

Bitec Inc. 2 Industrial Park Dr. Box 497, Morrilton AR 72110

Roof Cover: SPM-3.5H, SFM-3.5H-FR or SPS-3H
 Deck: Steel and Concrete (Recover where indicated)
 Coating: Karnak No.97 Coating applied at 1½ gal/sq (0.65 L/m²), coating is not required when SFM-3.5H-FR cap sheet is used
 Laps: 4 in. (102 mm) wide side and 6 in. (152 mm) wide end laps
 Application: Hot asphalt
 Base Sheet: Perma Ply No.28, Glas Base, VaporBar or GAFGLASS #75
 Ply Sheet: Compabase PS-2H, FS-2H, GlasPly IV, Glasply Premier
 Hail Rating: Class 1-SH
 ASTM E 108: Noncombustible deck as follows:
 SPM-3.5H: Class B, ¾ in 12 slope
 SFM-3.5H-FR: Class B, 1½ in 12 slope, coating is not required
 SPS-3H: Class A, ¾ in 12 slope With GlasPly IV or Glasply Premier ply sheet(s):
 Class A, 1½ in 12 slope
 With PS-2H, FS-2H or FA-2T ply sheet: Class A, ¾ in 12 slope

Roof Cover: APS-4T, APM-4T, APM-4.5T or SPM-4.5T
 Deck: Steel and Concrete (Recover where indicated)
 Coating: Karnak No.97 Coating applied at 1½ gal/sq (0.65 L/m²)
 Laps: 3 in. (76 mm) wide side and 6 in. (152 mm) wide end laps
 Application: Torch adhered
 Base Sheet: Perma Ply No.28, Glas Base, VaporBar or GAFGLASS #75
 Ply Sheet: Compabase PS-2H, FS-2H, FA-2T; GlasPly IV, Glasply Premier
 Hail Rating: Class 1-SH
 ASTM E 108: Noncombustible deck as follows:
 SPM-4.5T; Class B, 1½ in 12 slope
 APM-4T; APM-4.5T Class B, 1½ in 12 slope
 APS-4T: Class A, 1½ in 12 slope
 With GlasPly IV or Glasply Premier ply sheet(s): Class A, 1½ in 12 slope
 With PS-2H, FS-2H or FA-2T ply sheet: Class A, ¾ in 12 slope

Construction #1: Min 1 in. (25 mm) thick Armor Board Regular, Esgard, Celotex Fiberboard, GAFTEMP Fiberboard, Huebert Fiberboard, Kop-R Wood Fiber, Celotherm, ConPerl, GAFTEMP Permalite, Permalite, Fesco Board, or min 5/8 in. (16 mm) thick Exeltherm Fiberbond are secured to the roof deck with fasteners applied at 2 ft² (0.19 m²) max contributory area per fastener. The base sheet is adhered with hot asphalt and roof cover then adhered with joints staggered from base sheet. Karnak No.97 coating is applied as indicated above. Meets Class 1-60.

Fasteners: 1) Dekfast Stainless Steel with 3 in. Round plate; #12, #14, #15 Dekfast or Omega with Hex Plate, Dekfast Autoseal Plate; HWH Dekfast with #12 Hex Plate. 2) AccuTrac or Hextra with Recessed or AccuTrac Plate; #12, ¼ in., #14-10 or #15 Roofgrip with Recessed or Flat Bottom. 3) Olympic #10, Olympic Standard, Olympic Heavy Duty, Stainless #12, Hex Head #12, #14, Iron-Lok or Strap Toggle with Standard or G-2 plate. 4) Rawl #12, #14 or Speed-Lock Toggle Bolt with Rawl 3 in. Insulation Plate.

Construction #2: Min 15/16 in. (24 mm) thick, Standard and Wide Flute Fiberglass Roof Insulation, Standard and Wide Flute Fiber Glass Roof Insulation, Fiber Glass Roof Insulation (Standard and Wide Flute) insulation, is secured to the deck with fasteners and plates applied at a max 3 ft² (0.28 m²) contributory area per fastener. The fasteners, base sheets, roof cover and coating applied as in Construction #1. Meets Class 1-90.

Construction #3: Concrete. Deck is primed and covered with an insulation shown in Construction #1 or #2 adhered to the deck with hot asphalt. The base sheet, roof cover and coating applied as in Construction #1. Meets Class 1-90.

Construction #4: Insulation shown in Construction #1 or #2 is presecured to the deck. The base sheet is then secured to the roof deck with fasteners shown in Construction #1 applied 12 in. (305 mm) on center along the side and end laps and along the centerline of the base sheet. The roof cover and coating applied as in Construction #1. Meets Class 1-90.

Construction #5: Min 1.5 in. (38 mm) thick ACFoam-II, Armor R Plus, Kop-R(II), Polyiso HP-W, Thermal Tec, UltraGard ISO II, UltraGard Gold SP or USIso are loose laid over the deck and covered with min 1 in. (25 mm) thick Armor Board Regular, Esgard, Celotex Fiberboard, GAFTEMP Fiberboard, Huebert Fiberboard, Kop-R Wood Fiber or min ¾ in. (19 mm) thick Celotherm, ConPerl, GAFTEMP Permalite, Permalite or Fesco Board placed with all joints staggered, and mechanically fastened through the isocyanurate insulation to the deck with fasteners applied at 2 ft² (0.19 m²) max contributory area per fastener. Refer to Glass Felt BUR cover table for the particular deck type and min cover board type and thickness shown above for fastening requirements. The base sheet and cap sheet and coating are then applied as in Construction #1. For use with hot asphalt adhered roof covers only. Meets Class 1-90.

Construction #5a: Min 1.3 in (32 mm) thick ACFoam-II, ACFoam-III, Armor R Plus, Kop-R(II), Polyiso HP-W, Thermal Tec, HPG ISO II, UltraGard or USIso is loose laid over a min 22 ga steel or structural concrete deck. Min ¾ in. (19 mm) thick Celotherm, ConPerl, GAFTEMP Permalite or Fesco Board is placed over the insulation with all joints staggered and mechanically fastened through the insulation to the deck with fasteners applied at 2 ft² (0.2 m²) max contributory area per fastener. The base sheet, cap sheet and roof coating is then applied as per Construction #1. For use with hot asphalt adhered roof covers only. Meets Class 1-90.

Construction #6: Min 2 in. (51 mm) thick ACFoam Composite, Kop-R(WC) or USIso/Perlite Composite is secured to the deck with fasteners applied at 4 ft² (0.37 m²) max contributory area per fastener. Refer to Glass Felt BUR cover table for the particular deck type for fastening requirements. The base sheet and cap sheet and coating are then applied as in Construction #1. For use with hot asphalt adhered roof covers only. Meets Class 1-90.

Construction #7: Recover. The base sheet is adhered to a smooth surfaced existing BUR cover with hot asphalt. The roof cover and coating applied as in Construction #1. Meets Class 1-60/1-90 per existing roof.

Construction #8: Recover. Construction #1, #2 or #4 above may be used in recover applications. For recover over steel deck, the max insulation thickness shall be 1 in. (25 mm). Class 1-60/1-90 per above.

Construction #9: Min 1.3 in. (32 mm) ACFoam-II, Armor R Plus, Polyiso HP-W, GAFTEMP Isotherm-RA, Kop-R (WII), Poly ISO 2, UltraGard, US Iso, UltraGard Iso II are mechanically secured to the deck with fasteners applied at 4 ft² (0.4 m²) max contributory area per fastener. Min 0.75 in. (38 mm) thick Celotherm, ConPerl, GAFTEMP Permalite, Permalite or Fesco Board is secured to the insulation with hot asphalt (all joints are staggered). For deck types and fasteners, see individual insulation listing in the Insulation and Fastener Tables for Approved Glass and Organic Felt Built Up Roofs. Base and cap sheets are hot mopped to the cover board. For use with hot asphalt adhered roof covers only. Meets 1-90.

Construction #10: Insulation and cover boards as shown in Construction #5 or #9 are mechanically fastened to the deck with Dekfast, Olympic, Rawl or Buildex fasteners (all metal plates only) at a fastener density of 1 fastener per 2 ft². The base sheet is then adhered to the top surface of the overboard with hot asphalt. One or two plies of GlasPly IV or Glasply Premier, with joints staggered, is adhered to the base sheet with hot asphalt. The roof cover, with joints staggered, is then adhered to the interply sheet with hot asphalt or torching as appropriate. Karnak No. 97 Coating is applied as indicated above. Meets Class 1-90.

Construction #10a: Same as Construction #10 except that interply is limited to one ply of Compabase PS-2H, FS-2H or FA-2T, with joints staggered, is adhered to the base sheet with hot asphalt or torching as appropriate. Meets Class 1-90.

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OB3A7.AM
(4470)

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APPROVAL OF INTERPLY SHEETS
FOR USE IN
CLASS 1 INSULATED
ROOF CONSTRUCTIONS

for

BITEC
#2 INDUSTRIAL PARK DRIVE
PO BOX 497
LITTLE ROCK, AR 72110

I INTRODUCTION

1.1 Bitec submitted several interply roof membrane products for an evaluation to determine if they meet Factory Mutual Research Corporation (FMRC) Approved Standard 4470 requirements for Class 1 Fire and 1-60 and 1-90 Windstorm Classifications when used as a roofing component in Class 1 insulated roof constructions. The objective of this program was to allow the use of these interply sheets in some of their currently listed FMRC Approved assemblies.

1.2 The following products have been submitted and examined as part of this test program.

1.2.1 Non-modified interply sheets – Schuller’s Glas Ply IV and Glasply Premier

1.2.2 Modified interply sheets – Bitec’s Compabase PS-2H; FS-2H; and FA-2T

1.3 The examination included small scale pull through and delamination testing, full scale wind uplift testing, fire testing for interior fire spread and ASTM E-108 testing for potential exterior fire spread.

1.4 As a manufacturer of a Factory Mutual Research Corporation Approved product, Bitec will be subjected to FMRC’s follow-up Facilities and Procedures Audit inspection program. The purpose of the inspections is to satisfy FMRC that the manufacturer is using sufficient quality controls to assure continued production of units equivalent to those originally tested and Approved.

1.5 Tests show that the interply roof membrane products, as shown and described elsewhere in this report, meet FMRC Approval Standard 4470 requirements for Class 1 Fire and 1-60 and 1-90 Windstorm Classifications when installed as described in the CONCLUSIONS of this report.

1.6 Testing for this program was conducted under two separate projects, JI OB3A7.AM and JI OB3A8.AM. This report contains all tests descriptions, results and conclusions for both of the above protects. Details of each individual test program are contained in the respective Protect Data Reports (PDRs) which are on file in the FMRC Technical Information Center.

II MATERIAL DESCRIPTION

The following products used in this test program are shown below. All formulations are on file at FMRC. Only the new products not previously FMRC Approved are described in detail. The products used in this program that were previously Approved are simply referenced.

2.1 Compabase PS-2H – is an interply sheet, nominal 0.078 in (2 mm) thick and 45 lbs/sq (2.2 kg/m²). It utilizes a spunbond polyester mat and Styrene-Butadiene-Styrene (SBS) modified bitumen asphalt. Both the top and bottom surfaces are sanded. It is designed for use as a single layer interply sheet in hot mopped asphalt applications. Each roll is 49.2 ft (15 m) long, 39.4 in (1 m) wide and covers approximately 150 ft² (14 m²).

2.2 Compabase FS-2H – is an interply sheet, nominal 0.078 in (2 mm) thick and 45 lbs/sq (2.2 kg/m²). It utilizes a fiberglass mat and SBS modified bitumen asphalt. Both the top and bottom surfaces are sanded. It is designed for use as a single layer interply sheet in hot mopped asphalt applications. Each roll is 49.2 ft (15 m) long, 39.4 in (1 m) wide and covers approximately 150 ft² (14 m²).

2.3 Compabase FA-2T – is an interply sheet, nominal 0.078 in (2 mm) thick and 45 lbs/sq (2.2 kg/m²). It utilizes a fiberglass mat and Atactic Polypropylene (APP) modified bitumen asphalt. The top surface is lightly sanded while the bottom surface is covered with a thin polyethylene film. It is designed for use as a single layer interply sheet in torch applied applications. Each roll is 49.2 ft (15 m) long, 39.4 in (1 m) wide and covers approximately 150 ft² (14 m²).

2.4 Other previously Approved products used in conjunction with this program include:

2.4.1 Cap sheets – Bitec SPM-3.5H, SFM-3.5H-FR, SPS-3H, APS-4T, APM-4T, APM-4.5T and SPM-4.5T

2.4.2 Base sheets – Schuller Glas Ply IV, Glasply Premier, PermaPly #28, GlasBase, and GAF's GAFGLASS #75

2.4.3 Insulations and insulation fasteners – see the CONCLUSIONS of this report.

III TESTS: PROCEDURES AND CRITERIA

Tests were conducted as required by FMRC Approval Standard 4470, "Class 1 Roof Covers"

3.1 FMRC Calorimeter Fire Tests

3.1.1 A calorimeter fire test was conducted using the FMRC Construction Materials Calorimeter which measures the maximum acceptable rate of fuel contribution by the sample roof, also expressed as a maximum heat release rate (HRR). For a Class 1 rating, the assembly must exhibit a heat release rate (HRR) no greater than those shown in paragraph 5.1 during the 30 minute fire exposure.

3.2 FMRC Windstorm Classification Tests – Steel Decks

3.2.1 The tests were conducted using the FMRC simulated wind uplift test apparatus to evaluate the ability of the above deck components to resist a simulated wind force of 60 psf (2.9 kPa) and 90 psf (4.3 kPa) without failure of the assembly.

3.2.2 The uplift pressure test utilizes a 9 ft (2.7 m) long by 5 ft (2.5 m) wide x 2 in. (51 mm) deep steel pressure vessel arranged to apply air pressure at pre-established standard rates to the underside of the test panel which forms the top of the pressure vessel. The vessel is pressurized with compressed air.

3.2.3 A net force of 30 psf (1.4 kPa) was applied to each test sample and maintained for one minute. The force was increased to 45 psf (2.2 kPa), then to 60 psf (2.9 kPa) and held for one minute at each increment. The pressure was increased in increments of 15 psf (0.7 kPa) every minute until failure occurred.

3.3 ASTM E-108 (91) Fire Tests

3.3.1 The exterior fire tests were conducted in accordance with the ASTM E-108 (91) Fire Tests of Roof Coverings, Class A, noncombustible deck test procedure. The wind velocity over the top of each sample was adjusted to 12 ± 0.5 mph (5.4 ± 0.2 m/s). The tests were conducted at a slope of 3/4 and 1-1/2 inch per foot (0.75:12 and 1.5:12), respectively.

3.3.2 Spread of Flame Tests. The flame was adjusted to $1400 \pm 50^\circ\text{F}$ ($760 \pm 28^\circ\text{C}$) as 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 panel. Sample size was 3 ft 4 in. x 8 ft (1.0 m x 2.4 m). The flame was applied continuously for 10 minutes. During and after the application of the flame, the panel was observed for distance of maximum flame spread, glowing brands and other damage.

3.4 Comparative Tinius Olsen Delamination Testing

3.4.1 A series of Tinius Olsen 'T' peel delamination tests were conducted to compare the various base/interply/cap sheet delamination performance. For each delamination test, force was exerted in a direct line perpendicular to the surface of the specimen at a speed of 2 in/min (51 mm/min) until failure/delamination occurred, resulting in a respective delamination value. These values were used as the basis for selection of the most critical components to be used in full scale wind uplift testing. All samples were made with 1 in (25 mm) wide strips and adhered along surfaces that measured 6 in (152 mm).

3.5 Simulated Hail Damage. Resistance to Foot Traffic. Susceptibility to Leakage Tests and Oxygen Bomb Tests and Comparative Tinius Olsen Pull Through Tests – were either waived or values from previous successful test programs sponsored by Bitec were used.

IV TEST SAMPLES

4.1 FMRC Class 1 Fire Test Panels

Four test samples, each 4 ft 6 in. x 5 ft 0 in. (1.4 x 1.5 m), were constructed as follows:

4.1.1 Sample 1 – Atlas ACFoam II roof insulation, 1.5 in. (38 mm) thick was loosely laid over a steel deck. Wood fiber, 1 in (25 mm) thick, was placed over the insulation and mechanically attached through both layers into the steel deck. A single ply of PermaPly #28, 2 plies of Glas Ply IV and Bitec's SPM-3.5H cap sheet (mineral surfaced), all hot mopped with asphalt at a rate of 25 lbs/sq (1.2 kg/m²) where in turn placed on the assembly.

4.1.2 Sample 2 – Atlas ACFoam II roof insulation, 1.5 in. (38 mm) thick was loosely laid over a steel deck. Wood fiber, 1 in (25 mm) thick, was placed over the insulation and mechanically attached through both layers into the steel deck. A single ply of PermaPly #28, a single ply of Compabase PS-2H and and Bitec's SPM-3.5H cap sheet (mineral surfaced), all hot mopped with asphalt at a rate of 25 lbs/sq (1.2 kg/m²) where in turn placed on the assembly.

4.1.3 Sample 3 – Atlas ACFoam II roof insulation, 1.5 in. (38 mm) thick was loosely laid over a steel deck. Wood fiber, 1 in (25 mm) thick, was placed over the insulation and mechanically attached through both layers into the steel deck. A single ply of PermaPly #28 was hot mopped with asphalt at a rate of 25 lbs/sq (1.2 kg/m²) to the wood fiber. A single ply of Compabase FA-2T and Bitec's APM-4.5T cap sheet (mineral surfaced) were torch applied to the assembly.

4.1.4 Sample 4 – NRG's E'NRG'Y 2 roof insulation, 1.5 in. (38 mm) thick was loosely laid over a steel deck. Perlite, 0.75 in (19 mm) thick, was placed over the insulation and mechanically attached through both layers into the steel deck. A single ply of PermaPly #28 was hot mopped with asphalt at a rate of 25 lbs/sq (1.2 kg/m²) to the perlite. A single ply of Compabase FA-2T and Bitec's APM-4.5T cap sheet (mineral surfaced) were torch applied to the assembly.

4.2 Windstorm Classification Tests

A simulated wind uplift pressure test panel, 5 ft x 9 ft (1.5 m x 2.7 m), was constructed as follows:

4.2.1 Sample 1 – Atlas ACFoam II roof insulation, 1.5 in. (38 mm) thick, was loosely laid over a steel deck. Fesco (perlite), 0.75 in (19 mm) thick, was placed over the insulation and with both layers mechanically attached to the steel deck with four (4) Olympic Standard Metal Plates and screws per 2 ft x 4 ft (0.6 x 1.2 m) perlite board. Single plies of PermaPly #28 and Bitec's FS-2H were in turn hot mopped with asphalt at a rate of 25 lbs/sq (1.2 kg/m²). Bitec's SPM-4.5T cap sheet was placed on top of the assembly and torch applied to the interply sheet.

4.3 ASTM E-108 (91) Spread of Flame Samples

Five samples, 3 ft 4 in. x 8 ft 0 in. (1 m x 2.4 m) were constructed as shown below. All utilized 1.5 in. (38 mm) thick ACFoam II or E'NRG'Y 2 insulation loose laid with either a 1 in (25 mm) thick wood fiber or 0.75 in (19 mm) thick perlite coverboard mechanically attached through the insulation to the plywood deck. A single layer of PermaPly #28 was hot mopped to the coverboard. The membrane combinations used were as shown below. All assemblies were topped with Karnak's #97 Coating applied at a rate of 1.5 gal/sq (0.6 L/m²)

- | | |
|-------------|--|
| Sample No.1 | 1 in (25 mm) wood fiber, PermaPly #28, 2 plies of Glas Ply IV and Bitec SPM-3.5H cap sheet, all hot mopped. Karnak #97 coating. Slope was 1.5:12 |
| Sample No.2 | Same as #1 |
| Sample No.3 | 0.75 in (19 mm) perlite, PermaPly #28, one ply of Bitec PS-2H and Bitec SPM-3.5H cap sheet, all hot mopped. Karnak #97 Coating. Slope was 0.75 12 |
| Sample No.4 | 0.75 in (19 mm) perlite, PermaPly #28 hot mopped, one ply of Bitec FA-2T torch applied and Bitec APM-4T cap sheet, torch applied. Karnak #97 Coating. Slope was 0.75:1 2 |
| Sample No.5 | 0.75 in (19 mm) perlite, PermaPly #28, one ply of Bitec FS-2H and Bitec SPM-3.5H cap sheet, all hot mopped. Karnak #97 Coating. Slope was 0.75:12. |

4.4 Comparative Tinius Olsen 'T' Peel Delamination Testing

4.4.1 A series of small scale comparative Tinius-Olsen Pull Through test samples were conducted in order to determine the most critical combination for use in full scale tests.

V RESULTS

5.1 FMRC Class I Fire Test Panels

5.1.1 Four calorimeter tests were conducted. The initial series consisted of two tests, Sample Nos. 2 and 3. Upon review of these results, two additional samples were tested at a later date. Sample Nos. 1 and 4. A review of the results of the 1st series of tests indicated that the values were very similar. As a result, only Sample 2 was evaluated. Sample 3 was considered to be slightly more critical. The calorimeter tests showed that some of the test panels have fuel contribution rates below the maximum permissible rate for Class 1 Insulated Steel Deck Roof construction. The results and the Class 1 limits are given below:

Maximum Average Rate of Fuel Contribution
Btu/sq ft/min (kg-cal/sq margin) for
Various Intervals of Time

	<u>3 min.</u>	<u>5 min.</u>	<u>10 min.</u>	<u>Avg.</u>	<u>Result</u>
Class I Standard	410 (1111)	390 (1057)	360 (975)	285 (772)	
Sample No.1 (Test No.4635)	340 (921)	340 (921)	321 (869)	279 (756)	Pass
Sample No.2 (Test No.4599)	417 (1127)	401 (189)	375 (1016)	350 (948)	Fail
Sample No.3 (Test No.4600)	Not evaluated				Fail
Sample No.4 (Test No.4634)	194 (526)	191 (518)	176 (477)	139 (377)	Pass

5.2 FMRC Windstorm Classification Tests

The Spread of Flame Test results are noted below:

5.2.1 Sample 1 met the 90 psf (4.3 kPa) requirement for Class 1-90 Windstorm Classification.

5.3 ASTM E-108 (91) Spread of Flame Samples

	<u>Slope</u>	<u>Class Tested</u>	<u>Max. Flame Spread</u>	<u>Class Obtained</u>
Sample No.1	1.5:12	A	50 in (1.2 m)	A
Sample No.2	1.5:12	A	24 in (0.6 m)	A
Sample No.3	0.75:12	A	14 in (0.4 m)	A
Sample No.4	0.75:12	A	14 in (0.4 m)	A
Sample No.5	0.75:12	A	12 in (0.3 m)	A

5.4 Comparative Tinius Olsen 'T' Peel Delamination Testing

5.4.1 "T" peel values were obtained for various base/interply and cap sheet combinations as shown below. All samples were hot mopped except those designated with (t) which is used to indicate that they were torch adhered. NT denotes not tested because a more critical membrane was tested in its place. X denotes that the membrane combinations are not viable combinations.

Ply sheets	<u>Average of Three (lbs)</u>				
	<u>Glas Ply IV</u>	<u>Glas Ply Premier</u>	<u>PS-2H</u>	<u>FS-2H</u>	<u>FA-2T</u>
<u>Base/cap sheets</u>					
PermaPly #28	3.5	6.1	4.3	3.0	4.9(t)
GlasBase	3.8	4.9	4.9	4.5	3.2(t)
GAFGLASS #75	5.8	4.8	6.1	5.0	4.7(t)
SPM-3.5H	6.8	3.4	3.6	6.4	X
SFM-3.5H-FR	6.5	7.0	6.3	6.2	X
SPS-3H	5.3	5.7	4.8	4.1	X
APS-4T	5.3(t)	5.4(t)	X	X	5.2(t)
APM-4T	4.8(t)	4.9(t)	X	X	4.0(t)
APM-4.5T	NT	NT	X	X	NT
SPM-4.5T	9.6(t)	13.3(t)	6.0(t)	3.3(t)	X
GlasPly IV	5.6	X	X	X	X
Glas Ply Premier	X	4.6	X	X	X

VI CONCLUSIONS

6.1 The test results obtained indicate that the roofing interply membrane products as shown below, meet FMRC Approved Standard 4470 requirements for Class 1 Fire and 1-60 Windstorm Classifications in insulated roof construction, when installed as shown in the current edition of the FMRC Approval Guide and as outlined below.

6.2 Class 140 and 1-90 Windstorm Classification – Non-Modified Interply Sheets

6.2.1 The following assemblies meet FMRC Class 1-60 and 1-90 Windstorm Classification requirements when constructed as outlined below. The assemblies have a Class A rating (per ASTM E108) at a maximum slope of 1 1/2 in per 12 in (1.5:12).

6.2.1.1 Roof insulation boards, minimum 1.5 in (38 mm) thick, are loose laid over a steel or concrete deck. A 1 in (25 mm) thick wood fiber or 3/4 in (19 mm) thick perlite coverboard is placed over the insulation boards and mechanically secured through both layers to FMRC Approved steel decks (min 22 ga) or structural concrete decks using four (4) screws and stress plates (#14 screws for structural concrete) per 2 ft x 4 ft (0.6 x 1.2 m) coverboard lone fastener per 2 ft² (0.19 m²). A base sheet is hot mopped to the coverboard with hot asphalt. One or two plies of the interply sheets are hot mopped to the base sheet with hot asphalt. The roof cover is then adhered to the interply sheet with either hot asphalt or by torching, as appropriate. All hot mopping is applied at a rate of 25 lbs/sq (1.2 kg/m²). Karnak #97 Coating is then applied to the roof cover at a rate of 1-1/2 gal/sq (0.65 L/m²).

Roof insulations, min 1.5 in (38 mm) thick:
Wood fiber, min. 1 in (25 mm) thick:

E'NRG'Y 2; ACFoam II
Armor Board Regular; Esgard; Celotex
Fiberboard; GAFTEMP Fiberboard; Huebert
Fiberboard; Kop-R Wood Fiber

Perlite, min 3/4 in (19 mm) thick;	Celotherm; ConPerl; GAFTEMP Permalite; GAFTEMP Perlite; Fesco Board
Fasteners (metal plates only):	Dekfast Hex Plate; Olympic; Rawl 3 in; Buildex Flat Bottom
Base sheets:	PermaPly #28; GlasBase; VaporBar, GAFGLASS #75
Interply sheets;	GlasPly IV; GlasPly Premier
Cap sheets (hot asphalt applied):	SPM-3.5H; SFM-3.5H-FR; SPS-3H
Cap sheets (torch applied):	APS-4T; APM-4T; SPM-4.5T

6.3 Class 1-60 and 1-90 Windstorm Classification – Modified Interply Sheets

6.3.1 The following assemblies meet FMRC Class 1-60 and 1-90 Windstorm Classification requirements when constructed as outlined below. The assemblies have a Class A rating (per ASTM E108) at a maximum slope of 3/4 in per 12 in (0.75:12).

6.3.1.1 Roof insulation boards, minimum 1.5 in (38 mm) thick, are loose laid over a steel or concrete deck. A 3/4 in (19 mm) thick perlite coverboard is placed over the insulation boards and mechanically secured through both layers to FMRC Approved steel decks (min 22 ga) or structural concrete decks using four (4) screws and stress plates (#14 screws for structural concrete) per 2 ft x 4 ft (0.6 x 1.2 m) coverboard [one fastener per 2 ft² (0.19 m²)] A base sheet is hot mopped to the coverboard with hot asphalt. One ply of the interply sheet is hot mopped or torch applied, as appropriate. The roof cover is then adhered to the interply sheet by torching. All hot mopping is applied at a rate of 25 lbs/sq (1.2 kg/m²). Karnak #97 Coating is then applied to the roof cover at a rate of 1-1/2 gal/sq (0.65 L/m²).

Roof insulations, min 1.5 in (38 mm) thick:	E'NRG'Y 2; ACFoam II
Perlite, min 3/4 in (19 mm) thick;	Celotherm; ConPerl; GAFTEMP Permalite; GAFTEMP Perlite; Fesco Board
Fasteners (metal plates only):	Dekfast Hex Plate; Olympic; Rawl 3 in; Buildex Flat Bottom
Base sheets:	PermaPly #28; GlasBase; VaporBar, GAFGLASS #75
Interply sheets:	Compabase PS-2H; FS-2H; FA-2T
Cap sheets (torch applied):	APS-4T; APM-4T; APM-4.5T; SPM-4.5T
Cap sheets (hot asphalt applied):	SPM-3.5H; SFM-3.5H-FR; SPS-3H

Note: The PS-2H and FS-2H interply sheets shall only be used with an SBS modified cap sheet. Likewise, the FA-2T interply sheet shall only be used with an APP modified cap sheet.

6.4 These and previous tests show that the above roof constructions in and of themselves alone would not create a need for automatic sprinkler protection.

6.5 The number of insulation fasteners must be increased by 50% at the roof corners to meet 1-60 Windstorm Classification and at the roof corners and edges to meet 1-90 Windstorm Classification. See Loss Prevention Data Sheets 1-28, 1-29, and 1-29S for details.

6.6 The roof covers must be installed using an FMRC Approved roof perimeter flashing system (see FMRC Approval Guide).

6.7 The tested insulations, when installed as described above, meet Factory Mutual Research Corporation Approval requirements, and when Approval is effective, will be listed in the Factory Mutual Research Corporation Approval Guide.

6.8 Approval is effective when the Approval Agreement (FMRC Form L-15) is signed and received by Factory Mutual Research Corporation.

6.9 Continued Approval will depend upon satisfactory field experience and periodic Facilities and Procedures Audit quality assurance follow-up inspections.

VII MARKINGS

7.1 The manufacturer shall mark each packing container with the manufacturer's name and product trade name, the FMRC Approval Mark, and the words, "Roof membrane subject to the conditions of Approval as described in the FMRC Approval Guide."

7.2 Markings indicating FMRC Approval may only be applied to such products as Approved by this report at manufacturing facilities under FMRC's follow-up Facilities and Procedures Audit program.

VIII MANUFACTURER'S RESPONSIBILITIES

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

8.2 The manufacturer shall notify the Factory Mutual Research Corporation of any planned change in the Approved product prior to general sale or distribution. All requests for changes shall be made and agreed to in writing, utilizing Factory Mutual Research Corporation Form 797, "Approved Product-Revision Report".

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

8.4 Continued Approval is based upon the manufacture of roof membranes in accordance with this Approval Report, satisfactory field experience, and continued use of acceptable quality control procedures as determined by Facilities and Procedures Audits.

IX FACILITIES AND PROCEDURES AUDITS

9.1 Ongoing follow-up Facilities and Procedures Audits at the Bitec facility located in Morrilton, AR have indicated that Bitec has the necessary equipment, facilities, personnel and quality controls to manufacture roof membranes listed in this report, according to Factory Mutual Research Corporation Approval requirements.

9.2 Periodic, unannounced Facilities and Procedures Audits will be conducted to determine that the quality and uniformity of the component parts being used in the manufacture of Factory Mutual Research Corporation Approved roof membranes are being maintained and that they are providing a level of quality equivalent to that originally tested and Approved.

9.3 Factory Mutual Research Corporation Approval recognition is contingent upon satisfactory results of the follow-up Facilities and Procedures Audits.

9.3.1 Unsatisfactory results of Facilities and Procedures Audits may result in additional Facilities and Procedures Audits as deemed necessary by Factory Mutual Research Corporation or forfeiture of Approval recognition.

TEST SUPERVISION AND REPORT BY:

REVIEWED BY:



Jeffrey E. Gould
Assistant Section Manager



George A. Smith, Manager
Building Materials Section

JEG/0B3A7.REP



Factory Mutual Research

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P.O. Box 9102
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1Z7A0.AM
(4470)

December 27, 1995
(Re-issued Jan. 31, 1996)

APPROVAL OF MODIFIED BITUMEN
ROOF COVERS
FOR USE IN
CLASS 1 INSULATED
STEEL AND STRUCTURAL CONCRETE
ROOF CONSTRUCTIONS

for

BITEC, INC.
PO BOX 497
MORRILTON, ARKANSAS 72110

I INTRODUCTION

1.1 Bitec, Inc. submitted their APS-4T, APM-4T, APM-4.5T, SPM-4.5T, SPS-3H, SPM-3.5H and SFM-3.5H-FR modified bitumen roof covers for an evaluation to determine if they meet Factory Mutual Research Corporation (FMRC) Approved Standard 4470 requirements for Class 1 Fire and 1-60 and 1-90 Windstorm Classifications when used as a roofing component over various NRG Barriers, Inc. insulation boards in Class 1 insulated roof constructions.

1.2 Prior Approval has been given to these membranes under a previous test program. For details, see FMRC report JI OQ3A3.AM.

1.3 This examination included small scale pull through and delamination testing, full scale wind uplift testing and fire testing for interior and exterior fire spread as required by Approval Standard 4470.

1.4 As a manufacturer of a Factory Mutual Research Corporation Approved product, Bitec, Inc. will be subjected to FMRC's follow-up Facilities and Procedures Audit inspection program. The purpose of the inspections is to satisfy FMRC that the manufacturer is using sufficient quality controls to assure continued productions of units equivalent to those originally tested and Approved. Facilities that are under the Facilities and Procedures Audit inspection program and authorized to apply markings denoting FMRC Approval are as follows:

1.4.1 Bitec, Inc. No.2 Industrial Park Drive Morrilton, AR

1.5 Tests show that the Bitec, Inc. modified bitumen roof covers, as shown and described elsewhere in this report, meet FMRC Approval Standard 4470 requirements for Class 1 Fire and 1-60 and 1-90 Windstorm Classifications when installed as described in the CONCLUSIONS of this report.

1.5.1 This report is re-issued to correct the original report which incorrectly showed the product name as SPM-3.5H-FR. The correct product name is SFM-3.5H-FR.

II MATERIAL DESCRIPTION

2.1 The products shown below were used in this test program. All formulations are on file at FMRC.

2.1.1 Roof covers – manufactured by Bitec, Inc.

2.1.1.1 The APP (Atactic Polypropylene) membranes (APS-4T; APM-4T and APM-4.5T) are bitumen polymer roof covers, strengthened with plastomers and reinforced with a continuous filament, non-woven spunbond polyester core. They are supplied in 0.18 or 0.15 in. (4.5 or 4.0 mm) thicknesses. They are designed to be hot torch applied to a base sheet.

2.1.1.2 The SBS (Styrene Butadiene Styrene) membranes (SPM-4.5T; SPM-3.5H; SFM-3.5H-FR and SPS-3H) are polymer modified roof covers, reinforced with a continuous filament non-woven spunbond polyester core. They are supplied in 0.18, 0.14 or 0.12 in. (4.5, 3.5 or 3.0 mm) thicknesses. They are designed for either hot mopping (H) or hot torching (T) applications to a base sheet. The SPM-3.5H-FR membrane is fire retardant treated.

2.1.2 Fasteners – previously Approved and manufactured by others as shown:

- a) Olympic Standard Plate (metal) with #12 Olympic screw
- b) Rawl 3 in. Insulation Plate (metal) with #12 screw
- c) Dekfast Hex Plate (metal) with #12 Dekfast screw
- d) Buildex Premium Metal Plate (metal) with #12 Roofgrip screw

2.1.3 Insulations and Cover Boards – 1.5 in. (38 mm) thick unless shown otherwise: All thicknesses are minimums.

- a) NRG Barriers: E"NRG"Y 2; E"NRG"Y 2 Composite; E"NRG"Y 2 Plus
- b) Perlite 0.75 in. (19 mm) thick
- c) Wood Fiber 1.0 in. (25 mm) thick

2.1.4 Base Sheets – previously Approved and manufactured by others as shown:

- a) GAF: GAFGLASS #75
- b) OCF: PermaPly #28
- c) Celotex: Vaporbar GB
- d) Schuller GlasBase

2.1.5 Roof Coatings – previously Approved and manufactured by others as shown:

- A) Karnak No. 97 Emulsion Coating

III TESTS: PROCEDURES AND CRITERIA

Tests were conducted as required by FMRC Approval Standard 4470, "Class I Roof Covers"

3.1 FMRC Calorimeter Fire Tests

3.1.1 A calorimeter fire test was conducted using the FMRC Construction Materials Calorimeter which measures the maximum acceptable rate of fuel contribution by the sample roof, also expressed as a maximum heat release rate (HRR). For a Class 1 rating, the assembly must exhibit a heat release rate (HRR) no greater than those shown in paragraph 5.1 during the 30 minute fire exposure.

3.2 FMRC Windstorm Classification Tests

3.2.1 The tests were conducted using the FMRC simulated wind uplift test apparatus to evaluate the ability of the above deck components to resist a simulated wind force of 60 psf (2.9 kPa) and 90 psf (4.3 kPa) without failure of the assembly.

3.2.2 The uplift pressure test utilizes a 9 ft. (2.7 m) long by 5 ft. (2.5 m) wide x 2 in. (51 mm) deep steel pressure vessel arranged to apply air pressure at pre-established standard rates to the underside of the test panel which forms the top of the pressure vessel. The vessel is pressurized with compressed air.

3.2.3 A net force of 30 psf (1.4 kPa) was applied to each test sample and maintained for one minute. The force was increased to 45 psf (2.2 kPa), then to 60 psf (2.9 kPa) and held for one minute at each increment. The pressure was increased in increments of 15 psf. (0.7 kPa) every minute until failure occurred.

3.3 Comparative Tinius Olsen Pull Through Testing

A series of Tinius Olsen tension tests were conducted as a comparative evaluation of the fastener/stress plate pull through performance of insulations or base sheets, as applicable, with different fasteners. For each pull-through test, force is exerted in a direct line parallel to the shank of the screw at a speed of 2 in./min (51 mm/min) until failure occurred, resulting in a respective pull-through value for each sample. These values were used as the basis for selection of the most critical components to be used in full scale wind uplift tests.

3.4 Comparative Tinius Olsen Delamination Testing

A series of Tinius Olsen delamination tests were conducted to compare the various insulation/base sheet/cap sheet delamination performance. For each delamination test, force was exerted in a direct line perpendicular to the surface of the specimen at a speed of 2 in/min (51 mm/min) until failure/delamination occurred, resulting in a respective delamination value. These values were used as the basis for selection of the most critical components to be used in full scale wind uplift testing.

3.5 ASTM E108 Fire Tests

3.5.1 The exterior fire tests were conducted in accordance with the ASTM E108 Fire Tests of Roof Coverings, Class A, non-combustible deck test procedure. The wind velocity over the top of each sample was adjusted to 12 ± 0.5 mph (5.4 ± 0.2 m/s). The tests were conducted at a 3/4 in 12 slope.

3.5.2 The Spread of Flame Tests were conducted by adjusting the flame to $1400 \pm 50^\circ\text{F}$ ($760 \pm 28^\circ\text{C}$) as determined by a thermocouple located 1 in. (25 mm) above the surface and 0.5 in. (13 mm) toward the source of the flame from the lower edge of the panel. The sample size was 3 ft. 4 in. by 8 ft. (1.0 by 2.4 m). The flame was applied continuously for 10 minutes. During and after the application of the flame, the panel was observed for distance of maximum flame spread, glowing brands and other damage.

3.6 Simulated hail damage, resistance to foot traffic susceptibility to leakage and some ASTM E-108 spread of flame testing were waived due to previous successful test results on these membranes.

IV TEST SAMPLES

4.1 FMRC Class 1 Fire Test Panels

A test sample 4 ft. 6 in. x 5 ft. 0 in. (1.4 x 1.5 m) was constructed as follows:

NRG 2 Plus roof insulation, 1.5 in. (38 mm) thick (wood fiber side up) was mechanically attached to an 18 ga (1 mm) steel deck. PermaPly #28 base sheet hot mopped with asphalt to the insulation with Bitec's SPM-3.5H roof cover hot mopped with asphalt to the base sheet.

4.2 FMRC Windstorm Classification Tests

Two 5 ft. x 9 ft. (1.5 m x 2.7 m) simulated wind uplift pressure test panels were constructed as follows:

Sample No. 1: NRG 2 insulation boards, 1.5 in.(38 mm) thick, was loose laid over a 22 ga steel deck. Perlite, 3/4 in. (19 mm) thick, with joints staggered, was placed over the insulation and mechanically fastened through the insulation into the steel deck using four (4) Olympic Standard Metal Plates with #12 screws per 2 ft. x 4 ft. (0.6 x 1.2 m) coverboard [1 fastener per 2 ft² (0.09 m²)]. PermaPly #28 base sheet was hot mopped with asphalt to the perlite coverboard with Bitec's APM-4T roof cover torch applied to the base sheet.

Sample No. 2: NRG 2 Composite, 1.5 in. (38 mm) thick, (perlite side up) was mechanically attached to a 22 ga steel deck with four (4) Olympic Standard Metal Plates with #12 screws per 4 ft. x 4 ft. (1.2 m x 1.2 m) board (one fastener per 4 ft² [0.4 m²]). PermaPly #28 base sheet was hot mopped with asphalt to the NRG 2 Composite board with Bitec's APM-4T roof cover torch applied to the base sheet.

4.3 Comparative Tinius Olsen Pull Through Tests

A series of fastener pull through test samples were prepared by cutting the selected insulations into 14 in. x 14 in. (0.4 x 0.4 m) pieces before being placed in an angle iron frame. The frame allows for a clear span of 12 in. x 2 in. (0.3 x 0.3 m). The fastener (screw and plate) was placed through the center of the sample with the shank of the screw held in the upper jaws of the tester. Force was exerted in a direct line parallel to the shank of the screw. A pull through value was obtained for each specimen.

4.4 Comparative Tinius Olsen Delamination Tests

A series of delamination tests were conducted by cutting the selected membranes into 2 in. (51 mm) wide strips and adhering the base and cap sheets together with either hot asphalt or hot torching. An edge of each of the membranes was placed in both the upper and lower jaws of the tester. Force was exerted in a direct line perpendicular to the membranes until a peel value was obtained for each combination of membranes.

4.5 ASTM E108 Spread of Flame Test Samples

Three 3 ft. 4 in. by 8 ft. (1.0 x 2.4 m) test decks were constructed over 1/2 in. (13 mm) thick plywood as follows:

1.5 in (38 mm) NRG 2 Plus mechanically attached
PermaPly #28 Base Sheet hot mopped to the insulation
SFM-3.5H-FR torch adhered to the base sheet

V RESULTS

5.1 FMRC Class I Fire Test Panels

The calorimeter tests showed that the test panel has fuel contribution rates below the maximum permissible rate for Class 1 Insulated Steel Deck Roof construction. These rates and the Class 1 limits are given below:

	Maximum Average Rate of Fuel Contribution Btu/sq ft/min (kg-cal/sq m/min) for <u>Various Intervals of Time</u>			
	<u>3 min.</u>	<u>5 min.</u>	<u>10 min.</u>	<u>Avg.</u>
Class I Standard	410 (1111)	390 (1057)	360 (975)	285 (772)
Sample No. 1	348 (943)	333 (902)	304 (823)	269 (729)

5.2 FMRC Windstorm Classification Tests

Both of the Simulated Wind Uplift Pressure Test samples met the 60 psf (2.9 kPa) requirement for Class 1-60 Windstorm Classification. In addition, Sample No. 2 met the 90 psf (4.3 kPa) requirement for Class 1-90 Windstorm Classification.

5.3 Fastener Pull Through Insulation Tests

The results of the fastener pull through insulation tests are as shown below. The NRG 2 Composite and Plus insulation boards were tested with the coverboard side face up.

<u>Fastener</u>	<u>Insulation</u>	<u>Average of Three</u>	
		<u>Avg. Load. lbs (kg)</u>	
Dekfast Hexplate (metal)	1.5 in. NRG 2 Composite	283	(129)
	1.5 in. NRG 2 Plus	358	(163)
	1 in. wood fiber	210*	(95)
	3/4 in. perlite	102*	(46)
Olympic Standard (metal)	1.5 in. NRG 2 Composite	275	(125)
	1.5 in. NRG 2 Plus	331	(150)
	1 in. wood fiber	216*	(98)
	3/4 in. perlite	103*	(46)
Buildex Premium (metal)	1.5 in. NRG 2 Composite	285	(130)
	1.5 in. NRG 2 Plus	330	(150)
	1 in. wood fiber	104*	(47)
	3/4 in. perlite	101*	(46)
Rawl 3 in Insulation (metal)	1.5 in. NRG 2 Composite	292	(133)
	1.5 in. NRG 2 Plus	328	(149)
	1 in. woodfiber	199*	(90)
	3/4 in. perlite	105*	(48)

* values are taken from JI OQ3A3.AM

5.4 Base and Cap Sheet Delamination Tests

The results of the base and cap sheet membrane delamination tests are shown below. From the previous test program, PermaPly #28 Base Sheet is considered to be the most critical.

<u>Cap Sheet</u>	<u>Application</u>	<u>Average of Three</u>	
		<u>Avg. Load. lbs (kg)</u>	
APS-4T	Torched	4.9	(2.2)
APM-4T	Torched	4.5	(2.0)
SPM-4.5T	Torched	9.8	(4.5)
SPS-3H	Hot asphalt	6.5	(2.9)

5.5 ASTM E108 Spread of Flame Tests

<u>Sample No.</u>	<u>Slope</u>	<u>Class</u>	<u>Max Flame Spread. ft(m)</u>	
1	1/2 in 12	A	2.5	(0.8)
2	3/4 in 12	A	1.3	(0.4)
3	3/4 in 12	A	2.9	(0.8)

VI CONCLUSIONS

6.1 The test results obtained, in conjunction with and/or compared to the results obtained in J.I. OQ3A3.AM, indicate that Bitec, Inc. modified bitumen roof covers, as shown below, meet FMRC Approved Standard 4470 requirements for Class 1 Fire and 1-60 and 1-90 Windstorm Classifications in insulated roof construction, when installed as outlined in the current edition of the FMRC Approval Guide and as outlined below.

6.2 Insulation boards may be mechanically attached to steel or structural concrete roof decks using the minimum insulation thicknesses and fasteners shown below for the particular Windstorm Classification. Alternately, the insulation boards meet FMRC Class 1-60 and 1-90 Windstorm requirements, when secured to structural concrete decks with hot asphalt at the application rate of 25 lbs/sq. (1.1 kg/ m²).

6.2.1 Class 1-60 Windstorm Classification

6.2.1.1 NRG 2 – Min. 1.5 in. (38 mm) thick roof insulation boards are loosely laid over the roof deck. A min 1 in. (25 mm) thick wood fiber cover board or a 0.75 in. (19 mm) thick perlite cover board is placed over the insulation, with joints staggered, and mechanically secured through the insulation to the deck using the fasteners shown below applied at a density of 1 fastener per 2 ft² (0.2 m²). The Approved base sheets are hot mopped to the coverboard. The cap sheets are then adhered to the base sheet with hot asphalt or by hot torching as shown below (see Appendix A for fastener pattern). Karnak No.97 emulsion coating is applied to the cap sheet (coating is not required when SPM-3.5H-FR cap sheet is used) at a rate of 1-1/2 gal/sq (0.6 liters/m²).

6.2.2 Class 1-90 Windstorm Classification

6.2.2.1 NRG 2 Composite or NRG 2 Plus, min. 1.5 in. (38 mm) thick, 4 x 4 ft (1.2 x 1.2 m) roof insulation boards are placed over the roof deck and secured to the deck using the fasteners shown below applied at a density of 1 fastener per 4 ft² (0.4 m²). The Approved base sheets are hot mopped to the coverboard. The cap sheets are then adhered to the base sheet with hot asphalt or by hot torching as shown below (see Appendix A for fastener pattern). Karnak No.97 emulsion coating is applied to the cap sheet (coating is not required when SPM-3.5H-FR cap sheet is used) at a rate of 1-1/2 gal/sq (0.6 liters/m²).

6.3 The following base sheets and fasteners may be used in the assemblies described above:

6.3.1 Base sheets

- a) GAF: GAFGLASS #75
- b) OCF: PermaPly #28
- c) Celotex: Vaporbar GB
- d) Schuller: GlasBase

6.3.2 Fasteners (# 12 screws for steel deck and #14 screws for concrete decks)

- a) Olympic Standard Plate (metal)
- b) Rawl 3 in. Insulation Plate (metal)
- c) Dekfast Hex Plate (metal)
- d) Buildex Premium Metal Plate (metal)

6.4 ASTM E108 Spread of Flame Ratings – the roof cover assemblies shown above have obtained the following ASTM E108 Spread of Flame ratings for non-combustible decks when coated with Karnak No.97 emulsion coating (coating is not required when the SPM-3.5H-FR cap sheet is used):

<u>Roof Cover</u>	<u>Max. Slope</u>	<u>Rating</u>
APS-4T	1.5 in 12	A
APM-4T; APM-4.5T	1.5 in 12	B
SPM-4.5T; SPM-3.5H	3/4 in 12	B
SPS-3H	3/4 in 12	A
SFM-3.5H-FR	3/4 in 12	A

6.5 These and previous tests show that the above roof constructions in and of themselves alone would not create a need for automatic sprinkler protection.

6.6 The number of insulation fasteners must be increased by 50% at the roof comers to meet 1-60 Windstorm Classification and at the roof comers and edges to meet 1-90 Windstorm Classification. See Loss Prevention Data Sheets 1-28, 1-29, and 1-29S for details.

6.7 The roof covers must be installed using an FMRC Approved roof perimeter flashing system (see FMRC Approval Guide).

6.8 The tested insulations, when installed as described above, meet Factory Mutual Research Corporation Approval requirements, and when Approval is effective, will be listed in the Factory Mutual Research Corporation Approval Guide.

6.9 Approval is effective when the Approval Agreement (FMRC Form L-15) is signed and received by Factory Mutual Research Corporation.

6.10 Continued Approval will depend upon satisfactory field experience and periodic Facilities and Procedures Audit quality assurance follow-up inspections.

VII MARKINGS

7.1 The manufacturer shall mark each roll with the manufacturer's name and product trade name, the FMRC Approval Mark, and the words, "Roof cover subject to the conditions of Approval as described in the FMRC Approval Guide."

7.2 Markings indicating FMRC Approval shall only be applied to such products as Approved by this report at manufacturing facilities that are under FMRC's follow-up Facilities and Procedures Audit program.

VIII MANUFACTURER'S RESPONSIBILITIES

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

8.2 The manufacturer shall notify the Factory Mutual Research Corporation of any planned change in the Approved product prior to general sale or distribution. All requests for changes shall be made and agreed to in writing, utilizing Factory Mutual Research Corporation Form 797, "Approved Product-Revision Report'.

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

8.4 Continued Approval is based upon the manufacture of roof covers in accordance with this Approval Report, satisfactory field experience, and continued use of acceptable quality control procedures as determined by Facilities and Procedures Audits.

IX FACILITIES AND PROCEDURES AUDITS

9.1 Ongoing follow-up Facilities and Procedures Audits at the Morrilton, AR facility have indicated that Bitec, Inc. has the necessary equipment, facilities, personnel and quality controls to manufacture roof covers listed in this report, according to Factory Mutual Research Corporation Approval requirements.

9.2 Periodic, unannounced Facilities and Procedures Audits will be conducted to determine that the quality and uniformity of the component parts being used in the manufacture of Factory Mutual Research Corporation Approved roof insulation boards is being maintained and that they are providing a level of quality equivalent to that originally tested and Approved.

9.3 Factory Mutual Research Corporation Approval recognition is contingent upon satisfactory results of the follow-up Facilities and Procedures Audits.

9.3.1 Unsatisfactory results of Facilities and Procedures Audits may result in additional Facilities and Procedures Audits as deemed necessary by Factory Mutual Research Corporation or forfeiture of Approval recognition.

TEST SUPERVISION AND REPORT BY:



Jeffrey E. Gould
Assistant Section Manager

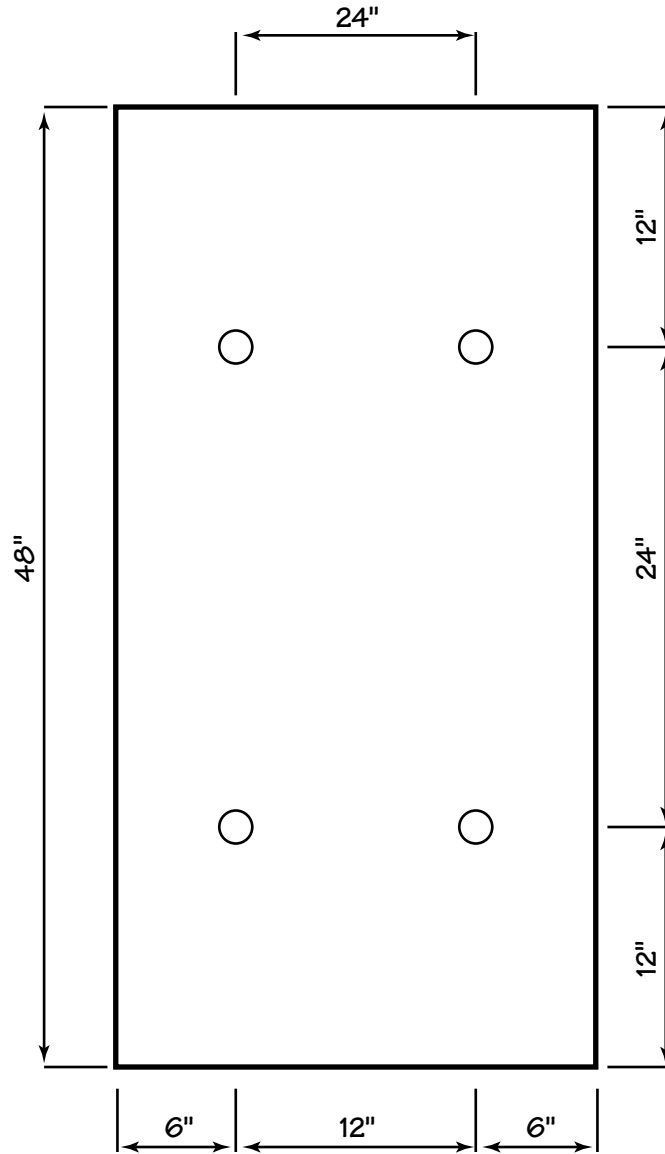
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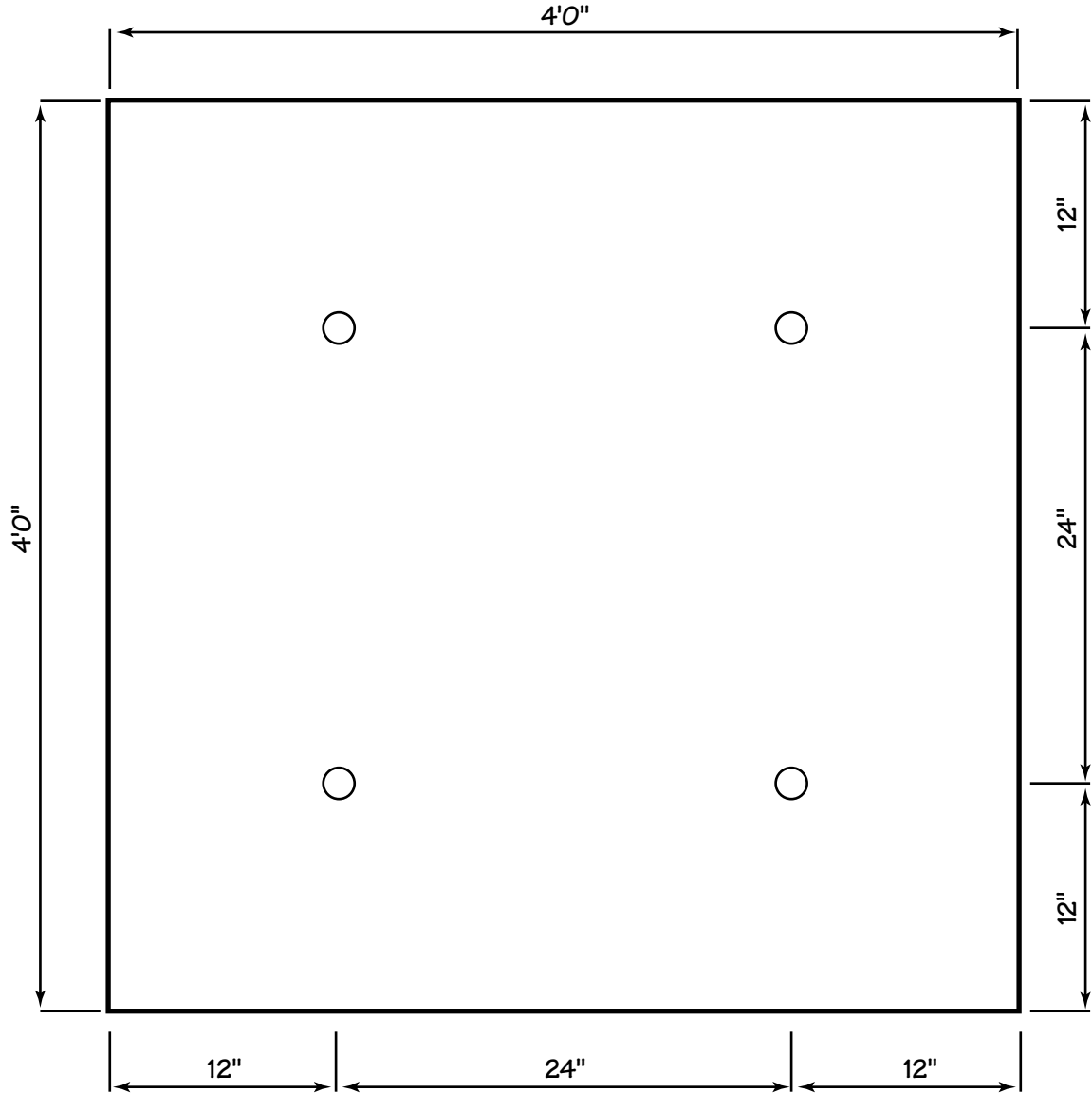


George A. Smith, Manager
Building Materials Section

Attached: Appendix A – Fastener Pattern, 1-60 and 1-90 Rating



1-60 Fastener Pattern For Use With Cover Boards
Four (4) Fasteners per 2 ft x 4 ft (0.6m x 1.2 m) Cover Board
[1 fastener per 2 ft² (0.2 m²)]



1-90 Fastener Pattern
Four (4) Fasteners per 2 ft x 4 ft (1.2 m x 1.2 m) Composite Board
[1 fastener per 4 ft² (0.4 m²)]



Factory Mutual Research

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

OQ3A3.AM
(FMRC STANDARD 4470)

March 23, 1989

BITEC MODIFIED BITUMEN
ROOF COVERS
(APM-4.5T, APS-4T, SPM-4.5T, SPM 3.5H, and SPS-3H)
FOR USE IN

- 1) Recover
- 2) Insulated Steel Deck
- 3) Concrete Deck Constructions

from
BITEC INCORPORATED

P.O. BOX 497
NO. 2 INDUSTRIAL PARK DRIVE
MORRILTON, ARKANSAS 72110

I INTRODUCTION

1.1 Bitec Incorporated submitted their modified bitumen membrane roof covers for testing to determine if they meet Factory Mutual Research Corporation Standard 4470 approval requirements for Class I Fire and I-60 or I-90 Windstorm Classification in Recover and Insulated Steel and Concrete Deck Roof Constructions.

1.2 Examination included fire testing for potential interior fire spread, ASTM E-108 (83) Fire Tests of Roof Coverings, and physical testing for fastener pull-through-insulation, pull-through-base sheet, simulated wind uplift, simulated hail damage, resistance to foot traffic, and susceptibility to leakage.

1.3 Test results indicate that the modified bitumen membrane roof covers meet Factory Mutual Research Corporation Standard 4470 approval requirements for Class I Fire and I-60 or I-90 Windstorm Classification when installed as described in the Conclusions of this report.

II MATERIAL DESCRIPTIONS

2.1 The proprietary formulations of the following materials are on file at Factory Mutual Research Corporation.

2.2 Components

2.2.1 APP Membrane (APS or APM) is a bitumen-polymer waterproofing membrane of distilled bitumen, strengthened with plastomers and reinforced with a continuous filament non-woven spunbond polyester core, supplied in 0.15 or 0.13 in. (4 or 4.5 mm) thickness.

2.2.2 SBS membrane (SPS or SPM) is a polymer-modified elastomeric waterproofing membrane based on styrene butadiene styrene thermoplastic, reinforced with a continuous filament non-woven spunbond polyester core. Supplied in 0.18, 0.14, and 0.12 in. (4.5, 3.5 and 3.0 mm) thickness.

2.2.3 FMRC Approved fasteners and metal plates.

2.2.3.1 Screws: The screw is Size No. 10 or larger with No. 12 high thread design and Truss No. 3 Phillips head. It has a modified BP type milled slot self-drilling point. The length varies and at least 1/2 in. (12 mm) of the screw must protrude through the steel roof deck when installed.

2.2.3.2 Metal Stress Plates: Steel sections formed in various dimensions with a hole in the center through which the screw is driven.

2.2.4 Insulation, FMRC Approved.

2.2.4.1 Fiberglass Roof Insulation board is a rigid factory fabricated board consisting of a glass fiber core faced on the top side with 40 lb (18.1 Kg) Kraft paper sheet. The paper facing is adhered to the glass fiber core with hot asphalt. The board is manufactured in 4 ft x 3-8 ft (1.2 m x 0.9-2.4 m) sizes.

2.2.4.2 Perlite Board Roof Insulation is expanded perlite blended with selected binders and fibers. It is supplied in 2 ft x 4 ft (0.6 x 1.2 m) size and 3/4 in. (19 mm) thick.

2.2.4.3 Wood Fiberboard Roof Insulation is an asphalt emulsion coated wood fiber based board 1 in. (25 mm) thick. The insulation is supplied in 4 ft x 2-8 ft (1.2 m x 0.6-2.4 m size).

2.2.5 Factory Mutual Approved fiberglass base sheet is an asphalt coated fiberglass mat supplied in rolls 3 ft x 100 ft (0.9 m x 30.5 m). It is further coated with either fine or coarse mineral surfacing.

2.3 Roof Cover Systems

2.3.1 APS – 4T

Approved insulation, one ply of fiberglass base sheet and one ply of APS-4T (0.15 in.) modified bitumen roofing membrane, torch applied – smooth surface.

2.3.2 APM – 4.5T

Approved insulation, one ply of fiberglass basesheet and one ply of APM4.5T (0.18 in.) modified bitumen roofing membrane, torch applied – mineral (granular) roof surface.

2.3.3 SPM-4.5T

Approved insulation, one ply of fiberglass basesheet and one ply of SPM-4.5T modified bitumen roofing membrane, torch applied – mineral (granular) roof surface.

2.3.4 SPM – 3.5H

Approved insulation, one ply of fiberglass basesheet and one ply of SPM-3.5H modified bitumen roofing membrane, hot mop applied – mineral (granular) roof surface.

2.3.5 SPS-3H

Approved insulation, one ply of fiberglass basesheet and one ply of SPS-3H modified bitumen roofing membrane, hot mop applied – smooth roof surface.

III TESTS: CRITERIA AND PROCEDURES

3.1 Tests conducted were as required by Factory Mutual Research Corporation Standard 4470 – Roof Covers.

3.2 FMRC Class I Fire Tests

The fire tests were conducted using the Factory Mutual Research Corporation Construction Materials Calorimeter which measures the maximum rate of fuel contribution by the sample roof cover/insulation combination, also expressed as maximum heat release rate (HRR); e.g. for a Class I rating, the assembly must exhibit a 3 minute heat release rate (HRR) no greater than 410 Btu/ft²/min. (1111 Kg-cal/m²/min.) in any 3 minute time frame during the 30 minute fire exposure.

3.3 ASTM E-108 (83) Fire Tests

3.3.1 The exterior fire tests were conducted in accordance with the ASTM E-108 (83) Fire Tests of Roof Coverings, Class A, noncombustible deck test procedure. The wind velocity over the top of each sample was adjusted to 12 ± 0.5 mph (5.4 ± 0.2 m/s). The tests were conducted at various slopes.

3.3.2 Spread of Flame Tests – The flame was adjusted to 1400 ± 50°F (760 ± 28°C) as 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 panel. Sample size was 3-1/3 ft x 10 ft (1.0 m x 3.05 m). The flame was applied continuously for 10 minutes. During and after application of the flame, the panel was observed for distance of maximum flame spread, glowing brands and other damage.

3.4 Fastener Pull-Through-Insulation and Pull-Through Base Sheet Tests

3.4.1 Pull-through tests of fastener/insulation combinations and fastener/base sheet combinations were conducted prior to full-scale uplift tests to determine comparative performance of board strength or base sheet strength to resist “pull-through” of the fastener head. These comparative tests were conducted to determine the most critical constructions to be evaluated in the full-scale uplift tests.

3.4.2 Tests were conducted using the Tinius Olsen tensile testing machine with force exerted on each test sample at a constant speed of 2 in. (51 mm)/min.

3.5 FMRC Windstorm Classification Tests

3.5.1 Tests were conducted using the FMRC uplift test apparatus to evaluate the ability of the above deck components to resist a simulated wind force of 60 psf (2.9 kPa) or 90 psf (4.3 kPa) without failure of the assembly.

3.5.2 The uplift pressure test utilizes a 9 ft (2.7 m) long x 5 ft (1.5 m) wide x 2 in. (51 mm) deep steel pressure vessel arranged to apply air pressure at pre-established standard rates to the underside of the test panel which forms the top of the pressure vessel. The vessel is pressurized with compressed air.

3.5.3 A net force of 30 psf (1.4 kPa) was applied to each test sample and maintained for 1 minute. The force was increased to 45 psf (2.2 kPa), then to 60 psf (2.9 kPa) and held for 1 minute at each increment. This schedule was increased in increments of 15 psf (0.7 kPa) every minute until failure occurred .

3.6 FMRC Simulated Hail Damage Test

3.6.1 The simulated hail damage test was conducted using the Factory Mutual Research Corporation simulated hail damage test apparatus to evaluate the ability of the roof covering to withstand a hailstorm without damage to the membrane. The test criteria requires that there must be no evidence of splitting or rupture of the roof cover.

3.6.2 A 1-3/4 in. (49 mm) diameter steel ball weighing 0.73 lbs. (0.3 kg) was dropped from a 17 ft 9-1/2 in. (5.4 mm) height through a 2 in. (51 mm) ID steel tube. This procedure was repeated several times on various sections of the sample. After each drop, the sample was inspected for any cracks in the weatherproof membrane. Initially, the sample was tested after a 28 day cure period. Following the initial testing, the sample was conditioned (weathered) for 1000 hours in the Factory Mutual Research Corporation Ultraviolet Weatherometer. The test procedure was then repeated on the conditioned sample.

3.7 FMRC Resistance to Foot Traffic Test

3.7.1 The test was conducted to evaluate the ability of the roof cover to withstand simulated foot traffic without damage to the weather-proof membrane. The test criteria requires that there shall be no tearing or cracking of the protective cover causing exposure of the insulation.

3.7.2 A 3 in. (76 mm) square steel plate with rounded corners was placed on the test sample. A 200 lb (91 kg) load was imposed on the plate, then reduced to zero. This cycle was repeated four additional times. After each cycle, the covering was inspected for damage.

3.8 FMRC Susceptibility to Leakage Test

3.3.1 The leakage test was conducted in accordance with the Factory Mutual Research Corporation Susceptibility to Leakage Test procedure.

3.8.2 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 caps cemented to 7-3/4 in. (197 mm) diameter clear acrylic pipe. An 11-5/8 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.

3.8.3 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 (6.8 kPa) level and cycled 25 times from 1 psig (6.8 kPa) to ambient. Test criteria states 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.

IV TEST samples

4.1 FMRC Class 1 Fire Test Samples

Two 4-1/2 ft x 5 ft (1.1 m x 1.5 m) calorimeter panels were constructed using 18 gauge corrugated steel roof deck as follows:

Test Sample 1

15/16 inch (24 mm) thick fiberglass insulation board
mechanically fastened to the steel deck
fiberglass base sheet hot mop applied.
System APM-4.5T membrane torch applied.

Test Sample 2

1 inch (25.4 mm) thick Perlite insulation board mechanically fastened to the steel deck
fiberglass base sheet hot mop applied.
System SPM-3.5H hot mop applied.

4.2 ASTM E-108 Spread of Flame Test Samples

Five, 40 in. x 10 ft (1 m x 3 m) test decks were constructed over 1/2 in. (13 mm) thick plywood (CDX) as follows:

Test Sample 1

15/16 in. (24 mm) thick fiberglass insulation board.
fiberglass base sheet hot mop applied.
System APS-4T membrane torch applied.
3 inch (76 mm) wide lap.

Test Sample 2

15/16 in. (24 mm) thick fiberglass insulation.
fiberglass base sheet hot mop applied.
System APM-4.5T torch applied with a 4 inch (102 mm) lap.

Test Sample 3

15/16 inch (24 mm) thick fiberglass insulation.
Fiberglass base sheet hot mop applied.
System SPM 4.5T torch applied with a 4 inch (102 mm) lap.

Test Sample 4

1 inch (25 mm) thick wood fiber insulation.
fiberglass base sheet hot mop applied.
System SPS-3H membrane hot mop applied at a 25 lb (11.3 Kg) per square (9.3 m²) rate with 3 inch (76 mm) lap.

Test Sample 5

1 inch (25 mm) thick wood fiber insulation.
Fiberglass base sheet hot mop applied.
System SPM-3.5H membrane hot mop applied at a 25 lb (11.3 kg) per square (9.3 m²) rate with a 3 in. (76 mm) lap.

All samples were coated with Karnak No. 97 emulsion coating at a 1-1/2 gallon (5.7 liters) per square (9.3 m²) rate.

4.3 Fastener Pull-Through-Insulation and Pull-Through Base Sheet Test Samples

A series of fastener pull-through test samples were prepared by cutting the selected insulations and base sheets into 14 in. x 14 in. (0.35 x 0.35 m) pieces before being placed in an angle iron frame.

The frame allows for a clear span of 12 in. x 12 in. (0.3 m x 0.3 m). The fastener (screw and plate) was placed through the center of the sample with the shank of the screw held in the upper jaws of the tester. Force was exerted in a direct line parallel to the shank of the screw. A pull-through value was obtained for each specimen.

4.4 EMRC Windstorm Classification Test Sample

Five 5 ft x 9 ft (1.5 m x 2.7 m) simulated wind uplift panels were constructed on 22 ga. steel deck. The constructions were as follows:

Test Sample 1

15/16 in. (24 mm) thick fiberglass insulation board was mechanically fastened to the steel deck for preliminary securement with 2 fasteners per 3 ft x 4 ft (0.9 x 1.2 m) board.

A fiberglass base sheet was loose laid with a 4 inch (102 mm) lap. Fasteners were spaced 12 in. (.3 m) on center along laps and 12 in. (.3 m) o.c. along center line and driven through the insulation and deck.

System APM-4.5T membrane was torch applied with a 4 inch (102 mm) lap.

Test Sample 2

3/4 inch plywood was used to simulate a concrete deck.

A fiberglass base sheet was loose laid with a 2 inch (51 mm) lap. Zonolite mechanical fasteners were spaced 7-1/2 inch (190 mm) on center along laps, and 16 inch (0.4 m) on center on center line.

System APS-4T membrane was torch applied with a 3 inch (76 mm) center line lap.

Test Sample 3

15/16 inch (24 mm) thick fiberglass insulation fastened to steel deck with one fastener per 2 sq. ft.
A fiberglass base sheet was hot mop applied.
System APS-4T membrane torch applied with 3 inch (76 mm) side lap.

Test Sample 4

15/16 inch (24 mm) fiberglass insulation board mechanically fastened to steel deck with 1 fastener per 3 sq. ft.
A fiberglass base sheet was hot mop applied.
System SPM 4.5T torch applied with 4 inch (102 mm) side laps.

Test Sample 5

1 inch (25 mm) thick Perlite insulation board mechanically fastened to deck with 1 fastener per 2 sq. ft.
A fiberglass base sheet hot mop applied.
System SPS-3H membrane hot mop applied at a 25 lb (1.3 kg) per square (9.3 m²) rate.

4.5 FMRC Simulated Hail Damage Test Sample

Three 2 ft x 4 ft (0.6 m x 1.2 m) samples were prepared. The constructions were:

Test Sample 1

System SPS-3H hot mop applied to fiberglass insulation board.

Test Sample 2

System SPM-4.5T torch applied to fiberglass base sheet which was hot mop applied to fiberglass insulation board.

Test Sample 3

System APS-4T torch applied to fiberglass base sheet which had been hot mop applied to perlite insulation board.

4.6 FMRC Resistance to Foot Traffic Test Sample

One 2 ft x 4 ft (0.6 m x 1.2 m) panel was prepared. The construction was identical to that described in Paragraph 4.4, Sample No. 3.

4.7 FMRC Susceptibility to Leakage Test Sample

One 18 in. (45 mm) diameter sample was prepared as follows: A typical field seam was constructed using two pieces of membrane. The sample was coated as noted above, then conditioned in the Factory Mutual Research Corporation Ultraviolet Weatherometer for 1000 hours. The sample was then cut to a 10 in. (254 mm) diameter size and placed in the leakage test apparatus.

V RESULTS

5.1 FMRC Class I Fire Tests

The calorimeter tests showed the test panels to have fuel contribution rates below the maximum permissible rates for Class I Insulated Steel Deck Roof Construction. These rates and the Class I limits are given as follows:

Maximum Average Rate of Fuel Contribution
 Btu/sq ft/min. (Kg-Cal /m2/min.) for
Various Intervals of Time of Most Combustible Construction

	<u>3 Min.</u>	<u>5 min.</u>	<u>10 min.</u>	<u>Avg.</u>
Class I Standard	410 (1111)	390 (1057)	360 (975)	285 (772)
Test Sample 2	219 (591)	170 (459)	121 (327)	76 (205)

5.2 ASTM E-108 (83) Spread of Flame Tests

The spread of flame test results are noted below:

<u>Sample No.</u>	<u>System Designation</u>	<u>Slope</u>	<u>Class</u>	<u>Max. Flame Spread</u>
1	APS-4T	1-1/2 in. (38 mm)	IA	6 ft-0 in. (1.8 m)
2	APM-4.5T	1-1/2 in. (38 mm)	IB	8 ft-0 in. (2.4 m)
3	SPM-4.5T	3/4 in. (19 mm)	IB	7 ft-2 in. (2.1 m)
4	SPS-3H	3/4 in. (19 mm)	IA	6 ft-0 in. (1.8 m)
5	SPM-3.5H	3/4 in. (19 mm)	IB	7 ft-6 in. (2.2 m)

At no time during the spread of flame tests was the deck exposed, flying brands developed or excessive lateral flame spread observed.

5.3 Fastener Pull-Through-Base Sheet or Insulation

5.3.1 The results of the fastener pull-through-base sheet tests are given in the table below:

<u>Fastener</u>	<u>Base Sheet</u>	<u>Avg. Applied Ult. Load in lbs (Kg)</u>
Dekfast	Permaply 28	139 (63)
	GAF No. 75	170 (77)
	GlasBase	126 (57)
	Vaporbar	132 (60)
Olympic	Permaply 28	89 (40)
	GAF No. 75	118 (54)
	GlasBase	99 (45)
	Vaporbar	115 (52)
Rawl (Round)	Permaply 28	93 (42)
	GAF No. 75	120 (54)
	GlasBase	97 (44)
	Vaporbar	103 (47)
Rawl (Square)	Permaply 28	90 (41)
	GAF No. 75	151 (68)
	GlasBase	106 (48)
	Vaporbar	96 (44)
Roofgrip	Permaply 28	166 (75)
	GAF No. 75	137 (62)
	GlasBase	138 (63)
	Vaporbar	111 (50)

5.3.2 The results of the fastener pull-through-insulation tests are given in the table below:

<u>Fastener</u>	<u>Insulation</u>	<u>Avg. Applied Ult. Load in lbs (Kg)</u>
Dek fast	Wood fiber	210 (95)
	Perlite	102 (46)
	Fiberglass	170 (77)
Olympic	Wood Fiber	216 (98)
	Perlite	103 (47)
	Fiberglass	197 (89)
Rawl (Round)	Wood Fiber	199 (90)
	Perlite	105 (48)
	Fiberglass	171 (78)
Rawl (Square)	Wood Fiber	207 (94)
	Perlite	114 (52)
	Fiberglass	162 (73)
Roofgrip	Wood Fiber	104 (47)
	Perlite	101 (46)
	Fiberglass	164 (74)

5.4 FMRC Windstorm Classification Tests

5.4.1 All Simulated Wind Uplift test panels met the 60 psf (2.9 kPa) Factory Mutual Research Corporation requirements for Class I-60 Windstorm Classification. In addition, Sample Nos. 1, 2, 3, and 4 met the 90 psf (4.3 kPa) Factory Mutual Research Corporation requirements for Class I-90 Windstorm Classification.

5.5 After each drop of the simulated hail impactor, the Simulated Hail Damage Test samples were examined for cracking. There was no evidence of any cracking in the membrane during each test.

5.6 After each test cycle, the Resistance to Foot Traffic Test sample was examined. There was no evidence of damage to the roof cover.

5.7 The Leakage Test sample showed no signs of water leakage during the 7 day period or during or after the pressure cycles.

VI CONCLUSIONS

6.1 Test results indicate that Bitec modified bitumen roof covers: APM-4.5T, APS-4T, SPM-4.5T, SPM-3.5H and SPS-3H meet Factory Mutual Research Corporation Standard No. 4470 Approval requirements for Class I Fire and I-60 and I-90 Windstorm Classifications when installed as follows:

6.2 For Class I-60 Windstorm Classification

6.2.1 Min. 1 in. (25 mm) thick FMRC Approved perlite or wood fiber roof insulation attached to the steel or concrete deck with any fastener listed below applied at a rate of one fastener per 2 ft² (0.2 m²). Any base sheet listed below is then applied to the top of the insulation with a full mop (25 lbs/sq (11.3 Kg/9.3 m²)) of hot asphalt. The assembly is then topped with any roof cover assembly listed above.

6.3 For Class I-90 Windstorm Classification

6.3.1 Either Fiberglass (min. 15/16 in. (24 mm)), Perlite (min. 1 in. (25 mm)) or wood fiber (min 1 in. (25 mm)) insulation is fastened to the deck for preliminary securement with a minimum of two (2) FMRC Approved fasteners per board for all boards up to 4 ft x 4 ft (1.2 m x 1.2 m) or a minimum of four (4) fasteners per board for all boards between 4 ft x 4 ft (1.2 m x 1.2 m) and 4 ft x 8 ft (1.2 m x 2.4 m). Any base sheet listed below is then laid loose over the insulation with a 4 in. (102 mm) lap and fastened (with any fastener listed below) 12 in. (0.3 m) o.c. along the laps and the center line of the sheet. The assembly is then topped with any roof cover assembly listed above.

6.3.2 Min. 15/16 in. (24 mm) thick Fiberglass roof insulation is fastened to the deck at a minimum rate of one fastener per 3 ft² (0.3 m²), Any base sheet listed below is then applied to the top of the insulation with a full mop (25 lbs/sq (11.3 Kg/9.3 m²)) of hot asphalt. The assembly is then topped with any roof cover assembly listed above.

6.3.3 Any base sheet listed below is attached to FMRC Approved light weight concrete roof deck with Zonolite fasteners and large stress plates applied 7-1/2 in. (190.5 mm) o.c. along the 2 in. (50 mm) laps and 16 in. (406 mm) o.c. along the center line of the sheet. The base sheet is then topped with any roof cover assembly listed above.

Fasteners:

- | | |
|-------------------------|------------------|
| 1. Steel Deck | 2. Concrete Deck |
| Dekfast | Confas |
| Olympic | Olympic (No. 14) |
| Rawl (square and round) | Rawl (drive) |
| Roofgrip | Tapcon |

6.4 The roof cover assemblies tested obtained the following ASTM E-108 Spread of Flame designation for non-combustible decks when applied over any of the insulation assemblies described above and coated with Karnak No. 97 emulsion coating applied at a rate of 1-1/2 gal/sq (5.7 /9.3 m²).

<u>Roof Cover Designation</u>	<u>Slope (Max.)</u>	<u>Rating</u>
APS-4T	1-1/2 in. (38 mm)	A
APM-4.5T	1-1/2 in. (38 mm)	B
SPM-4.5T	3/4 in. (19 mm)	B
SPS-3H	3/4 in. (19 mm)	A
SPM-3.5H	3/4 in. (19 mm)	B

6.5 Based on these tests, Approval is extended to include recover application for steel deck construction up to a maximum insulation thickness of 1 in. (25 mm) for all the above combinations. In addition, for concrete deck constructions for all the above combinations up to the maximum FMRC Approved insulation thicknesses.

6.6 Based on these tests, Approval is extended to include min. 5/8 in. (16 mm) thick FMRC Approved Type X core gypsum board as an alternate to the perlite constructions listed above.

6.7 Tests show that the above roof constructions in and of themselves alone would not create a need for automatic sprinkler protection.

6.8 The number of insulation fasteners must be increased by 50% at the roof corners to meet I-60 Windstorm Classification and at the roof corners and edges to meet I-90 Windstorm Classification. See Loss Prevention Data Sheet 1-28 and I-29S for details.

6.9 The roof covers must be installed using an FMRC Approved roof perimeter flashing system (see Factory Mutual Research Corporation Approval Guide) or in accordance with the recommendations of FMRC Loss Prevention Data Sheet 1-49 (Perimeter Flashing).

6.10 The tested roof covers, when installed as described above, meet the Factory Mutual Research Corporation Approval requirements for roof covers and when Approval is effective, will be listed in The Factory Mutual Research Corporation Approval Guide, Roof Coverings Section.

6.11 Approval is effective when the Manufacturer's Agreement is signed and received by Factory Mutual Research Corporation.

6.12 Continued Approval will depend upon satisfactory field experience and periodic Quality Audit Inspections.

VII MARKING

7.1 The manufacturer shall mark each packing container with the manufacturer's name and product trade name. In addition, the container must be marked with the Factory Mutual Research Corporation Approval Mark and the words, "Roof Cover – Subject to the conditions of Approval as described in FMRC Report OQ3A3.AM."

7.2 The manufacturer agrees that use of the Factory Mutual Research Corporation name or Approval Mark is subject to the conditions and limitations of the Factory Mutual Research Corporation Approval. Such conditions and limitations must be included in all references to Factory Mutual Research Corporation Approval.

VIII MANUFACTURER'S 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.