# A Guide for Selection of Elastomeric Protective Coatings Over Sprayed Polyurethane Foam

RECOMMENDED
DESIGN CONSIDERATIONS
AND GUIDE SPECIFICATIONS

**Spray Polyurethane Foam Alliance**



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## SECTION I—WHY PROTECTIVE COATINGS ARE REQUIRED

Sprayed polyurethane foam has a closed cell structure and is water resistant. It must, however, be protected with a covering to prevent surface degradation caused by UV exposure. Elastomeric coatings correctly specified and applied will protect polyurethane foam from this surface degradation. Elastomeric coatings can also be used for other purposes:

To inhibit moisture vapor transmission.
To enhance the aesthetics of the system.
To increase the impact and abrasion resistance of the system.
To achieve flammability and code requirements.

## SECTION II—COATING CLASSIFICATIONS AND DEFINITIONS

**Elastomeric Coatings:** For the purpose of this document an **"elastomeric"** coating is one which is capable of elongating at least 100% and recovering its original dimensions.

**Water Vapor Transmission:** Water vapor tends to migrate or diffuse from regions of high absolute humidity to regions of low absolute humidity. Protective coatings form films or membranes which retard, to varying degrees, the transmission of water vapor. The rate of water vapor transmission across or through a protective coating is dependent upon (1) the chemical makeup of the coating, (2) the thickness of the coating, and (3) the absolute humidity difference on either side of the coating.

ASTM E-96, "Standard Test Method for Water Vapor Transmission of Materials," is used to determine the water vapor transmission rates of protective coatings. The resulting value may be expressed in either of two ways:

| Value | Coating thickness | Units |
|---|---|---|
| 1. Permeability | Common Thickness | ng/(Pa·s·m$^2$) (Perm-inch) |
| 2. Permeance | Specific Thickness such as 0.5 mm (20 mils) | ng/(Pa·s·m) (Perm) |

Coatings having higher permeabilities or permeances are more "breathable" than coatings with low values. Coatings may be relative "breathers" or "vapor retarders." Thickness is as important as coating chemistry: a thickly applied breathable coating could perform as a relative vapor retarder (and vice versa).

For design calculations, the in-place water vapor transmission must be determined by converting the reported permeability or permeance values to the application thickness of the specific coating. The permeance of the protective coating at its application thickness is termed the "perm rating."

Water vapor transmission, per se, is harmless. However, when the diffusing water vapor chills to its dew point, it condenses to liquid water resulting in potential loss of insulation value or deterioration of building components. Selection of protective coatings, thickness, and placement will influence the likelihood of condensation.

**Packaging of Elastomeric Coatings:** Coatings are packaged as single or plural component materials. Single component coatings are packaged in one container. Plural component coatings may be packaged in two or more containers. Some plural component coatings must be sprayed through plural component equipment.

## SECTION III—THEORETICAL FILM COVERAGE VS ACTUAL FILM COVERAGE

**(A) Theoretical Coverage:**

1. **METRIC (SI) UNITS:** The theoretical coverage rate of a coating is the number of square meters covered by one liter of a coating material spread over a flat smooth surface area at a thickness of 1 millimeter. One liter of a coating material that has roofs solid content by volume will cover 1 square meter, 1 dry millimeter thick (1 mm.$m^2$/L). This definition is used to calculate theoretical coverage rates for coatings containing less than 100% solids. For example a coating with a 60% (0.60) solid content by volume (SCV) to be applied at 0.8 millimeter dry film thickness (DFT) will be used in the formulas listed to arrive at various theoretical coverages. (NOTE: These calculations use solids content by volume, NOT solids content by weight.)

a. TO FIND THE THEORETICAL THICKNESS FOR ONE (1) LITER OF COATING,:

Theoretical Thickness per Liter = % Solids X 1 $mm^2$/L
= 1 x 0.60
= 0.60 mm.$m^2$/L

b. TO FIND THE THEORETICAL NUMBER OF LITERS REQUIRED AT A SPECIFIED THICKNESS:

Theoretical Thickness per Liter = DFT / Theoretical Thickness per Liter
= 0.8 mm.$m^2$/L
= 1.3 L/$m^2$

2. **TRADITIONAL U.S. UNITS:** The theoretical coverage rate of a coating is the number of roofing squares covered by one gallon of a coating material spread over a flat smooth surface area at a thickness of 1/1000 of an inch (0.001" or 1 mil). One gallon of a coating material that has 100% solid content by volume will cover an area 16 roofing squares (R□), 1 dry mil thick (16 R□·mil/gal). This definition is used to calculate theoretical coverage rates for coatings containing less than 100%. solids. For example a coating with a 60% (0.60) solid content by volume (SCV) to be applied at 30 mil dry film thickness (DFT) will be used in the formulas listed to arrive at various theoretical coverages. (NOTE: These calculations use solids content by volume, NOT solids content by weight.)

a. TO FIND THE THEORETICAL THICKNESS FOR ONE (1) GALLON OF COATING:

Theoretical Thickness per gallon = 16 R□·mil/gal x % Solids
= 16 x 0.6
= 9.6 R□·mil/gal

b. TO FIND THE THEORETICAL NUMBER OF GALLONS REQUIRED AT A SPECIFIED THICKNESS:

Theoretical Thickness per gallon = DFT / Theoretical Thickness per gallon

= 30 mil /9.6 R□·mil/gal

= 3.1 gal/R□

(R□ = Roofing Square = 100 square feet)

NOTE: For conversion between Traditional U.S. Units and Metric (SI) Units, refer to *Spray Polyurethane Foam Estimating Reference Guide* Stock No. AY-121.

**(B) Actual Coverage Requirements**:

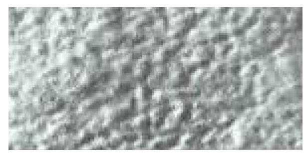
When coatings are applied over sprayed polyurethane foam, many factors, such as the polyurethane surface texture, overspray loss, container residue, equipment characteristics, applicator technique, etc. will directly affect the amount of coating material required to meet the designed in-place minimum dry film thickness (DFT). Therefore, it is very important that additional material be added to the theoretical quantities to ensure that the proper minimum coating thickness is applied.

Consideration must be given to the following factors:

1. **Minimum dry film thickness (DFT):** In order to perform the functions required of the elastomeric coating, the coating material should form a cured film of a prescribed thickness. The surface of sprayed polyurethane foam is somewhat uneven—never completely smooth like a piece of glass. Therefore, peaks and valleys exist and the film thickness over the peaks can be considerably less than in valleys. In order to overcome this potential problem, the minimum dry film thickness (DFT) of any given coating is defined as the in-place dry film thickness (DFT) at its thinnest point on the coated surface.

2. **Polyurethane foam surface textures:** The surface texture of sprayed polyurethane foam influences the extra material needed to achieve the minimum in-place dry film thickness (DFT). Smoother surfaces require less coating material than rougher surfaces. It is also important to note that excessively rough surface textures must not be coated
due to the inability of the coating material to provide complete coverage without voids, pinholes, etc. The photographs below show various polyurethane foam textures that have been established as industry reference standards. An elastomeric coating should **not be applied over a surface** texture rougher than verge of popcorn.

   a. **Smooth Surface Texture**
   Description: The surface exhibits spray undulation and is ideal for receiving a protective coating. Even though the surface texture is classified as smooth, this surface requires at least 5% additional material to the theoretical amount.



   b. **Orange Peel Surface Texture**
   Description: The surface exhibits a fine texture and is compared to the exterior skin of an orange. This surface is considered acceptable for receiving a protective coating. This surface requires at least 10% additional material to the theoretical amount.

   c. **Coarse Orange Peel Surface Texture**
   Description: The surface exhibits a texture where nodules and valleys are approximately the same size and shape. This surface is acceptable for receiving a protective coating because of the roundness of the nodules and valleys. This surface requires at least 25% additional material to the theoretical amount.

   d. **Verge of Popcorn Texture**
   Description: The verge of popcorn surface is the roughest texture suitable for receiving the protective coating. The surface shows a texture where nodules are larger than valleys, with the valleys relatively curved. The surface is considered undesirable due to the additional amount of coating required to protect the surface. This surface requires at least 50% additional material to the theoretical amount.

   e. **Popcorn Surface Texture or Tree bark**
   Description: The surface exhibits texture where valleys form sharp angles. This surface is unacceptable for coating application.

   f. **Oversprayed Surface Texture**
   Description: The surface exhibits a coarse textured pattern and/or a pebbled surface. This surface is typically found downwind from the spray polyurethane foam path and can vary from mild to severe. This surface requires 25% to 50% additional material to the theoretical amount. Severe oversprayed surfaces are not acceptable for coating applications.

3. **Wind Loss:** In spray applications, up to 30% of the coating may be lost due to wind. Consider using wind screens

and add wind loss to your coating calculations.

4. **Miscellaneous Loss:** A miscellaneous factor must be added to the theoretical coverage rate to cover losses due to material left in containers, equipment problems, etc. Use a percentage factor of between 3% to 10%, depending on the contractor's experience and efficiency.

**(C)** **Summary:** Taking into consideration minimum dry film thickness, polyurethane foam surface textures, wind loss and miscellaneous loss, a total percentage can be arrived at and added to theoretical coverage formulas found in Section 111, Paragraphs (1) Metric SI or (2) Traditional U.S. To compare theoretical overages with actual coverage requirements, the formula to find the theoretical amount of liters (gallons) needed to cover one square meter (one roofing square) at a specified dry film thickness will be used.

The example coating is 60% solid content by volume (SCV) to be applied at 0.8 millimeters (30 mils) dry film thickness (DFT). The additional material percentages (AMP) are as follows:

| | | |
|---|---|---|
| Orange Peel Texture | — | 10% |
| Wind Loss | — | 12% |
| Miscellaneous | — | 5% |
| Total (AMP) | | 27% |

**Metric (SI)**
Actual Coverage = Theoretical Coverage x AMP
= 1.3 L/m$^2$ 1.27
= 1.7 actual liters/square meter

**Traditional U.S.**
Actual Coverage = Theoretical Coverage x AMP
= 3.1 gal/R$^{\square}$ x 1.27
=3.9 actual gallons/roofing square

## SECTION IV—GENERIC TYPES OF ELASTOMERIC COATINGS

This section contains a review of the elastomeric coating materials most frequently used over sprayed polyurethane foam. As generic types— rather than specific coatings—are discussed, the information presented is very general. Manufacture's data should be used for comparing particular coatings and for specifying dry film thickness, application procedures, etc.

**Elastomeric Coatings**

1. Acrylic
2. Butyl Rubber
3. Hypalon®
4. Neoprene®
5. Silicone
6. Polyurethane Elastomer
7. Modified Asphalt

### A. ACRYLICS:

1. **General Description:** Acrylic coatings are single component coatings based on acrylic polymers. They are water based, which allows for easy clean up. Acrylic coatings have good resistance to weathering, and have a high moisture vapor transmission rate or permeability.

2. **Color Availability:** Acrylics are generally available in white, tan, or grey. Other colors may also be obtained.

3. **Compatibility with other Elastomeric Coatings:** Acrylics have been used in conjunction with other elastomeric coatings, however, manufacturers should be consulted to ensure compatibility.

4. **Minimum Dry Film Thickness:** A dry film thickness (DFT) of 0.6 - 0.8 mm (25-30 mils), applied in a minimum of two coats, is generally recommended. The specified thickness is dependent on existing project conditions and manufacturers recommendations.

5. **Application Recommendations:** It is important that the application of the acrylic coatings be done in strict accordance with the manufacturers recommendations. A few of the more common requirements are:

   SURFACE PREPARATION: The spray polyurethane foam substrate should have positive slope to drains, and be clean, dry and free of UV degradation.

   MINIMUM NUMBER OF COATS: The coating should be applied in two separate contrasting color coats. After the first coat is cured, the second coat should be applied at right angles to the first. Heavy coats may cause the coating to blister or mudcrack as it dries.

   AMBIENT TEMPERATURE CONDITIONS: Acrylic coatings should not be applied below 10°C (50°F) or above 49°C (120°F). Do not allow material to freeze.

   FILM CURE TIME: 4 to 12 hours at 24°C (75°F).

   EQUIPMENT REQUIREMENTS: Airless spray equipment is recommended. Acrylic coatings may also be brush or roller applied.

6. **Limitations:**

   a. Do not apply when inclement weather is imminent. Curing is necessary prior to precipitation to avoid washing off the coating or affecting adhesion or physical properties.

   b. Do not apply if temperature will drop below 10°C (50°F) within 4-6 hours.

   c. Keep material from freezing.

   d. Do not apply when the relative humidity is in excess of 85%. Avoid applying late in the day when conditions for dew and condensation are imminent.

   e. Acrylic coatings have a high permeability and should not be used when a vapor retarder is required.

**B. BUTYL RUBBERS:**

1. **General Description:** Butyl rubber is an elastomer which has extremely low water vapor permeability. Having the lowest permeability in comparison to other elastomers, it is especially recommended in situations which have relatively high vapor drives such as low temperature applications (coolers, freezers, and cryogenic storage) or water immersion (water storage and ponding water). When exposed to exterior weathering or in areas where mechanical damage may occur, butyl rubber should be topcoated with tougher or more weather resistant coatings (consult with coating manufacturers for specific recommendations.) While most butyl rubbers are two-component materials, some single-component versions are available .

2. **Color Availability:** Black and gray.

3. **Compatibility With Other Coatings:** Other elastomeric coatings can be used as a top coat over butyl rubbers. Consult the coatings manufacturers for specific recommendations.

4. **Minimum Dry Film Thickness (DFT):** A dry film thickness (DFT) of 0.5mm (20 mils) is generally recommended. When butyl rubbers are used as vapor retarders in cooler and freezer construction or low temperature vessels, additional DFT is recommended for optimum performance. Total system DFT will be determined by the type of top coating used and manufacturers recommendation.

5. **Application Recommendations:**

   SURFACE PREPARATION: The spray polyurethane foam substrate should be clean, dry and free of UV degradation.

   MINIMUM NUMBER OF COATS: The coating should be applied in two (2) separate contrasting color coats. After the first coat is cured, the second coat should be applied at right angles to the first.

   FILM CURE TIME: 8 to 12 hours at 24°C (75°F) (faster curing butyls are available). Note: Cure time will vary depending upon ambient temperature and humidity.

   AMBIENT TEMPERATURE REQUIREMENTS: Should be applied between 7°C (45°F) and 38°C (100°F).

   EQUIPMENT REQUIREMENTS: Consult with the coating manufacturer for equipment requirements.

   IMPORTANT: When butyls are to be used as vapor retarders, particular care must be taken in applying the butyl to produce a pinhole-free membrane. Furthermore, butyl rubbers should always be applied to the correct side in applications involving vapor drives (see Moisture Vapor Transmission, Stock No. AY-118.)

6. **Limitations:**

   a. Plural component butyl rubbers have a limited working life due to a material pot life of 1 1/2 hours (or less) depending upon ambient temperature conditions.

   b. Butyl rubbers have limited impact (hail or mechanical) and traffic resistance.

   c. Butyls are subject to more rapid weathering and chalking than some coatings and should be top coated with other compatible coatings for optimum performance.

## C. HYPALONS :

1. **General Description:** Hypalons® (a registered trademark of E. I. DuPont de Nemours Co.) are chlorosulfonated polyethylene rubbers. They are fast-drying single-component materials that have exceptional fire retardancy, chemical resistance, weathering properties, and moisture vapor transmission resistance. They may be used as an entire coating system or as a topcoat over other elastomeric coatings in roofing, tank and cooler applications.

2. **Color Availability:** Hypalons® are available in white and gray. Other colors may be obtained.

3. **Compatibility With Other Coatings:** Hypalons® are used as topcoats for Butyl Rubber, Neoprene®, and some Polyurethanes. Consult the coating manufacturer for specific recommendations.

4. **Minimum Dry Film Thickness:** As a total system, a minimum dry film thickness (DFT) of 0.8mm (30 mils) applied in at least two coats is generally recommended. As a topcoat for other elastomeric coatings, a minimum of 0.2mm (8 mils) is generally recommended.

5. **Application Recommendations:**

   SURFACE PREPARATION: The polyurethane foam substrate should be clean, dry and free of UV degradation.

   MINIMUM NUMBER OF COATS: Multiple coats are required to reduce possible sagging and pinholing. Each coat should be applied at right angles to the previous coat once the previous coat has cured.

FILM CURE TIME: 3/4 to 2 hours at 24°C (75°F). Note: Cure time will vary depending upon ambient temperature, humidity and color.

AMBIENT TEMPERATURE REQUIREMENTS: Can be applied between 2°C (35°F) and 38°C (100°F.)

EQUIPMENT REQUIREMENTS: Airless spray equipment is recommended for optimum results. It can also be roller or brush applied.

6. **Limitations:**

   a. Hypalon® coatings have limited impact resistance and elasticity at temperatures below -18°C (0 °F)

   b. Hypalon® coatings continue to polymerize with age and exterior exposure, which results in reduced elasticity and flexibility.

   c. Shelf life is limited. Significant increases in viscosity may occur over time.

   d. Due to a variety of formulations and physical properties, recommended dry film thicknesses vary widely. Consult specific system manufacturers data for comparisons.

**D.** **<u>NEOPRENES®</u>:**

1. **General Description:** Neoprenes® (a registered trademark of E. I. DuPont de Nemours & Co.) are polychloroprene rubbers. They are low solids, fast-drying, single-component coatings used as vapor retarders and as primers for other coatings. They should be topcoated for exterior exposure.

2. **Color Availability:** Black.

3. **Compatibility with other Elastomeric Coatings:** Various coatings can be used as a top coat over Neoprene, such as polyurethane elastomers and Hypalons. Consult the coating manufacturer for specific requirements.

4. **Minimum Dry Film Thickness:** A dry film thickness (DFT) of 0.5mm (20 mils) is generally recommended. The total system DFT will be determined by the top coating used and manufacturers recommendations.

5. **Application Recommendations:**

SURFACE PREPARATION: The polyurethane foam substrate should be clean, dry and free of UV degradation.

MINIMUM NUMBER OF COATS: Multiple coats are required to reduce possible sagging and pinholing. Each coat should be applied at right angles to the previous coat once the previous coat has cured.

FILM CURE TIME: 3/4 to 2 hours at 24°C (75°F). Note: Cure time will vary depending upon temperature and humidity.

EQUIPMENT REQUIREMENTS: Consult with the coating manufacturer for equipment requirements.

6. **Limitations:**

   a. Neoprene® coatings have limited impact resistance and elasticity at temperatures below -18°C (0°F).

   b. Neoprene® coatings continue to polymerize with age and exterior exposure, which results in reduced elasticity and flexibility.

   c. Neoprenes® tend to degrade under UV exposure and should be topcoated with a more UV resistant material.

**E. SILICONES:**

1. **General Description:** Silicone coatings are silicone polymer elastomeric coatings. They are available in single or

plural component materials. They are characterized by their exceptional weatherability, their ability to withstand temperature extremes and retain physical properties. Silicone coatings have a high moisture vapor permeability and are classified as breathable coatings.

2. **Color Availability:** Single component silicone coatings are available in white, gray, tan and dark gray. Two component silicone coatings are available in light and medium gray.

3. **Compatibility With Other Coatings:** Other coatings will generally not adhere to silicone. Silicone may be used as a top coat over other elastomeric coatings. The manufacturer should be consulted to ensure compatibility.

4. **Minimum Dry Film Thickness:** A dry film thickness (DFT) of 0.5 mm (20 mils) applied in two coats is generally required.

5. **Application Recommendations:**

   SURFACE PREPARATION: The Polyurethane Foam substrate should have a positive slope to drain and be clean, dry and free of UV degradation.

   MINIMUM NUMBER OF COATS: The coating should be applied in two separate contrasting color coats. After the first coat has cured, the second coat should be applied at right angles to the first.

   FILM CURE TIME:

   Single component—2 to 8 hours at 24°C (75°F).
   Plural component—10 to 30 minutes (with fast catalyst); 1 to 8 hours (with slow catalyst).

   TEMPERATURE REQUIREMENTS: Silicones can be applied between 2°C (35°F) and 49°C (120°F)

   EQUIPMENT REQUIREMENTS: Consult with the coating manufacturer for equipment requirements.

6. **Limitations:**
   a. Silicone Coatings are breathable type coatings and should not be used alone when a vapor retarder is required.

   b. Other materials may not adhere well to silicones.

   c. Granules are often imbedded into the wet topcoat to enhance mechanical resistance and traction.

**F. POLYURETHANE ELASTOMERS:**

1. **General Description:** Polyurethane is a general term describing a polymer based on an isocyanate and polyol or amine reaction. There are a number of different types of polyurethane elastomers and they typically are classified as follows:

   a. **Aromatic or Aliphatic Polyurethanes:** Aromatic polyurethanes are polymers based on unsaturated aromatic backbones. This unsaturation accounts for the slight to moderate darkening and chalking characteristics in exterior exposure. The degree to which the discoloration and chalking occur depends on the particular formulation. Aromatic polyurethanes are mostly used as a base coat for the aliphatic polyurethane, however, some may be used as a finish coat with only mild chalking and discoloration. Aliphatic polyurethanes have similar physical properties to aromatics but in contrast to aromatic polyurethanes have no unsaturation and are characterized by their exceptional color and gloss retention. They are recommended in applications where a highly aesthetic finish coat is required.

   b. **Modified Polyurethanes:** These are polyurethanes which have been modified with non-reactive resins such as phosphate or pthalate plasticizers, synthetic hydrocarbons, refined oils, tar or asphalt. Due to the wide variety of modifying resins there is a great variance in physical properties.

   c. **Single-Component or Plural-Component:** Aromatic, aliphatic, and modified polyurethanes are available as single-component and plural-component materials. A wide range of properties are found in this broad family of coatings.

Moisture-cure polyurethanes are single component and cure from reaction with moisture in the air, which allows the polyurethane to polymerize.

Plural-component polyurethanes polymerize by the reaction of the isocyanate (Component A) with polyols (Component B). These polyurethanes are normally available in two versions: standard cure and fast set.

2. **Color Availability:**

Aliphatics are generally available in white. Other colors are available.
Aromatics are generally available in aluminum, gray, and tan. Other colors are available.

3. **Compatibility With Other Coatings:** Aliphatic and aromatic polyurethanes may be used as base or topcoats for other coatings. Consult the manufacturer for specific recommendations.

4. **Minimum Dry Film Thickness:** Dry film thickness will range from 0.5 to 0.8 mm (20 to 30 mils) depending on the system used.

5. **Application Recommendations:**

SURFACE PREPARATION: The polyurethane foam substrate should be clean, dry, and free of UV degradation.

NUMBER OF COATS: The coating should be applied in a minimum of two (2) separate contrasting color coats. After the coating is cured, each coat should be applied at right angles to the previous coat.

CURE TIME*

| Type | Dry To Touch | Cure |
|---|---|---|
| Aliphatic | 4-6 hours | 10-24 hours |
| Aromatic: | | |
| Standard | 4-6 hours | 10-24 hours |
| Fast Set | 3 sec to 20 min | 10-24 hours |
| Moisture Cure | 6-8 hours | 10-24 hours |

*Cure times may vary depending upon temperature, humidity and coating thickness.

AMBIENT TEMPERATURE REQUIREMENTS: Apply between 2°C (35°F) and 43 °C (110°F).

EQUIPMENT REQUIREMENTS: Varies with specific system. Spray fast-set polyurethane with plural component equipment as recommended by the coating manufacturer.

6. **Limitations:**

   1. Plural-component materials have a limited working pot life. Some may only be sprayed through plural equipment.

   2. Polyurethanes are sensitive to moisture or water on the substrate.

**G. MODIFIED ASPHALTS:**

1. **General Description:** The modified asphalts are coatings that are made elastomeric by the addition of rubber-like polymers to asphalts. Most cure by chemical reaction, rather than solvent evaporation, and are available as single or plural component products. All are considered vapor retarders.

2. **Color Availability:** Black.

3. **Compatibility With Other Coatings:** Modified asphalts will not adhere well to other asphalts; but will adhere well to other coating systems. Consult the manufacturer for specific recommendations.

4. **Minimum Dry Film Thickness (DFT):** 1.3 to 1.5 mm (50 to 60 mils).

5. **Application Recommendations:**

   SURFACE PREPARATION: Surfaces should be clean, dry, free of grease, oil, etc.

   NUMBER OF COATS: Recommended thickness could be applied in one (1) coat; however, two (2) coats are recommended.

   FILM CURE TIME: 24 to 48 hours, time varies according to temperature and humidity.

   TEMPERATURE REQUIREMENTS: Substrate temperatures can be below freezing so long as the surfaces are free of frost. condensation, etc. Material temperatures should be at 16°C (60°F) or above for spray application.

   EQUIPMENT REQUIREMENTS: May be applied by brush, spray or trowel.

6. **Limitations:**

   a. Modified asphalts are subject to softening and deterioration by petroleum solvents, oils, greases, etc.

   b. Some modified asphalts may be subject to UV degradation and should be protected with a top coating.

## SECTION V—FLAMMABILITY AND CODE REQUIREMENTS

Coatings based on organic compounds are subject to combustion and exhibit characteristics similar to all other combustibles under fire conditions. emitting heat, smoke and toxic gases. Additives are formulated into coating compositions, inhibiting ignition and/or reducing fuel contribution to a fire.

Users of spray-applied rigid polyurethane foam insulation materials should be familiar with the various applicable test procedures, codes and laws—national, state, and local. In addition, insurance companies may have specific requirements of fire performance.

Polyurethane foam used in interior spaces must be protected by an ignition or thermal barrier and/or smoke detectors or sprinkler systems as required by local building code or insurance requirements.

The risks involved with combustible roof coverings include exterior flame spread across the surface of the roof and interior flame spread resulting from combustible vapors and liquids entering the building through seams, joints, and openings in the roof's substrate. The tests and standards described below have been developed over the years and are designed to evaluate fire propagation for both exterior and interior areas.

**(A) Underwriters Laboratory (UL)**

To be classified. both the coating and polyurethane foam must meet standards and inspections of Underwriters Laboratories. The system classification denotes a specific foam with a specific coating at a specified slope. For re-cover over an existing roof with a non-combustible deck, spray-applied foam systems with minimum 3.8 cm (1 inch) thick foam will assume the foam system's construction rating. For combustible decks, the lesser of the existing roof or the foam roof rating, will prevail.

1. **UL-790 (ASTM E-108):** UL-790 is the UL test for resistance to fire originating front sources outside a building. The tests include the intermittent-flame test, the spread-of-flame test, and the burning-brand test. Systems are rated Class A (best), Class B, and Class C.

2. **UL-723 (ASTM E-85) Steiner Tunnel Test:** This test is valuable for comparing the flame spread and smoke development of polyurethane foams. It utilizes a 25-foot tunnel and compares the performance of foam with that of red oak planking.

3. **UL-1256:** This tests roof deck constructions and membranes for their resistance to interior fires Construction Numbers 136. 181. and 206 in the UL Roofing Materials and Systems Directory are spray-applied polyurethane foam systems

4. **UL-263 Fire Resistance (P Rating):** Measures the ability of the roof, ceiling and structural members to withstand interior fires for specified time periods, i.e., 1 hour, 2 hours. and 3 hours. New construction designs for SPF are provided in the UL Fire Resistance Directory, under Design No. P733.

**(B) Factory Mutual (FM)**

The Factory Mutual Engineering and Research Corporation tests the flame spread potential of building materials and assemblies related to their end-use application. The fire tests include ASTM E-84 Standard Test Method for Surface Burning Characteristics of Building Materials (25-foot tunnel test), ASTM E-119 Standard Test Methods of Fire Tests of Building Construction and Materials, ASTM E-108 Standard Methods of Fire Tests of Roof Coverings, the FM building corner test. and the FM heat release rate calorimeter. Ratings are Class 1(A) (best), Class l(B), and Class l(C).

FM approved systems (Class 1) are listed in FM's Approval Guide. Additionally FM publishes Loss Prevention Delta sheets. such as 1-57 Rigid Plastic Building Materials, which discuss acceptable uses of various materials and components.

**(C) Summary of Code Approvals**

Although Model Building Codes do not have the force of law, they are good references since most state and local codes (which do have the force of law) are based on their provisions.

Three major organizations, the Building Official and Code Administrators (BOCA), the International Conference of Building Officials (ICBO), and the Southern Building Code Congress International (SBCCI), and a central organization, the Council of American Building Officials (CABO), evaluate each coating system through data submitted by coatings manufacturers.

These data are comprised of literature, UL and FM approvals. and independent testing results. Acceptance of the coating system allows the system to be used in areas that must comply with specific building and safety codes.

## SECTION VI—DESIGN CONSIDERATIONS FOR SELECTION OF A PROTECTIVE COATING

The specter should consider a number of factors on each specific project when making the selection of a suitable protective coating.

**(A) Environmental Conditions:** An elastomeric coating system must be able cure to under the expected climatic conditions in the area of application. High tensile strength or abrasion resistance will be required in areas where hail or blowing abrasives are expected. If unusual atmospheric conditions are present, such as chemical attack or pollutants, the coating's resistance to these contaminants must be assessed prior to use.

**(B) Code and Flammability Requirements:** Any system specified should meet all local code and insurance requirements. Independent documentation of ratings should be provided by the appropriate agencies.

**(C) Mechanical Damage and Foot Traffic:** A coating must be able to resist anticipated mechanical damage and foot traffic. Key physical properties for a coating system to inhibit mechanical damage are tensile strength, elongation, Shore A hardness, and dry film thickness (DFT). Damage resulting from punctures and other surface stresses can be reduced through the use of high tensile strength and high elongation coatings. Increasing dry film thickness in potential damage areas will also reduce the possibility for mechanical damage. Granules and reinforcements in walkway areas are also helpful.

**(D) Moisture Vapor Transmission:** Protective coatings, in con junction with spray-applied polyurethane foam, can reduce the likelihood of condensation within the foam or other building components. Install building materials, including foam and coatings, such that relative vapor retardance increases toward the side with the higher absolute humidity (usually the warm side). When this practice cannot be followed, install a vapor retarder such that:

1. The vapor retarder is positioned as close as possible to the side with the higher absolute humidity (usually the warm side), and

2 The vapor retarder has an installed perm rating substantially less than that of the next lowest component

**(E)** **Ponding Water:** The accumulation of water in low-lying areas that exceeds the manufacturere's specification and/ or contact documents.

**(F)** **Maintenance:** Recommendations for temporary repair and preventive maintenance procedures for use with coating system should be provided by the manufacturer.

**(G)** **Aesthetics:** Many elastomeric coatings can be colored or tinted various shades to comply with job requirements. The use of colored granules may create a more uniform appearance on the coated surface. Various colored granules are also available to meet job requirements.

**(H)** **Other Factors:** Once the selection process has narrowed to a particular type of coating or the systems of a particular manufacturer, the specifier should weigh these factors:

1. Field Experience,
2. Manufacturer Quality Control,
3. Warranty, and
4. Applicator Experience.

Careful consideration of these factors in the selection process should help insure a successful, long lasting application.

## SECTION VII—QUALITY CONTROL AND PHYSICAL TESTING

**(A)** **Manufacturer's Responsibility:** It is the manufacturer's responsibility to provide a product that conforms to its claims relative to basic product description and uses, physical properties, and in-place performance. In order to assure that the end user actually receives a product comparable to the manufacturer's claims, manufacturers should provide the following:

1. **Literature:** Literature published to provide information about a particular product should include the following: Product description, basic uses, wet physical properties, cured physical properties, performance characteristics, fire rating and approvals, building code and insurance acceptance, application instructions and techniques, limitations, and precautions.

2. **Plant Quality Control:** Coating manufacturers should provide strict quality assurance to produce a product that will comply with their advertising and literature claims. All products manufactured should be tested to insure batch-to-batch uniformity and to determine that product quality is indeed within the established parameters. Manufacturers should also retain liquid samples for a specified time. These samples should be taken from each batch produced.

3. **Shipping and Handling:** Coatings should be properly and expediently shipped to the contractor job site, or distributor. The product should be packaged in clean, properly sealed and labeled containers according to ICC regulations and other pertinent laws. Coatings that are beyond their advertised shelf life should not be sold by manufacturers or distributors.

4. **Applicator Training and Approval:** Most manufacturers will help the contractor train personnel to handle and apply their products. This training can be undertaken in formal seminar-type programs or as an in-field exercise, depending on the complexity of the product and/or the equipment necessary for its application.

   With the advent of more complex product and equipment, manufacturers may require formal training prior to sale of products or issue of license or approval on a specific application.

5. **Job Inspection:** For warranted applications, many manufacturers require various inspections.

    a. **Techniques and Procedures:** The job should be visually inspected to determine that the following areas are in compliance with the manufacturers printed instructions: Surface texture, uniformity of coating coverage, minimum coating thickness, existence of pinholes, evidence of uncoated polyurethane foam and overall appearance. Where deficiencies exist, these should be brought to the attention of the contractor for correction.

       Coating dry film thickness (DFT) is usually measured from a slit sample using an optical comparator

    b. **Inspection Accessories:** The following is a list of devices used for testing during the application of a polyurethane foam and coating installation:

       **Moisture Meter:** To measure degree of moisture within or on the surface or a particular substance.

       **Sling Psychrometer:** Measures ambient temperature and humidity.

       **Surface Thermometer:** Reads temperature of a particular surface.

       **Optical Comparator:** Provides scale, in millimeters or inches (or mils) to read dry film thickness (DFT) of a coating.

       **Lighted Magnifying Glass:** Allows for close-up inspection of surface film.

       **Razor Knife:** To cut slit samples from the installed roof system.

       **Wet Film Thickness Gauge:** Used to read wet coating thickness and through use of coverage formulas determine thickness of the film when dry.

       **Caulking Gun with Compatible Caulking Material:** To repair areas where dry film was removed for inspection or where other coating deficiencies exist.

       **Coating:** Small amount of coating to touch-up areas or test areas after installation of caulking.

**(B)** **Contractor's Responsibility:** The contractor should assume responsibility for product use, handling, and proper application.

1. **Knowledge of Product:**
    a. Contractors and their crews should be aware of all the parameters regarding the proper application of a particular product, including uses, packaging, mixing, storage, and all application requirements.

    b. Field personnel should be provided with the proper training and knowledge by both the contractor and supplier to successfully apply the particular system.

2. **Equipment**

    a. Applicators must have a complete understanding of their equipment and its use with the particular material being applied. Of particular importance are mix ratios, solvents, pressures, output, filters, spray tip size, and operating temperatures.

    b. Proper maintenance, repair and clean-up of equipment will also provide for minimum downtime, increased production, and better crew and product performance.

3. **Job Inspection:**

    a. Spot checks of product ratios, output, wet and dry film thickness, and cured film properties are good measures for quality control.

b. Monitoring specific output measured in liters (gallons), film thickness, and areas covered will provide material yields and more uniform coverage.

The quality control of a coated polyurethane foam system is the responsibility of everyone involved; from the selection and testing of raw materials to the inspections of project slit samples. It is incumbent on all those involved to have the knowledge, equipment, and personnel to provide the most successful application possible in this most important aspect of our industry.

## SECTION VIII—PHYSICAL PROPERTY TESTS

**(A) Tensile Strength (ASTM D-412):** The maximum tensile stress applied during stretching of a specimen to its rupture point. The type of die used, temperature and speed at which the sample is tested should be reported.

Tensile strength relates to the membrane's resistance to rupturing when subjected to forces such as the impact by hail or falling objects.

**(B) Elongation, Ultimate (ASTM D-412):** The maximum extension or stretching of the membrane at the time of rupture. The type of die used, temperature and speed at which the sample is tested should be reported.

The elongation relates to the membrane's ability to stretch with thermal movement or with various indentations and compressions to the foam.

**(C) Tear Strength (ASTM D-624):** The measurement of the force required to propagate a tear in the membrane. Two methods are used to test the membrane:

1. A die produces a circular cut; or

2. A die produces a 90° angle cut.

The angle cut (#2) is a harsher test and will produce lower results.

The tear strength relates to the resistance of a membrane to tearing or to the migration of a tear.

**(D) Hardness (ASTM D-2240):** A measurement of a membrane's inherent resistance to compression and indentation. In many instances, a coating with a greater degree of hardness (in the Shore A range of 40-90) will have better abrasion resistance as well as resistance to cutting and tearing. Also, some harder coatings have better dirt release properties than softer coatings.

**(E) Abrasion Resistance (ASTM D-4060):** The measurement of the amount (by weight) of coating lost when subjected to an abrasive wheel of a Taber Abraser. The test is normally performed with a 1,000 gram weight and the weight lost is reported after 1.000 revolutions. The abrasive wheels used for elastomers membranes are either the CS-17 or CS-10 (the CS-17 wheel is more abrasive than the CS-10 and will produce higher weight lost figures. The type of wheel used should be reported.)

The abrasion resistance is related to the wear resistance of a membrane when subjected to repeated traffic or abrasive materials.

**(F) Impact Resistance (ASTM D-2794):** This test involves a procedure for rapidly deforming, by impact, a coating film and its substrate (usually a metal panel) and for evaluating the effect of such deformation. The apparatus for this test is a cylindrical weight which is raised and dropped within a quite tube onto the coating film from various heights. Failure is indicated by cracks in the film.

**(G) Adhesion-In-Peel of Elastomeric Joint Sealants (ASTM C-794):** This test methodcovers a procedure for determining the adhesion-in-peel of single or multi-component joint sealants used in building construction.

**Peel or Stripping Strength of Adhesive Bonds (ASTM D-903):** This test method covers the determination of the comparative peel or stripping characteristics of adhesive bonds.

**(H) Moisture Vapor Transmission (ASTM E-96):** The measurement of the amount of moisture vapor transferred through a membrane.

ASTM E-96 uses perm cups which are either filled with water or desiccant, depending on the test method. The amount of moisture which passes through the membrane is measured by weighing the cups at periodic intervals. There are two methods normally used:

l. Procedure B—water is placed inside the cup and the cup is placed in an environment of 50% humidity @ 23°C (73°F).

2. Procedure E—a desiccant is placed inside the cups and the cups are placed in an environment of 90% humidity @ 38°C (100 °F). (Procedure E produces a greater vapor drive and will produce a higher value.)

**(I) Water Absorption (ASTM D-471):** The amount of water absorbed by a membrane when totally immersed in water at a given temperature.

This is related to a membrane's resistance to swelling and temporary or permanent degradation of physical properties due to the influence of retained water.

**(J) Low Temperature Flexibility:** The following two methods can be used (in both methods an unsupported free film of the membrane is used for testing):

1. ASTM D-2137: determines the lowest temperature at which flexible elastomeric materials will not exhibit fractures or cracks when subjected to impact.

2. ASTM D-2136: determines the ability of rubber-like materials to resist the effect of low temperature when subjected to bending at specified temperatures.

This factor is particularly relevant to coating performance during the winter season. It is an indication of the coating's ability to flex and elongate with stress, impact, or building movement at lower temperatures.

**(K) High Temperature Resistance (ASTM D-573):** The maximum temperature a membrane can be exposed to without permanent deterioration. This information is necessary in applications where a coating may be exposed to abnormally high temperatures.

**(L) Heat Aging (ASTM** D-573): The resistance of a membrane to degradation when subjected to various specified elevated temperatures. A typical temperature for a elastomer designed for roofing is 70°C (160°F) for a minimum of 30 days.

This property is pertinent to the membrane's retention of physical properties over an extended period of time and therefore may related to expected life. It is also correlated to sun loads across various parts of the country.

**(M) Chemical Resistance (ASTM** D-471): The ability of a membrane to retain physical properties when subjected to spill, splash, or immersion conditions in various chemical solutions.

**(N) Accelerated Weathering:** Accelerated weathering can be simulated when membranes are subjected to an intense concentrated ultraviolet light, high humidity, or condensation, and elevated temperatures.

**ASTM G151-97 Standard for Exposingg Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources:** This practice provides general procedures to be used when exposing nonmetallic materials in accelerated test devices that use laboratory light sources. Detailed information regarding procedures to be used for specific devices is found in standards describing the particular device being used. For example, detailed information covering exposures in devices that use carbon-arc, senon-arc, and fluorescent UV light sources are found in Practices G 23, G 26 and G 53 repectively.

Signs of film deterioration and retention of physical properties are recorded at various intervals. These tests are generally used to screen coatings for comparison purposes.

The following tests are used to predict the long term properties of a coating:

**(O)** **Ozone Resistance (ASTM D-1149):** The resistance of a atmosphere containing a high concentration of ozone.

**(P)** **Mold and Mildew Resistance (ASTM D-3273):** The resistance of a membrane to mold and mildew growth and the resulting deterioration of film integrity. In addition, the growth also causes an unsightly appearance of the finish.

**(Q)** **Modulus (ASTM D-412):** The amount of stress of tensile strength required to stretch a membrane to a given elongation, such as 100%, 200%, 300%, etc.

For physical property test procedures related to flammability and building code requirements (see Section V).

**OTHER PROGRAMS AND SERVICES OFFERED BY SPFA**

**Professional Training**

The Accreditation Program offers individual and company accreditation in five areas: Contractor, Distributor, Elastomeric Coating Supplier, Foam Supplier and Independent Inspector. The objectives of the program are to **PROVIDE** an established set of criteria; to **IDENTIFY AND RECOGNIZ**E individuals and companies; and to **ENCOURAGE** responsibility for the quality of their work through self-education.

**Association Newsletter** published quarterly with "Special Show Edition" for the annual conference offers articles, alerts and technical information affecting the industry.

**The SPFA Web Site** is a direct communication to all member suppliers and contractors with web access. Up to date information is offered… And as a member you may link into the web site (www.sprayfoam.org)

**A "*HOT-LINE*" 800 number** is available for your use to answer those technical questions (800-523-6154). The SPFA sponsors research and development and product testing that allows approval for generic types of spray foams, covering and related products.

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