.I. OZ3Q4.AM.

3.3 ASTM E108 (93) Spread of Flame Fire Tests - The exterior fire tests were conducted in accordance with ASTM E108 (93) Fire Tests of Roof Coverings for Class A non-combustible deck test procedures. The wind velocity over the top of each sample was adjusted to 12±0.5 mph (5.4±0.2 m/s). The machine was calibrated with a "Blank" panel set at a slope of 5:12. The flame temperature was then adjusted to 1400°±50°F (760°±28°C) for the Class A tests. The temperature was determined by a thermocouple located 1 in. (25 mm) above the surface and 1/2 in. (13 mm) toward the source of the flame from the lower edge of the "Blank" panel. Samples were tested with the flame and air current applied continuously for a period of 10 minutes. During and after application of the flame, the samples were observed for distance of maximum flame spread, glowing brands and other damage.

3.4 FMRC Simulated Windstorm Classification Pull Tests - The simulated wind uplift pull tests were conducted to evaluate the ability of the above deck components to resist a simulated wind uplift force of 60, 90, 120, 150 or 180 psf (2.9, 4.3, 5.7, 7.1 or 8.6 kPa) without failure of the assembly. Tests were completed in J.I. OZ3Q4.AM.

3.4.1 The uplift pull test utilizes a concrete block, approximately 4 ft x 4 ~ x 6 in. (1.2 m x 1.2 m x 152 mm) with a 2 x 2 ft (0.6 x 0.6 m) roof sample constructed in accordance with the manufacturers specifications. A 2 ft x 2 ft x 1.5 in. (0.6 m x 0.6 m x 38 mm) plywood square containing a centrally located eye-bolt is secured to the top surface of the roof sample.

3.4.2 One end of a force sensing device was then connected to the eyebolt and the other end connected to a chain hoist assemble. A effective net pressure of 30 psf (1.4 kPa) was applied to the test sample and maintained for 1 minute. The pressure was increased to 45 psf (2.2 kPa), then 60 psf (2.9 kPa), and held for 1 minute at each increment. This schedule was increased in increments of 15 psf (07.5 kPa) every minute until failure occurred or the limits of the test apparatus was reached.

3.5 FMRC Simulated Hail Damage Tests - The simulated hail damage tests were conducted using the FMRC simulated hail damage test apparatus to evaluate the ability of the roof cover/insulation combinations to withstand a hailstorm without damage to the covering. The test criteria state that there must be no signs of cracking, splitting, internal separation, delamination or rupture of the roof cover.

3.5.1 Severe Hail Damage Test for Class 1-SH - A 1.75 in. (49 mm) diameter steel ball weighing 0.78 lbs. (0.3 kg) was dropped from a 17 ft 9.5 in. (5.4 m) height through a 2 in. (51 mm) ID PVC tube. This procedure was repeated several times on various sections of the sample. After each drop the sample was inspected for cracking, splitting, internal separation, delamination and rupture of the roof cover.

3.6 FMRC Resistance to Foot Traffic - Tests were conducted using the FMRC resistance to foot traffic test apparatus to determine the ability of the roof cover/insulation combinations to resist foot traffic.

3.6.1 The test apparatus consists of a 3 in. (76 mm) square steel plate placed on the coated insulation. A 200 lb. (91 kg) load was imposed on the plate. The load was then reduced to zero and reloaded a minimum of four additional times. Penetration and residual readings were taken each time without removing the plate.

3.6.2 The specimen was inspected after the test and the condition of the cover at the steel plate interface noted. Tearing or cracking of the protective coating causing exposure of the foam or other compressible core materials is unacceptable.

3.7 FMRC Susceptibility to Leakage Test - Tests were conducted in accordance with the FMRC Susceptibility to Leakage Test procedure with a modification as noted below.

3.7.1 The test apparatus consists of top and bottom sections which are bolted together with the specimen being evaluated placed as a diaphragm between the sections. The top and bottom sections consist of 9-1/4 in. (203 mm) diameter pipe. An 11-518 in. (295 mm) diameter pipe flange is cemented to the other end of each pipe section. Both top and bottom sections are bolted together at the flanges with the cover being evaluated placed between them. The apparatus is fabricated to allow both a standing head of water above and additional air pressure below the test sample. Each section is fabricated with two 1/2 in. (13 mm) diameter pipe outlets to allow connection of an air pressure inlet and pressure gauge.

3.7.2 The 10 in. (254 mm) diameter specimen is bolted in place between the flanges of the test apparatus. Water is placed over the sample to a depth of 6 in. (152 mm) and maintained for a period of 7 days. At the end of the 7 day period, air is introduced below the water to a 1 psig (6.3 kPa) level and cycled 25 times from 1 psig (6.3 kPa) to ambient. Test criteria state that there shall be no signs of water leakage during the 7 day period. In addition, there shall be no signs of water leakage during or after the pressure cycles. Because the roof coatings are fully adhered, the pressure cycles were waived.

IV TEST SAMPLES

4.1 FMRC Class 1 Fire Tests - Two 4.5 x 5 ft (1.4 x 1.5 m) test samples were constructed to determine if specific existing Class 1 fire rated roof assemblies would continue to meet the Class 1 fire rating with additional insulating foam spray applied over the existing roof. Test sample constructions consisted of the following:

Sample No. 1:

1. 1.5 in. (38 mm) thick FMRC Approved fiberglass roof insulation was adhered to the deck with ribbons of hot asphalt applied at a rate 12 to 15 lb/sq (0.6 to 0.7 kg/m²) and covered with a 3-ply organic felt, asphaltic BUR.
2. Nominal 2.75 to 3.0 in. (70 to 76 mm) thick polyurethane spray foam was applied to the top surface of the BUR and coated with a coating Approved for use on polyurethane foam.

Sample No. 2:

1. 2 in. (51 mm) thick FMRC Approved perlite roof insulation was adhered to the deck with ribbons of hot asphalt applied at a rate 12 to 15 lb/sq (0.6 to 0.7 kg/m²) and covered with a 3-ply organic felt, asphaltic BUR.
2. Nominal 2.75 to 3.0 in. (70 to 76 mm) thick polyurethane spray foam was applied to the top surface of the BUR and coated with a coating Approved for use on polyurethane foam.

4.2 ASTM E108 (93) Spread of Flame Fire Test Panels - Three 3.33 x 8 ft (1.0 x 2.4 m) Spread of Flame tests were completed using nominal 2 in. (51 mm) thick SPI/SPFD polyurethane spray foams identified as Foam #1 and Foam #8. Samples were constructed and tested over 0.5 in. (13 mm) thick plywood decks. All test samples were coated with Acryshield roof coating.

4.3 FMRC Simulated Windstorm Classification Pull Tests - Twelve 2 x 2 ft (0.6 x 0.6 m) simulated wind uplift pull test samples were constructed on structural concrete blocks. One test was run with each foam (Sample No.'s 1 through 9) followed by three additional confirming tests (Samples No.'s 10, 11 and 12).

Sample No.'s 1 through 9:

1. Concrete block was covered with a layer of asphalt to simulate an existing asphaltic built up roof.
2. Nominal 2 in. (51 mm) thick polyurethane spray foam, one test with each foam submitted, was applied to the deck.

Sample No. 10:

1. Concrete block was primed with an asphalt primer and covered with nominal 2 in. (51 mm) thick Foam X3.
2. An Approved acrylic roof coating was applied to the top surface of the foam.

Sample No. 11:

1. Nominal 2 in. (51 mm) thick Foam #2 was adhered to the structural concrete block.
2. An Approved acrylic roof coating was applied to the top surface of the foam.

Sample No. 12:

1. Nominal 2 in. (51 mm) thick Foam #2 was adhered to the structural concrete block.
2. An Approved acrylic roof coating was applied to the top surface of the foam.

4.4 FMRC Simulated Hail Damage Test Sample - One 2 x 4 ft (1.2 x 2.4 m) test sample was prepared with nominal 2 in. (51 mm) thick SPI/SPFD polyurethane spray foam identified as Foam #6. The sample was tested with Acryshield roof coating.

4.5 FMRC Resistance to Foot Traffic Test Sample - One 12 in. (25 mm) square test sample was prepared with nominal 2 in. (51 mm) thick SPI/SPFD polyurethane spray foam identified as Foam #6. The sample was tested with Acryshield roof coating.

4.6 FMRC Susceptibility to Leakage Test Sample - One sample was prepared and tested with Acryshield roof coating. The sample was prepared by applying the coating to a polyethylene sheet. The roof coating was removed from the polyethylene sheet and tested after the coating cured.

V RESULTS

5.1 FMRC Class 1 Fire Tests - The calorimeter fire tests showed the test panels to have fuel contribution rates below the maximum permissible rates for Class 1 Insulated Steel Deck Roof Construction. The calorimeter test showed Sample No. 1 to have the highest fuel contribution rates. These rates and the Class 1 limits are as follows:

Maximum Ave. Rate of Fuel Contribution Btu/ft ² /min. (kg-Cal/sq m/min.) for Various intervals of time				
	<u>3 min.</u>	<u>5 min.</u>	<u>10 min.</u>	<u>Ave.</u>
Class 1 Standard	410 (1111)	390 (1057)	360 (975)	285 (772)
Sample No. 1	173 (469)	161 (436)	129 (350)	59 (160)

5.2 ASTM E108 (93) Fire Tests - At no time during the Spread of Flame tests were flying brands developed or excessive lateral flame spreads observed. The resulting classifications are:

<u>Coating</u>	<u>Foam</u>	<u>Slope</u>	<u>Resulting Classification</u>
AcryShield	#1	1-1/2	A
AcryShield	#8	1-1/2	A
AcryShield	#1	1-1/2	A

5.3 FMRC Simulated Windstorm Classification Pull Tests - Test Sample No.'s 2 through 12 remained intact and did not fail upon reaching the limits of the test apparatus. Foam #1 had failure at the asphalt/concrete interface at 240 psf (11.5 kPa). All samples meet Class 1-180 wind uplift requirements.

5.4 FMRC Simulated Hail Damage Tests - After each drop of the impactor the samples were observed for cracking, splitting, internal separation, delamination and rupture of the roof cover. After 10 drops of the impactor, the samples showed no sign of cracking, splitting, internal separation, delamination or rupture of the roof cover.

5.5 FMRC Resistance to Foot Traffic Test - After completion of testing, the sample was inspected for tearing and cracking of the protective cover. The samples showed no sign of tearing or cracking.

5.6 FMRC Susceptibility to Leakage Test - The leakage test sample showed no signs of water leakage during the 7 day period.

VI CONCLUSIONS

6.1 The test results indicate that the Acryshield Protective Coating submitted by National Coatings Corporation meets the Factory Mutual Research Corporation Approval requirements when constructed as follows:

6.1.1 New or Recover Constructions - A polyurethane spray foam roof insulation consisting of Burtin Corporation - BUC 124-3.0, Foam Enterprises, Inc. - FE 303-2.5, Gaco Westem, Inc. - Gaco Polyfoam 275, IPI, A Division of PMC, Inc. -ISOFOAM SS-1570-3.0, North Carolina Foam Industries- NCFI 591-2.8, Polythane Systems, Inc. - OSI-SH200-30, Resin Technology Company - RT-2031-3.0, SWD Urethane Company - SWD 525-3.0, or Urethane Technologies - UT 5100-2.7 is spray applied to the substrate and coated with a protective elastomer roof coating.

6.1.1.1 Acryshield Protective Coating is brush, roller or spray applied to the foam. Acryshield is applied in three coats with a combined application rate of 4.00 gal/sq (1.7 l/m²) providing a minimum dry thickness of 30 mil [0.030 in. (0.76 mm)].

6.1.2 Recover Roof Construction

6.1.2.1 Maximum 3 in. (76 mm) thick polyurethane spray foam roof insulation shown in Section 6.1.1 above is applied to one of the following existing Approved roof constructions and covered with Acryshield Protective Coating. Meets wind uplift rating of the existing roof, maximum Class 1-180.

Existing Roof #1: 1.5 to 2 in. (38 to 51 mm) thick fiberglass roof insulation is secured to the steel deck with mechanical fasteners or ribbons of asphalt applied at 12 to 15 lb/sq (0.6 to 0.7 kg/m²) and covered with a 3-ply organic felt, asphaltic BUR.

Existing Roof #2: 2 to 4 in. (51 to 102 mm) thick perlite roof insulation is secured to the steel deck with mechanical fasteners or ribbons of asphalt applied at 12 to 15 lb/sq (0.6 to 0.7 kg/m²) and covered with a 3-ply organic felt, asphaltic BUR.

6.1.2.2 Maximum 1 in. (25 mm) thick polyurethane spray foam roof insulation shown in Section 6.1.1 above is applied to any existing Approved, Class 1 rated asphaltic BUR and covered with Acryshield Protective Coating. Meets wind uplift rating of the existing roof, maximum Class 1-180.

6.1.2.3 Maximum 1 in. (25 mm) thick polyurethane spray foam roof insulation shown in Section 6.1.1 above is applied to any existing Approved, Class 1 rated insulated metal panel roof and covered with Acryshield Coating. Meets wind uplift rating of the existing roof, maximum Class 1-90.

6.1.2.4 Structural Concrete Recover- Maximum 3 in. (76 mm) thick polyurethane spray foam roof insulation shown in Section 6.1.1 above is applied to an existing Approved asphaltic BUR and covered with Acryshield Protective Coating. Meets wind uplift rating of the existing roof, maximum Class 1-180.

6.1.3 New Construction over Structural Concrete Roof Decks - The roof deck is either left uncoated or primed with an Approved asphaltic concrete deck primer or covered with a one or two ply asphaltic vapor barrier. Maximum 3 in. (76 mm) thick polyurethane spray foam roof insulation shown in Section 6.1.1 above is then applied to the substrate and covered with Acryshield Protective Coating. Meets Class 1-180.

6.1.4 ASTM E108 Ratings -Acryshield Protective Coating meets ASTM E108 Class A noncombustible deck classifications at max 1-1/2 in 12 slope when applied over the polyurethane spray foam roof insulations shown in Section 6.1.1 above.

6.1.5 Hail Ratings -Acryshield Protective Coating meets FMRC Hail Rating Class 1-SH when applied over the polyurethane spray foam roof insulation shown in Section 6.1.1 above

6.2 For Class 140 and 1-90 windstorm rated roof constructions, an FMRC Approved flashing system must be used. For the Class 1-120, 1-150 and 1-180 windstorm rated roof constructions, the roof cover must be installed using a perimeter flashing system capable of withstanding the anticipated loads. When an Approved system is unavailable, the flashing must be designed to withstand the anticipated wind uplift forces.

6.3 Test results show that the above roof constructions, in and of themselves alone, would not create a need for automatic sprinkler protection.

6.4 The tested roof systems, when installed as described above, meet the Factory Mutual Research Corporation Approval Standards and when Approval is effective, will be listed in the Factory Mutual Research Corporation Approval Guide, Roof Coverings section.

6.5 Approval is effective when the Approval Agreement is signed and received by Factory Mutual Research Corporation.

6.6 Continued Approval depends on satisfactory field experience and periodic Quality Audit Inspections.

VII MARKING

7.1 Protective roof coatings are placed in pails, drums or tanks for storage and shipped in pails, drums or bulk. Each pail or drum of material or bill of lading for bulk shipments shall be labeled with at least one label. The label shall contain, at a minimum, the manufacturer's name, product trade name, the FMRC Approval mark, and the words: "Subject to the conditions of Approval as a protective roof coating for use in Class 1 roof construction as described in the current edition of the FMRC Approval Guide."

7.2 Markings denoting FMRC Approval shall be applied by the manufacturer only within and on the premises of manufacturing locations that are under the FMRC Facilities and Procedures Audit Program.

7.3 The manufacturer agrees that use of the FMRC name or Approval Mark is subject to the conditions and limitations of the FMRC Approval. Such conditions and limitations must be included in all references to FMRC Approval.

VIII MANUFACTURERS RESPONSIBILITIES

8.1 To assure compliance with his procedures in the field, the manufacturer shall supply the roofer with necessary instructions or assistance required to produce the desired performance achieved in the tests.

8.2 Only contractors certified by the manufacturer shall be permitted to apply the Approved spray foam roof insulation and Approved protective coatings.

8.3 The manufacturer shall notify the Factory Mutual Research Corporation of any planned change in the Approved product prior to the general sale or distribution, using Form 797, Approved Product - Revision Report.

IX QUALITY AUDIT INSPECTIONS AND REEXAMINATION

9.1 A reexamination and manufacturing inspection will be conducted periodically on the Approved product at the Approved manufacturing location in Camarillo, CA to determine that the quality and uniformity of the product has been maintained and will provide the same level of performance as originally tested.

TESTS AND REPORT BY:

M. D. Tyrol
Engineer
Materials Section

REPORT REVIEWED BY:

L. N. D'Angelo
Senior Engineer