

6.1 General Information

6.1.1 The following section provides the application specifications currently available from Johns Manville (JM) for built-up roofing membranes and covers both hot asphalt and cold adhesive applications included in Section 6A and 6B.

6.1.2 All general information contained in this section and the current Johns Manville Commercial/Industrial Roofing Systems Manual should be considered part of these specifications.

6.1.3 Specifications are available for systems installed over insulation, nailable, non-nailable and lightweight insulating fill substrates. JM offers systems that can be installed in hot asphalt.

6.1.4 For hot applied built-up roofing system applications, JM approved asphalt is required. Asphalts are thoroughly evaluated before they are approved for use in any JM built-up roofing system. JM acknowledges that some specifiers choose to use coal tar pitch in built-up roofing systems. However, the use of coal tar pitch is not eligible for use within JM Roofing System Guarantees.

6.1.5 Each specification in this section is eligible to receive a JM Roofing Systems Guarantee. The system must be installed by a JM Approved Roofing Contractor that is approved for Built-Up Roofing Systems. Refer to the information on Guarantees in the current JM Commercial/Industrial Roofing Systems Manual, or contact the nearest JM sales representative.

6.1.6 This manual clearly differentiates between **requirements** and **recommendations**. This manual has been written to assist the specifier to develop a comprehensive bid package. The information is presented in an explanatory fashion rather than the authoritative, instructive manner commonly utilized in construction specifications. When experience, technical knowledge, or established testing procedures support a policy or position, it is clearly identified, (i.e., “JM **requires**” or “is not acceptable”). When the use of a particular product or practice is undesirable or questionable, the reference is stated as an opinion rather than an absolute fact, (i.e. “JM **recommends**” or “JM suggests”). **It is mandatory that all requirements be complied with, however it may not be necessary to follow all recommendations to qualify for a Guarantee.**

6.1.7 Drainage of water off any roof membrane is recognized as being critical to the proper performance of any roofing system.

6.1.8 Drainage: Design and installation of the deck and/or substrate must result in the roof draining freely and to outlets numerous enough and so located as to remove water promptly and completely. Areas where water ponds for more than 24 hours are unacceptable and will not be eligible for a JM Roofing System Guarantee.

6.1.9 Flashings: Refer to Section 9 in this manual on Flashing Specifications.

6.2 Membrane Substrate

6.2.1 The surface on which the built-up roofing membrane is to be applied should be one of JM’s roof insulations (Fesco, Tapered Fesco, Fesco Foam, Tapered Fesco Foam, E’NRG’Y 2, Tapered E’NRG’Y 2, Fiber Glass Roof Insulation or ½” Retro-Fit Board) or an approved structural substrate. The surface must be clean, smooth, flat and dry. Built-up roofing should not be applied directly to foam plastic insulations, as referenced in NRCA Bulletin #9.

6.3 Built-Up Roofing Over Non-Nailable Decks

6.3.1 These specifications are for use over any type of structural deck which is not nailable and which offers a suitable coating to receive the roof. Poured and precast concrete require coating with JM Concrete Primer prior to the application of hot asphalt. Pre-cast concrete panels also require a layer of approved roof insulation prior to installing a roof membrane.

6.3.2 These specifications are also for use over JM roof insulations (Fesco, Tapered Fesco, Fesco Foam, Tapered Fesco Foam, E’NRG’Y 2™, Tapered E’NRG’Y 2, Fiber Glass Roof Insulation and ½” Retro-Fit Board) or other approved insulations that offer a suitable surface to receive the roof. Built-up roofing should not be applied directly to foam plastic insulations, as referenced in NRCA Bulletin #9. These specifications are not to be used over lightweight insulating concrete decks or over a fill made of lightweight insulating concrete.

6.3.3 Non-nailable specifications are denoted by an “I” as the third character in the specification designation (e.g., 4GIG). See the “Roof Finder Index” in this section for more information.

6.4 Built-Up Roofing Over Nailable Decks

6.4.1 These specifications are for use over any type of structural deck (without insulation) which can receive and adequately retain nails or other types of mechanical fasteners recommended by the deck manufacturer. Examples of such decks are wood and plywood. Certain specifications are eligible for use over lightweight insulating concrete decks or over fill made of lightweight insulating concrete. Contact a JM Technical Service Specialist for approval of the lightweight fill to be used.

6.4.2 Nailable specifications are denoted by an “N” or an “L” as the third character in the specification designation (e.g., 4GNG, 4GLG). See the “Roof Finder Index” in this section for more information.

6.4.3 One ply of sheathing paper must be used over wood board decks under the base felt.

6.4.4 All of the specifications in this section require the use of a nailable base felt. Use nails or fasteners appropriate to the type of deck. See fastener data in the Roof Deck section.

6.5 Application of Materials

6.5.1 The proper application of roofing materials is as important to the satisfactory performance of the roof membrane as the materials themselves. JM suggests the following guidelines for application of all roofing materials.

- A. Wet or damaged materials should not be used.
- B. Never apply any roofing materials during rain or snow, or to wet surfaces. Moisture trapped within the roofing system as a result of this can cause severe damage to the roof membrane and insulation.
- C. Review the guidelines for application of roofing, roof insulations, coatings and accessories shown in the current Johns Manville Commercial/ Industrial Roofing Systems Manual.
- D. Always start application at the low edge of the roof per the individual specification diagram.
- E. Good roofing procedure restricts the application of hot asphalt to a maximum of 6' (1.83 m) in front of the roll.
- F. When using mechanical felt laying equipment, be sure that all orifices are open.
- G. All roofing ply felts should be well set into the hot asphalt utilizing a squeegee or some other device.
- H. Take special care when applying coated felts in cold weather. Roll out and cut all mineral surface BUR felts to specified lengths and allow them to flatten. Check the temperature of the asphalt at the mop or asphalt-spreader to determine that it is at the proper application temperature. Do not apply mineral surfaced cap sheet when the air temperature is below 50°F (10°C).
- I. Do not mix different grades of asphalt or dilute asphalt with any material.
- J. Heat the asphalt according to the manufacturer's recommendations. Check the temperature of the asphalt at the kettle and at the point of application. Have accurate thermometers on all roofing kettles. Adhere to the guidelines for the heating of asphalts in this section of the manual.
- K. Always use the proper grade asphalt. A JM Technical Service Specialist may allow the roofing contractor to deviate from our published recommendations in warmer climates. A good guideline to follow regarding the use of asphalt is "Use the softest grade of asphalt commensurate with the slope and climatic conditions."
- L. Always install water cut-offs at the end of each day's work to prevent moisture infiltration into the completed work area. Water cut-offs should be completely removed prior to resuming work.
- M. Heed the cold weather application procedures in **Paragraph 6.13** of this section.
- N. Always install the complete roofing system at one time. Phased construction may result in slippage of felts due to excessive amounts of asphalt between the phased plies. Blisters due to entrapment of moisture, or poor adhesion of the membrane due to dust and foreign material collecting on the exposed felts, are other hazards of phased construction.
- O. It is essential that traffic be minimized on a freshly laid roof, while the asphalt is still fluid. Asphaltic displacement through the porous fiber glass ply felts can result from rooftop traffic during asphalt "set" time. Depending on specific job factors, this set time can be as long as 45 minutes. Asphaltic displacement can result in "phantom" leaks and blistering of the membrane.

- P. **Always comply with published safety procedures for all products being used. See the "Introduction" section of the current JM Commercial/Industrial Roofing Systems Manual, MSDS, and container labels for health and safety recommendations.**

6.6 Roofing Felts

6.6.1 JM manufactures different fiber glass roofing felts for a variety of roofing needs: felts for flashings, vapor retarders, roof plies, base sheets, and special felts for venting.

6.6.2 Roofing felts are furnished in rolls consisting of one or more squares. A "factory" square of roofing contains sufficient material to cover 100 sq. ft. (9.29 m²) of roof surface accounting for nominal side and end laps.

6.7 Roofing Asphalts

6.7.1 Roofing asphalts are available in four grades, shown in **Paragraph 6.7.8** of this section. In general, they are grade specified by softening point. The slope of the roof governs the grade to be used, in conjunction with the climatic constraints. The success or failure of a roofing system depends on the use of the proper grade of asphalt as called for in the roofing specification.

6.7.2 Health and Safety

See Section 1.9 for health and safety information.

6.7.3 Heating

Asphalts are susceptible to damage from overheating. Overheating, even for short periods, can "crack", or degrade the asphalt (a drop in softening point and slight oiliness is a symptom). Fall back in softening point can result in slippage of felts in the roofing system. As the softening point decreases, the viscosity or "holding power" of the interply asphalt decreases, resulting in slippage. If the overheating is more gradual, the asphalt may "age" prematurely, losing the beneficial light oils that help the roofing system weather and stay waterproof. Since asphalts are thermoplastic, their viscosity varies with temperature. Application temperature must be in the range which will permit an adequate film of asphalt, whether applied by mop or machine.

6.7.4 The JM Technical Center, in conjunction with the National Roofing Contractors Association and the Asphalt Roofing Manufacturing Association, has been involved in considerable research developing guidelines for the proper heating and application of hot asphalt. These guidelines use the principle of Equiviscous Temperature.

6.7.5 In conjunction with these guidelines, the following information is printed on the cartons of asphalt, or on the bill of lading for asphalt shipments.

1. The Softening Point as determined by ASTM D 312.
2. The Minimum Flash Point (FP) of the asphalt as determined by ASTM D 92.

- The Equiviscous Temperature (EVT). As currently defined by ASTM, this is the temperature at which the asphalt viscosity is 125 centistokes. Asphalt applied within $\pm 25^{\circ}\text{F}$ ($\pm 14^{\circ}\text{C}$) of the EVT at the point of application, will provide a nominal 23-25 pounds of asphalt per 100 square feet (1.12 - 1.22 kg/m²).
- The Finished Blowing Temperature (FBT). This is the temperature at which the blowing of the asphalt is completed.

6.7.6 Work done by NRCA has shown that different EVT values should be used for mop-applied asphalt and machine-applied asphalt. Mop-applied asphalt should be applied at an EVT based on 125 centipoise, while machine-applied asphalt should be applied using an EVT based on 75 centipoise. ASTM is currently evaluating incorporating this information into its specifications. Some asphalt suppliers are now including both EVT values on their product. If only the 125 centipoise (centistokes) value is provided, then for machine application, the asphalt should be applied at a 25°F (14°C) higher temperature than the 125 centipoise values.

6.7.7 JM requires adherence to the following guidelines when the above information is furnished:

- Use the proper softening point asphalt as specified for the roof slope and material.
- For optimum application, the asphalt should be at the Equiviscous Temperature, $\pm 25^{\circ}\text{F}$ ($\pm 14^{\circ}\text{C}$), at the point of application.
- Never heat the asphalt to or above the Flash Point (FP). Heating in excess of the Flash Point can cause the asphalt to ignite, causing a fire.
- Heating above the Finished Blowing Temperature (FBT) should be strictly regulated, never for longer than 4 hours, to preclude excessive asphalt degradation.

6.7.8 The characteristics per ASTM D 312 of the various grades of asphalt are as follows:

Product	ASTM Type	Softening Point		Flash Point
		Min.	Max.	C.O.C.*
140°F (60°C) (dead level)	I	135°F (57°C)	151°F (66°C)	475°F (246°C)
170°F (77°C) (flat)	II	158°F (70°C)	176°F (80°C)	475°F (246°C)
190°F (88°C) (steep)	III	185°F (85°C)	205°F (96°C)	475°F (246°C)
220°F (104°C) (special steep)	IV	210°F (99°C)	225°F (107°C)	475°F (246°C)

*Cleveland Open Cup Method.

Product	Penetration (dmm)						
	32°F (0°C) 60 Sec. 200g.	77°F (25°C) 5 Sec. 100g.	115°F (46°C) 5 Sec. 50g.	Ductility @ 77°F (25°C) 5 cm/Min.			
140°F (60°C)	3	—	18	60	90	180	10.0
170°F (77°C)	6	—	18	40	—	100	3.0
190°F (88°C)	6	—	15	35	—	90	2.5
220°F (104°C)	6	—	12	25	—	75	1.5

6.7.9 If Equiviscous Temperature is not available, nominal heating temperature guidelines of the asphalt are as follows:

Recommended Temperatures

Asphalt Type	Heating	Application for BUR
140°F (60°C)	425°F (218°C)	335°F to 405°F (168°C to 207°C)
170°F (77°C)	450°F (232°C)	350°F to 415°F (177°C to 213°C)
190°F (88°C)	500°F (260°C)	365°F to 435°F (185°C to 224°C)
220°F (104°C)	500°F (260°C)	400°F to 475°F (204°C to 246°C)

6.7.10 Use of insulated buckets and insulated circulating lines for cold weather application can help maintain a proper EVT when temperatures are low and the distance from the asphalt source to the point of application is great.

6.7.11 When asphalts are applied within the EVT temperature ranges, the proper amount of asphalt will be placed between the plies. The recommended quantity of asphalt has been indicated on each specification in the current Johns Manville Commercial/Industrial Roofing Systems Manual. Regardless of the exact quantity of asphalt applied, it is important that the asphalt be continuous, so felt does not touch felt, and that there be full adhesion between all plies of the system. JM considers a $\pm 25\%$ deviation from the asphalt quantity listed to be acceptable.

6.7.12 Asphalt can come from a variety of crude sources. Many of these sources produce high quality mopping grade asphalts and many do not. Various physical properties of asphalts can affect the performance of the roofing system. For this reason, JM qualifies asphalt sources throughout the country and requires that only these asphalts be used to assure good performance and compatibility with the roofing products being used.

JM requires the use of Trumbull or another JM "approved" asphalt within systems which require a JM Roofing Systems Guarantee. These "approved" asphalts are periodically tested to assure conformance to both ASTM and JM asphalt specifications. For the names of approved asphalt suppliers in your area, contact a JM sales representative.

6.8 Modified Asphalt

6.8.1 PermaMop is a modified asphalt with a softening point of between 210-225°F (99-107°C). While the softening point is comparable to an ASTM D 312, Type IV asphalt, its other physical properties are more comparable to a lower melt point standard asphalt. As a result, PermaMop offers many of the adhesion and weathering advantages of a low melt point asphalt without the slope restrictions of a softer standard asphalt.

6.8.2 There is currently no ASTM standard which governs the physical property characteristics of this type of asphalt. The following chart lists some of the physical properties of PermaMop and other asphalts:

Property	PermaMop Asphalt		Type I Asphalt		Type II Asphalt		Type III Asphalt		Type IV Asphalt	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Softening Point (°F) (°C)	210	225	135	151	158	176	185	205	210	225
Flash Point (°F) (°C)	525	625	475	—	475	—	475	—	475	—
Penetration, (dmm) (@ 77°F [25°C])	15	35	18	60	18	40	15	35	12	25
Ductility (@ 77°F [25°C]) cm	6	—	10	—	3.0	—	2.5	—	1.5	—
Equiviscous Temperature (EVT) (°F) (°C)	355	420	350 (avg.)	—	385 (avg.)	—	410 (avg.)	—	440 (avg.)	—
	179	216	177	—	196	—	210	—	227	—

6.8.3 Safety

All safety guidelines applicable to standard asphalt should also be applied to the use of PermaMop modified asphalt. **See Section 1.9** for more information.

6.8.4 Equiviscous Temperature

The Equiviscous Temperature of PermaMop asphalt is between 355-420°F (179-216°C). Care should be taken to ensure that the PermaMop is applied at the Equiviscous Temperature.

6.9 Cements, Coatings and Primer

6.9.1 JM’s cold asphaltic cements and coatings are asbestos-free and are designed especially for use in asphaltic built-up roofing systems. They are used for priming various surfaces to improve bonding of membranes and flashings, as coatings for smooth-surface fiber glass roofs, for roof repair, for adhering flashings, or for sealing metal and other materials. JM also has BUR Adhesive which is designed to bond layers of fiber glass felts together to form a roof membrane without the use of hot asphalt.

6.9.2 Handling and Application

Cutback materials contain flammable solvents. Do not expose them to flame or high temperatures. Take all routine fire and safety precautions. Do not heat these materials in closed containers or in open containers above their flash point. Do not heat these materials under any circumstances with an open flame.

Do not apply any solvent-containing material in a confined space. Do not combine or dilute any of these materials.

6.9.3 Coverage and Selection of Roof Coatings and Surfacing

6.9.3.1 The type and quantity of roof surfacing is dictated by the following: the specification selected, incline of the roof structure, and Underwriters Laboratories Classification required.

6.9.3.2 The following is a list of the surfacings available and typical application rates per square:

Topgard Type A	1¾-2 gals. (6.6-7.6 liters)
(Emulsified Aluminum Coating)	
Topgard Type B Fibrated	2-3 gals. (7.6-11.4 liters)
Asphalt (Type consistent with incline).....	15 lbs. max. (6.8 kg)
Fibrated Aluminum Roof Coating*	2 gals. (7.6 liters)

* For immediate application, apply over Topgard B which has been allowed to dry for at least 72 hours. Otherwise apply over asphalt surfacing which has weathered over one summer. Application in 2 coats will result in improved coverage and appearance.

6.9.3.3 Refer to individual product information sheets for more detailed application instructions.

6.9.3.4 When final surfacing is not possible following application of the membrane, JM recommends, as good practice, that a glaze coat of hot asphalt (10-15 lbs. per square [0.49-0.73 kg/m²]) be mop or squeegee applied. To accommodate job conditions, the membrane may be left uncoated for a period of up to six months. Low spots and valleys should, however, be glazed to protect these areas of the roof. Following such delay, an appropriate repair must be made to all damaged areas and the entire roof surface cleaned and primed prior to final surfacing.

6.9.4 Topgard Type A or B

Store and apply Topgard Type A or B at temperatures above 40°F (4°C). Do not use if it has frozen. Do not apply when rain or freezing temperatures are expected within 24 hours.

Apply Topgard Type A or B only to surfaces that are clean, dry, and free of dust and dirt. If the surface is not clean, dry, and free of dust or dirt, it must be primed with Concrete Primer prior to the application of the coating. Allow Topgard Type B to dry for at least 72 hours before installing any other coating over it. See the appropriate product data sheet for more complete application directions.

6.9.5 Fibrated Aluminum Roof Coating

Asphalt surfacings, especially low softening point asphalts, continue to flex and flow after they are applied, therefore, it is not recommended that Fibrated Aluminum Roof Coating be applied over Type I and Type II asphalts. Higher softening point asphalts should weather at least one summer prior to the application of Fibrated Aluminum Roof Coating. If the Fibrated Aluminum Roof Coating must be applied right away, coat the roof with Topgard Type B which has been allowed to dry for at least 72 hours, and then apply the Fibrated Aluminum Roof Coating. Fibrated Aluminum Roof Coating must be thoroughly mixed to a smooth consistency and uniform silver color prior to using.

No roof coating will resist standing water. Light-colored coatings such as Fibrated Aluminum Roof Coating are particularly susceptible to erosion and discoloration by ponded water. Valleys and low spots should be poured with asphalt and surfaced with gravel or a reflective aggregate such as marble chips.

Coatings and surfacings will require periodic recoating. The frequency of re-coating will depend on the quantity and quality of application and numerous climatic and environmental factors.

6.9.6 BUR Adhesive

JM's BUR Adhesive is a one-part cold application adhesive specially formulated to set up quickly and when cured, forms a durable, elastomeric and watertight film.

It is used to adhere roofing plies and for aggregate surfacings or as a direct substitute for asphalt in all JM Cold BUR specifications. However, we recommend that only fully coated, non-porous felts, such as JM GlasBase™ and GlasBase Plus be used as ply and base sheets in cold process systems. Ventsulation® felt is also acceptable as a base felt. DO NOT USE GlasPly® IV or GlasPly® Premier in these systems. For best results, make certain the surface to which the adhesive will be applied is clean, dry and free of loose material. All masonry surfaces must be primed with JM Concrete Primer. The primer must be allowed to dry thoroughly before application of the adhesive.

6.10 Gravel and Slag Surfacing

6.10.1 Gravel or slag must be dry before using. Wet gravel or slag will cause foaming of the asphalt and prevent proper adhesion of the surfacing. In cold weather, if difficulty is experienced in obtaining proper embedment in the asphalt, the gravel or slag should be heated prior to application.

6.10.2 JM will approve the use of clean slag or gravel meeting ASTM D 1863, which applies to aggregates specified both for use in road construction and bituminous roofing. Aggregates meeting ASTM D 1863 are generally available commercially throughout the country.

6.10.3 Other surfacing material used in place of gravel or slag should be fairly cubical in shape, non-water-absorbent, hard and opaque, and of such size and nature as to result in firm embedment in the asphalt.

6.10.4 Do not use transparent or translucent stones, such as dolomite or crushed masonry.

6.10.5 Flood the surface with the appropriate hot asphalt for the roof slope, at an approximate rate of 60 lbs. per square (2.9 kg/m²). While the asphalt is still hot, embed the surfacing.

6.10.6 Gravel should be spread at the rate of 400 lbs. per square (19.5 kg/m²). Because of its lower weight in relation to volume, slag should be applied at the rate of 300 lbs. per square (14.6 kg/m²). In any case, sufficient amounts of gravel or slag should be applied to result in full and complete coverage of the roof surface with approximately 50% of the aggregate solidly adhered in the asphalt.

6.11 BUR Steep Slope Requirements

6.11.1 Built-up roofing membranes utilizing asphalt can be applied on inclines up to 6" per foot (500 mm/m) when proper precautions are taken. On non-nailable decks wood nailers must be used. Nailers act as insulation stops for the roof insulation and as a facility to nail the fiber glass built-up roofing felts. Cold applied BUR is limited to inclines of 3" (76 mm) per foot or less.

6.11.2 Spacing of Nailers

On decks where the incline is such that nailing of roofing felts

is required (2" [51 mm] and over for smooth surfaced roofs and 1" [25 mm] and over for gravel and mineral cap sheet surfaced roofs), wood nailing strips, 3/4" [89 mm] minimum actual width) should be provided at the ridge and at the following approximate, intermediate points:

Nailer Spacing and Type of Asphalt/Cap Sheet Roofs:

Incline	Nailer Spacing (D)*	Type of Asphalt
0"-1/2" (0-13 mm)	Not required	Type II†
1/2"-1" (13-25 mm)	Not required	Type III
1"-2" (25-51 mm)	20' (6.1m) face to face	Type III
2"-3" (51-76 mm)	10' (3.1m) face to face	Type III
3"-6" (76-152 mm)	4' (1.2 m) face to face	Type IV

Nailer Spacing and Type of Asphalt/Smooth Surfaced Roofs:

Incline	Nailer Spacing (D)*	Type of Asphalt
0"-1/2" (0-13 mm)	Not required	Type II†
1/2"-1" (13-25 mm)	Not required	Type III
1"-2" (25-51 mm)	Not required	Type III
2"-3" (51-76 mm)	20' (6.1m) face to face	Type III
3"-4" (76-102 mm)	10' (3.1m) face to face	Type IV
4"-6" (102-152 mm)	4' (1.2 m) face to face	Type IV

Nailer Spacing and Type of Asphalt/Gravel-Surfaced Roofs:

Incline	Nailer Spacing (D)*	Type of Asphalt
0"-1/2" (0-13 mm)	Not required	Type II†
1/2"-1" (13-25 mm)	Not required	Type III
1"-2" (25-51 mm)	20' (6.1m) face to face	Type III
2"-3" (51-76 mm)	10' (3.1m) face to face	Type III

* Allow sufficient clearance between nailers for insulation units.

† Consult a JM Technical Service Specialist regarding projects in hot climates as Type II Asphalt may not be permitted in some areas.

6.11.3 Nailing strips should be the same thickness as the insulation, and at least 3/4" (89 mm) wide. They should be securely attached to the deck with mechanical fasteners to resist a pullout force of 200 pounds (890 N). Nailers should run at right angles to the incline of the roof slope.

6.11.4 Nailable and Lightweight Concrete Decks

On decks where the incline is over 1" (25 mm) for gravel surfaced or cap sheet systems and 2" (51 mm) for smooth surfaced systems, the felts must be installed parallel to the incline. Ply felts and cap sheets are to be backnailed 3/8" (19 mm) from the leading edge at intervals equivalent to the nailer spacing shown in the table above.

6.11.5 Felt Application

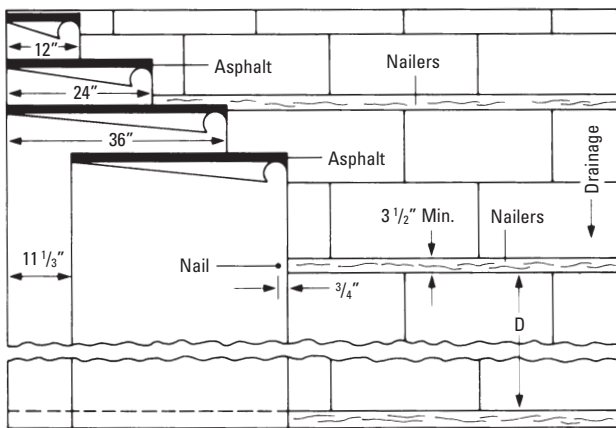
Felts used in smooth surfaced roofs must be installed parallel to the roof incline, on slopes greater than 2" per foot (166.6 mm/m). This requirement applies to gravel and mineral surfaced roofs at slopes greater than 1" per foot (83.3 mm/m). Nails must have a 1" (25 mm) minimum diameter cap. Where capped nails are not used, fasteners must be driven through caps having a minimum diameter of 1" (25 mm).

6.11.6 Fastener Spacing

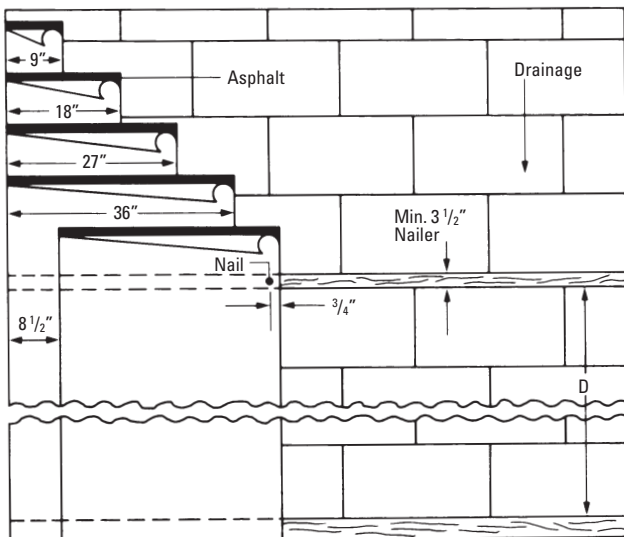
For 3, 4 and 5-ply roofs, locate a nail at each nailer, spaced $\frac{3}{4}$ " (19 mm) from the leading edge of each felt, as it is installed.

Termination of a continuous cap sheet MUST occur at a nailer. At points of termination, place 5 nails across the 36" (914 mm) width of the endlap of the cap sheet and into the nailer. The first nail is to be spaced $\frac{3}{4}$ " (19 mm) from the leading edge of the cap sheet, with the remaining 4 nails spaced approximately $8\frac{1}{2}$ " (216 mm) o.c., with the nails staggered across the width of the nailer to reduce the chance of the cap sheet tearing along the nail line.

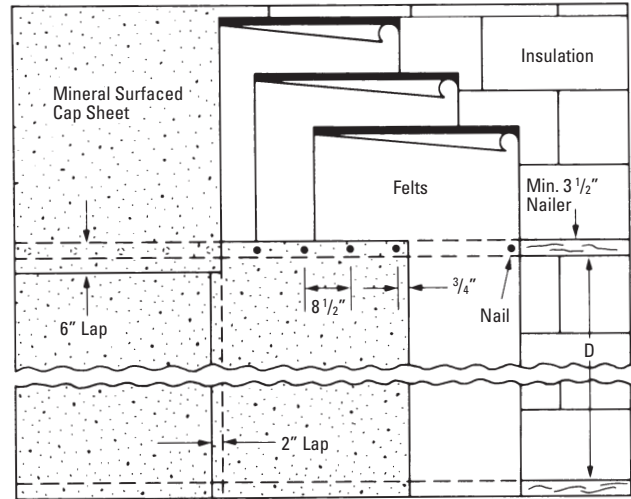
Nailing Pattern and Nailer Spacing shown with 3-Ply System.



Nailing Pattern and Nailer Spacing shown with 4-Ply System.



Nailing Pattern and Nailer Spacing shown with Cap Sheet Roofs.



6.12 Phase Construction

6.12.1 One of the greatest hazards of roof construction is the application of a roofing system in "phases". Phasing is a construction sequence in which a partially completed roof system is left exposed to the weather, for a period of time, even overnight. The remainder of the roofing system is installed at a later time. This can lead to entrapped moisture which can cause premature failure of the membrane.

6.12.2 Good roofing practice dictates that no more roofing materials should be applied at any one time, than can be completed in one day. This means that the finished membrane MUST be installed all in the same day. Water cut-offs must be installed at all exposed edges of a day's completed work and completely removed prior to commencing the next day's work.

6.12.3 Aggregate surfacing may be postponed for up to six months over fiber glass asphalt roofs, provided valleys and low spots are glazed with 10-15 lbs./sq. (0.49-0.73 kg/m²) of the interply asphalt. The roof surface must be free of dirt, debris and moisture prior to the application of asphalt flood coat and aggregate surfacing to assure proper adhesion. Surfaces that are excessively dirty should first be washed and cleaned with water, allowed to dry thoroughly, and then primed with JM Concrete Primer.

6.13 Cold Weather Application

6.13.1 Roof applications utilizing asphalt below 45°F (7°C) require special measures to ensure proper performance of the roofing system. JM strongly recommends that the following guidelines be followed when applying built-up roofing systems in cold weather:

- A. Use extra care to ensure that any moisture is removed from the deck surface. The presence of moisture may cause poor adhesion or skips in the mopping asphalt, which in turn can entrap moisture within the roofing system.
- B. Store materials in a heated warehouse or closed and heated trailer immediately prior to installing.
- C. Do not overheat the asphalt. Insulated asphalt lines and insulated roof-top equipment should be used. Set up job site equipment to minimize the distance between asphalt heating source and application point.
- D. Do not mop more than 4' (1.22 m) ahead of the roll. Embed the rolls into the hot asphalt immediately.
- E. Squeegee all fiber glass ply felts to ensure adhesion.
- F. Install only as much roofing material as can be completed and covered in one day.
- G. The use of temporary roofs should be strongly considered if construction schedules require roof applications in cold or rainy weather.

6.13.2 BUR Adhesive: The adhesive can be installed in temperatures between 40°F and 100°F (4°C and 38°C). However, when the temperature is below 50°F (10°C), the adhesive must be stored in a warm area (approximately 70°F [21°C]), for 24 hours before being used, to facilitate spreading. Note: Temperature affects the cure rate of the adhesive. Even in cooler weather, the product will develop bond strengths comparable to fully adhered single ply systems in a relatively short time. The membrane ultimately will develop adhesive bonds that exceed those of systems using asphalt as the adhesive.

6.14 Temporary Roof Coverings

6.14.1 At times, an owner or general contractor may require the building be closed-in when the weather is not conducive to good roof construction, or the roof area may have to be used as a work platform during construction. In the past, this situation has led to phase construction which has resulted in premature roof failure. When a completed roof system cannot be installed in one operation, it is recommended that the following procedures be observed:

- A. Nailable Decks:
 1. Apply one layer of approved JM base felt, lapping the felt 2" (51 mm), and nailing 9" (229 mm) o.c. along the lap and 12" (305 mm) o.c. through the center of the sheet. (Sheathing paper should first be installed on wood board decks. Sheathing paper is not required on plywood decks.)
 2. Mop one ply of approved JM ply felt in ASTM D 312, Type III asphalt and apply a glaze coat of 10-15 lbs. per square (0.49-0.73 kg/m²) of the same grade asphalt.
 3. When the permanent roof is to be installed, inspect the roof and remove all damaged and blistered areas. Apply a layer of approved JM base felt nailed through the temporary roof and into the deck as the first layer of the roofing system. As an

alternate, a layer of approved JM roof insulation may be mechanically fastened (with appropriate fasteners) through the temporary roof into the deck.

4. Proceed with installing the appropriate permanent roof specification.
- B. Steel Decks:
 1. Apply a minimum layer of approved JM insulation, in adequate thickness to the steel deck using the appropriate mechanical fasteners.
 2. Install two plies of fiber glass felt, both set in hot Type III asphalt to the insulation.
 3. Finish with a 10-15 lbs. per square (0.49-0.73 kg/m²) glaze coat of hot, Type III asphalt.
 4. When the permanent roof is to be applied, inspect the roof area. If the insulation has not been damaged and is dry, remove any blistered or damaged felt. Solid mop a layer of insulation board to the temporary roof with hot, Type III asphalt. Then apply the permanent roof system. In some regions of the country, a JM base felt may be machine spot-mopped or mechanically attached with appropriate insulation screws and plates directly to the sound temporary roof, followed by an asphaltic roofing membrane. Consult a JM Technical Service Specialist for acceptability.
 5. If the temporary membrane and/or roof insulation has been excessively damaged, remove all unusable material and replace.
 - C. Non-Nailable Decks Other Than Steel:
 1. Prepare the deck as would be done for a permanent roof.
 2. Solid mop two plies of approved JM fiber glass ply felt in hot ASTM D 312, Type III asphalt.
 3. Finish with a 10-15 lbs. per square (0.49-0.73 kg/m²) glaze coat of ASTM D 312, Type III roofing asphalt.
 4. When the permanent roof is to be installed, inspect and repair all defects in the temporary roof. Clean the surface of the temporary roof and prime with JM Concrete Primer if the surface is unusually worn, and proceed with the installation of the permanent roof.
 5. As an alternate to step 2 above, spot mop an approved JM base sheet using a mechanical spot mop machine. Next, solid mop one ply of an approved JM ply felt in hot ASTM D 312, Type III asphalt. When the permanent roof is to be installed, remove the entire temporary roof, prime the deck as required in the "Roof Deck" section of this manual, and proceed with the installation of the permanent roof.

6.14.2 The decision as to whether or not a temporary roof is to be left in place, is a judgment factor that must be made by the building owner or his representative. Although a JM representative may make suggestions in this area, JM will not be responsible for any problems that may develop with the roofing system due to the fact that the temporary roof is left in place.

6.15 Protected Roofing Membrane Systems (PRMA)

6.15.1 General Information: All general information contained in this Section and the current JM Commercial/ Industrial Roofing Systems Manual shall be considered part of these specifications.

6.15.2 The following JM Specifications are eligible for modification and use with Protected Roofing Membrane Systems: 4GIS, 3GIS, 5GNS, 4GNS, 3GNS, 5GLG, 4GLG. When these specifications are modified, the last digit of the specification number should be changed to a "P" to designate "Protected" (e.g., 4GIP).

6.15.3 Flashings: All flashings must conform to the requirements stated in this Section and the current JM Commercial/ Industrial Roofing Systems Manual. The flashing material must extend above the top of the extruded polystyrene insulation a minimum of 8" (203 mm). The standard flashing details for built-up roofing systems can be found in "Bituminous Flashings", Section 9.

6.15.4 Drainage: Design and installation of the deck and/or roof substrate must result in the roof draining freely, to outlets numerous enough, and so located, as to remove water promptly and completely. Areas where water ponds for more than 24 hours are unacceptable and will not be eligible for a JM Roofing System Guarantee.

6.15.5 When designing a PRMA roofing system, the designer must make sure that positive drainage exists on the roof. Even though some extruded polystyrene roof insulation products are designed with integral drainage channels, they will retard the flow of water due to the contact between the membrane and the insulation. JM recommends a minimum of 1/4" per foot (20.8 mm/m) slope be obtained on the finished roof membrane. This will greatly reduce the amount of water that will be retained against the membrane after a rain.

6.15.6 Decks (PRMA)

Pre-cast slabs and pre-stressed "T" or "TT" decks require a minimum of one layer of approved JM roof insulation as a leveling course, prior to the installation of the roof membrane.

For lightweight insulating concrete, gypsum decks, etc., consult a JM Technical Service Specialist for specifications and guarantee information.

For information on roof deck requirements not mentioned, refer to the "Roof Decks" Section of the current JM Commercial/ Industrial Roofing Systems Manual, or contact a JM Technical Service Specialist.

6.15.7 Asphalt Recommendations (PRMA)

Asphalts: The use of ASTM D 312, Type III asphalt is recommended to prevent adhesion of the extruded polystyrene insulation to the asphalt top pour. If a softer asphalt, such as a Type I or Type II is used, a separator sheet MUST be used. The minimum separator sheet is a 4 mil (0.1 mm) polyethylene sheet.

If a Type I or II asphalt is used without a separator sheet, the extruded polystyrene roof insulation can become adhered to the roof membrane. During periods of heavy rain, the buoyancy of the extruded polystyrene can cause strong upward forces to be exerted on the membrane. The buoyancy forces may be so severe as to tear the membrane.

6.15.8 Ballast Requirements (for use with extruded polystyrene roof insulation):

The ballast should be similar to ASTM D 448, Gradation #57. The following gradation is typical:

Passing 1/2" (13 mm)	10-60%
Passing 3/4" (19 mm)	100%

6.15.9 Ballast is applied at a rate of approximately 10-12 lbs. per sq. ft. (48.8-58.6 kg/m²) in the field of the roof over a layer of filter fabric. Twenty (20) lbs. per sq. ft. (97.6 kg/m²) of ballast is required over a 4' (1.22 m) wide area at the roof perimeter and at all penetrations. The following filter fabrics have been found to be acceptable:

- A. Confil 689H – 3.0 oz./yd. (93.5 g/m) black polyester from International Paper Company
- B. Rufon P3B – 3.0 oz./yd. (93.5 g/m) black polypropylene from Phillips Fiber Corporation

6.15.10 JM makes no claims as to the quality or performance of these products when exposed on the roof. See the product warranty supplied by the manufacturer.

6.15.11 When pavers are used as ballast, the pavers must be placed on supports or pedestals. These supports or pedestals can either be commercially available products or 6" (152 mm) square pieces of JM DynaTred Plus (to give a minimum 1/2" [13 mm] air space). These supports should be located at the intersection of the corners of the paver blocks. All four corners of adjacent pavers should rest on the same 6" (152 mm) square piece of JM DynaTred Plus or pedestal. The 1/2" (13 mm) air space between the pavers and insulation will allow moisture vapor to vent to the atmosphere. If the moisture is not allowed to vent to the atmosphere, the top surface of the insulation will begin to absorb water and the thermal performance will be reduced. **ROOF AREAS THAT HAVE PAVERS IN DIRECT CONTACT WITH THE INSULATION ARE EXCLUDED FROM COVERAGE IN A JM ROOFING SYSTEM GUARANTEE, INCLUDING THE THERMAL OVERLAY PORTION OF THE GUARANTEE.**

6.15.12 The use of pavers in high traffic areas, to and around equipment and other maintenance areas, is strongly recommended.

6.15.13 It is the owner's and/or specifier's responsibility to determine if the building structure can support the required amount of ballast and still meet the code design requirements for anticipated dead and live loads (including snow, wind, etc.).

6.15.14 Installing Ballasted, Unadhered PRMA Roof Insulation Over Built-Up Roof Membranes

The following are general recommendations for installing ballasted PRMA roof insulation over built-up roof membranes.

Materials per 100 sq. ft. (9.29 m²) of Membrane Area

Separator Sheet, if required:	108 sq. ft. (10.03 m ²)
Insulation:	Extruded polystyrene roof insulation 100 sq. ft. (9.29 m ²) per layer
Fabric:	12' wide, 105 sq. ft. (3.66 m wide, 9.75 m ²) 10' wide, 106 sq. ft. (3.05 m wide, 9.84 m ²) 8' wide, 107 sq. ft. (2.44 m wide, 9.94 m ²)
Ballast:	3/4" (19 mm) stone or crushed rock, 1000 - 1200 lbs. per square (48.8 - 58.6 kg/m ²)*

*Additional ballast is required at the perimeter and at penetrations.

6.15.15 Separator Sheet: (If required) Over Type I or Type II asphalt, use a 4 mil (0.1 mm) thick (minimum) polyethylene separator sheet installed directly over the asphalt with 2" (51 mm) minimum laps at all seams.

6.15.16 Insulation: Place extruded polystyrene insulation directly on the membrane (or separator sheet if used) with channel side down. The insulation boards should be tightly butted together. The maximum allowable gap between boards is 3/8" (9.5 mm). The boards shall be installed to within and no closer than 3/4" (19 mm) of all projections and cant strips.

6.15.17 For multilayer installations, install subsequent layers of insulation, unattached over the first layer. Stagger all joints in relation to the underlying layer. The bottom layer in multilayer applications must be at least 2" (51 mm) thick and as thick or thicker than the top layer.

6.15.18 Warning: Extruded polystyrene insulation is combustible and may constitute a fire hazard if improperly used or installed. It should be adequately protected. Use only as directed by the specific instructions for this product. This material should **NEVER** be exposed to an open flame or other source of ignition.

All roof deck systems over which the PRMA system is installed should provide an adequate fire barrier for the extruded polystyrene insulation.

For proper protection of plastic foam in storage, consult the National Fire Protection Association (NFPA) standards or the authority having jurisdiction.

6.15.19 Fabric: Loose lay an approved fabric over the extruded polystyrene roof insulation, with all joints lapped a minimum of 12" (305 mm). There should not be any end laps within 6' (1.83 m) of the perimeter. The fabric should extend 2" - 3" (51 - 76 mm) above the stone at the perimeter and at all penetrations.

Wetting the fabric is helpful in holding it in place on the insulation until the ballast is installed.

6.15.20 Ballast: Apply the correct size ballast at the rate of 1000 - 1200 lbs. per square (10 - 12 lbs. per sq. ft. [48.8 - 58.6 kg/m²]), over the fabric, as the fabric is being laid out in the field of the roof. For a width of 4' (1.22 m) at the roof perimeter or penetrations, install ballast at the rate of 20 lbs. per sq. ft. (97.6 kg/m²) or pavers at the rate of 22 lbs. per linear foot (32.7 kg/lin. m). If pavers are used, the fabric is not required. Pavers must be placed on pedestals. Pedestals can be either commercially available products or 6" (152 mm) squares of DynaTred Plus.

Ballast should be washed 3/4" (19 mm) gravel or crushed stone 3/4" (19 mm), with fines (smaller than 1/2" [13 mm]) accounting for not less than 10% or more than 60%. This gradation is similar to ASTM D 448, gradation #57.

6.16 Coal Tar General Information

6.16.1 JM acknowledges that ASTM D 450, Type I Coal Tar Pitch is used in certain gravel surfaced built-up roofing system specifications. However, coal tar pitch is not to be used within JM Roofing Systems.

Danger: Coal Tar is considered a hazard by inhalation, ingestion and skin contact. The International Agency for Research on Cancer (IARC) has classified coal tar as an agent which is carcinogenic to humans (Group 1). JM does not make or sell a coal tar pitch waterproofing agent, and does not recommend its use. Alternative materials, such as asphalt should be utilized.