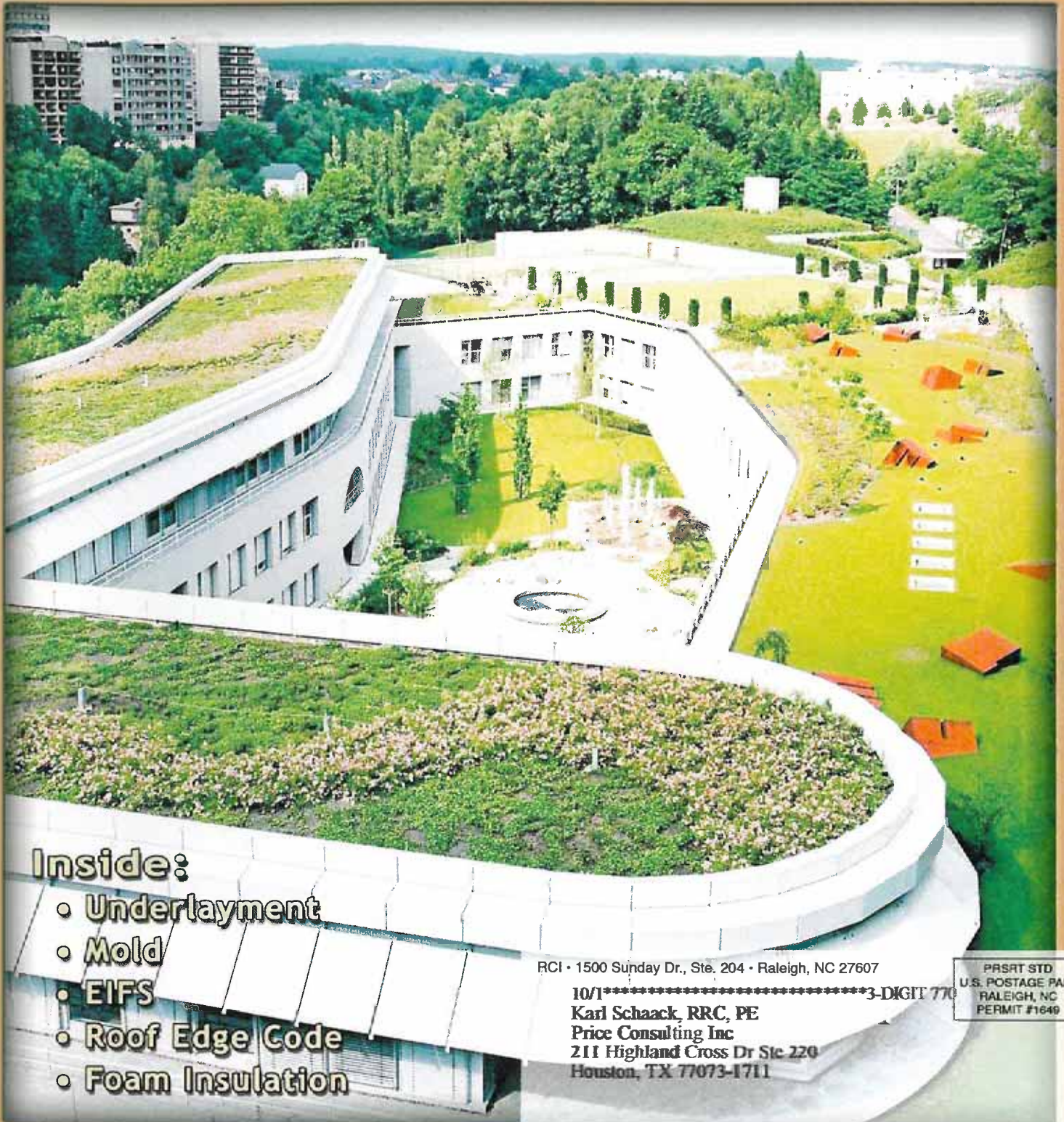




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THE UNDERLYING FACTS:

PRODUCT TYPES, STANDARDS, AND CHARACTERISTICS OF UNDERLAYMENTS

PART I
OF II

BY KARL SCHAACK, RRC, PE

As defined by the International Building Code: underlayⁿent *n*. "One or more layers of felt, sheathing paper, nonbituminous saturated felt, or other approved material over which a steep-slope roofing covering is applied." Currently, there are a multitude of material types, compositions, and installation techniques that are available for underlayments for steep-slope roof assemblies. The purpose of this paper, the first part of a two-part series, is to provide a general summary of the various material types of underlayments, identify applicable standards associated with underlayments, and identify basic material/performance characteristics of these products.

Underlayments are utilized under a variety of materials such as asphaltic shingles, wood shingles/shakes, metal panel roofing, metal shingles, slate, tile, and other synthetic steep-slope roof coverings. Underlayments can provide many functions for the roof assembly. Several common purposes for the installation of an underlayment are as follows:

1. Provide temporary protection for the substrate and the building interior to which it is applied prior to the application of the finished covering. This is particularly critical during replacement of roof coverings on existing buildings.
2. Provide a "cushion" or leveling layer between the roof covering and the substrate. Minor imperfections in the substrate and "picture framing" of sheathing panels can be concealed.
3. Provide a separation layer between the roof covering and the substrate.

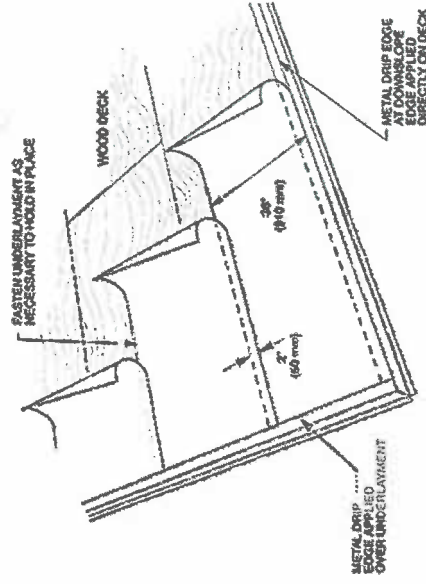
Resin pockets in pine wood planks used in decking could cause asphalt in the shingle to degrade prematurely.

4. Achieve specific fire resistance classification for the roof assembly.
5. Provide back-up water-shedding protection for the building if moisture migrating past the primary roof covering, particularly on lower degrees of slopes (i.e. <2:12).

MATERIAL TYPES & STANDARDS Bituminous Felts

The traditional underlayment that has been utilized for many years and still today in steep-slope roof applications is "asphalt saturated felt." This product is commonly referred to as "felt paper," "#15 felt" or "#30 felt," "building paper," "felt underlayment," or simply "underlayment." However, there are a wide variety of asphaltic-based products that are commercially available that can and are utilized as underlayments.

Typically, asphalt-saturated organic felts have been the most economical selection for underlayments. ASTM D-226, "Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing," has traditionally been used as a reference for this particular product. This standard identifies two types of felts, Type I, commonly called "No. 15 asphalt felt," and Type II, commonly called "No. 30 asphalt felt."



NOTE - DIMENSIONS ARE APPROXIMATE

Diagram of typical felt underlayment.

In the past, the felt number designation was correlated to the weight of the felt (i.e., a No. 15 felt weighed 15 pounds/100 square feet). However, the minimum weight established by ASTM D-226 of the current industry standard No. 15 felt is 11.5 pounds/square. The weight of the current industry standard No. 30 felt is 26 pounds/square. The No. 15 type of felt underlayment is traditionally available in a roll that weighs approximately 50 to 55 pounds and provides coverage of 4 squares. The No. 30 type of felt underlayment is traditionally available in a roll that weighs approximately 50 to 55 pounds and provides coverage of 2 squares.

ASTM D-4869 is another standard that is commonly used for asphalt-saturated felt products used as underlayments. ASTM D-4869 is the "Standard Specification for Asphalt-Saturated Organic Felt Shingle Underlayment Used in Roofing." The original standard identified two felt types - Type

I, "Shingle Underlayment," and Type II, "Heavy-Duty Shingle Underlayment." The weights of these felts, as identified by this standard, were 8.6 pounds/square for the Type I and 21.6 pounds/square for the Type II.

In 2003, ASTM revised this standard with the new title, "Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep-slope Roofing." The objective of this specification as stated by ASTM is "to provide a product that will lay flat and resist wrinkling, puckering, and shrinkage when left exposed to sun, rain, frost, or dew for two weeks after application." The current standard identifies four types of felt products:

- Type I - #8 Underlayment
- Type II - #13 Underlayment
- Type III - #20 Underlayment
- Type IV - #26 Underlayment

The number designations for these products reflect the minimum weight required by this standard of the respective materials.

Many manufacturers of roll goods produce "non-rated/un-rated" asphalt-saturated organic felts that are currently available and utilized as underlayments. These products are commonly referred to as "building paper," "underlayment," and often "#15" or "#30," but do not comply with the applicable ASTM standards. The weight of the roll goods for these types of products is typically on the order of 30 to 40 pounds. These products generally have the lowest pricing and the most unpredictable levels of asphalt saturation. Consequently, these products commonly exhibit severe wrinkling during and even after installation of the roof covering. Severe wrinkles in an underlayment could telegraph through a relatively thin roof covering, such as asphalt shingles, after the installation is complete. When these organic felt products are exposed, the asphalt dries and the organic mat absorbs moisture and expands, consequently resulting in wrinkles. These types of products are considered to be "hygroexpansive," which is the tendency of a material to absorb water and/or drawing moisture from the atmosphere. This process reduces the strength of the sheet, and it becomes more susceptible to tearing and physical damage. Corrective action of wrin-



Typical wrinkled organic felt underlayment.

kles could include the following measures:

1. Complete replacement of the underlayment.
2. Cut the wrinkles and repair with plastic cement and cut sections of underlayment.
3. Keep underlayment exposed and allow wrinkles to "relax," then install covering.

Asphaltic felt underlayment degradation can also occur after installation of the covering when water runs over the felt or collects and remains on the felt surface (i.e., behind wood battens for tiles).

Other various asphaltic-based (saturated/coated) felt products have also been used as underlayments, including organic base sheets, fiberglass base sheets, and roll roofing. ASTM D-2626, "Standard Specification for Asphalt-saturated and Coated Organic, Felt-Base Sheet Used in Roofing," covers asphalt-saturated and coated organic felt base sheets with a fine mineral surface on the top side, with or without perforations.

Most current industry standards recommend the use of non-perforated sheets for underlayments. The weight of this particular product is 37 pounds/square and is commonly referred to as a "#43 base sheet." This type of product is typically available in rolls that weigh approximately 80 to 90

pounds with coverage rate of 2 squares.

The standard for fiberglass-reinforced, asphaltic-based felt products that can be used as underlayments is ASTM D-4601, "Standard Specification for Asphalt-coated Glass Fiber Base Sheet Used in Roofing." This specification identifies two types of sheets: Type I, with a weight of 13.4 pounds/square; and Type II, with a weight of 15.5 pounds/square. Roll roofing products that can be used as an underlayment could be either smooth-surfaced or granule-surfaced and have either an organic mat or fiberglass reinforcement.

In the past, there were two standards that outlined the criteria for the smooth-surfaced and granule-surfaced, organic-reinforced products. ASTM D-224 was the "Standard Specification for Smooth-surfaced Asphalt Roll Roofing (Organic Felt)." This standard identified four types of sheets. Types I and IV had weights of 39.8 pounds/square, Type II had a weight of 54.6 pounds/square, and Type III had a weight of 51.1 pounds/square. The standard for granule-surfaced roll roofing was ASTM D-249, "Standard Specification for Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules." This specification identified two classifications: Type I, with a minimum net mass of 74.0 pounds/square; and Type II, with a minimum net mass of 71.5 pounds/square. This type of sheet has

been referred to in the past as "90#" or "90 pound."

In 2003, ASTM discontinued these two individual standards and created ASTM D-6380-03, "Standard Specification for Asphalt Roll Roofing (Organic Felt)." This product is typically available in rolls with a coverage rate of one square. This specification covers asphalt roofing in sheet form composed of asphalt-saturated organic felt coated on both sides with asphalt. This standard was developed to replace D-224, D-249, and D-371. This specification identifies three classifications of the sheet. "Class S" (smooth) rolls are surfaced with powdered talc, mica, or other fine mineral matter on both sides; "Class M" (mineral) rolls shall be surfaced on the weather side with mineral granules, except for any selvage edge; and "Class WS" (wide selvage) rolls shall be surfaced on the weather side with mineral granules for approximately half of the width of the sheet. The minimum net mass per unit area of these various sheets is as follows:

- Class S, Type III - 51.1 #/square
- Class S, Type IV - 39.8 #/square
- Class M, Type II - 71.5 #/square
- Class WS, Type III - 35.5 #/square
- Class WS, Type IV - 42.8 #/square

The standard for fiberglass-reinforced roll roofing products with a granule surfacing is ASTM D-3909, "Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules." This product has a minimum net mass of the granulated area of 63.2 pounds/square. This type of product has commonly been used as an underlayment installed under tile roof coverings. It is utilized for this type of application for the following reasons: the granule surfacing provides both a slip-resistant working surface and a surface roughness for foam-adhered tile systems; the product has relatively good durability for surface traffic and exposure; and the product has relatively good economic value.

Due to the wrinkling and lack of durability of the standard asphalt-based organic underlayment products, other types of products have been developed to overcome this inherent problem. These products are either fiberglass-reinforced, asphalt-coated sheets or non-asphaltic sheets that can be used as an alternate choice for underlayment. Some manufacturers have developed felt products that are coated with modified bitumen to provide better weathering characteristics. ASTM D-6757-02 is the

"Standard Specification for Inorganic Underlayment for Use with Steep Slope Roofing Products." This specification covers (1) inorganic, fiber-reinforced organic felts that are reinforced with inorganic fibers (typically fiberglass), and (2) inorganic, fiber-based asphaltic and nonasphaltic felts.

The intent of this standard is to provide criteria for producing and evaluating underlayments with a significantly reduced tendency to wrinkle

before or after installation of steep roofing products. This type of product is commonly available in rolls with coverage rates of 1.5 to 2 squares and weights on the order of 65 to 85 pounds. These products are commercially available from primary material manufacturers that offer asphaltic and roll good products on a national or regional basis.

Modified Bitumen

Similar to roll roofing products, modified bitumen sheet products can and have been used as underlayments where additional durability is required or warranted. The primary modified bitumen sheet that has been used for underlayment is the SBS variation. The ASTM standards for SBS-modified bitumen products include ASTM D-6162, "Standard Specification for Styrene

Butadiene Styrene Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements," ASTM D-6163, "Standard Specification for Styrene Butadiene Styrene Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements," and ASTM D-6164, "Standard Specification for Styrene Butadiene Styrene Modified Bituminous Sheet Materials Using Polyester Reinforcements."



Typical installation of felt and ice dam protection.

mass per unit area for these products is shown in Table 1.

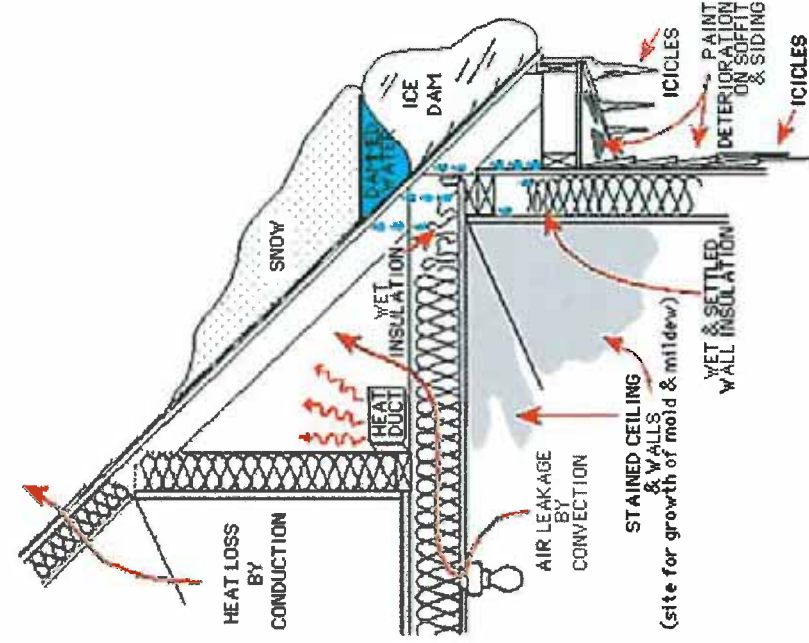
The recent advent of the self-adhering technology for the installation of SBS and APP modified bitumen-based products has also created a new class of products that are being used as underlayments for steep-slope roof applications. The modified bitumen products are commercially available for commercial roofing applications.

Rubberized Self-Adhering Sheets

Another type of product that has gained extreme popularity for use as an underlay-

D6162		D6163		D6164	
Type I	Type II	Type I	Type II	Type I	Type II
45 lbs/sq	50 lbs/sq	45 lbs/sq	45 lbs/sq	54 lbs/sq	70 lbs/sq
60 lbs/sq	75 lbs/sq	65 lbs/sq	75 lbs/sq	75 lbs/sq	90 lbs/sq

TABLE 1



Pictorial representation of an ice dam.

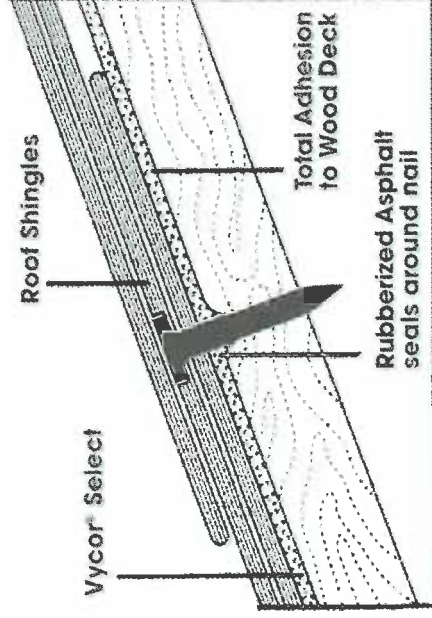
ment over the past years is the self-adhering rubberized sheet. This product has been utilized as an underlayment for what would be considered a "higher" level of roof coverings such as standing-seam metal panel and tile coverings. The standard for this type of product is ASTM D-1970-01, "Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection." As stated by ASTM, this specification "covers polymer-modified bituminous sheet materials intended for underlayment on roof eaves, valleys, or both to prevent leakage of shingle, tile, or metal roofs from water back-up due to ice dams. This product shall have a sticky adhesive layer which is exposed by removal of a protective sheet and the top surface is suitable to work on during the application of the exposed roofing."

This standard outlines the following physical requirement for this type of product: thickness, maximum load, elongation, adhe-

sion to plywood, slip resistance, waterproof integrity at lap seam, sealability around nails, thermal stability, flexibility temperature, tear resistance, moisture vapor permeance, and low temperature flexibility.

This type of product has not only been used for ice dam protection, but has gained widespread use as an underlayment installed across the entire substrate. Due to its increased popularity and industry acceptance, a wide variety of products have been developed and are currently available from numerous suppliers, either by direct manufacturing or private labeling arrangements. The product is typically a minimum of 40 mils thick (ASTM standard), but thicker products (i.e., 55

to 80 mils) are also available. Although the ASTM standard identifies this product as a polymer-modified bituminous sheet, the rubberized composite can consist of SBS/APP modified bitumen, butyl rubber, or non-asphaltic, re-processed rubber materials. The top surface of this product commonly consists of a cross-laminated polyethylene sheet, which is laminated to the rubberized composite. In order to provide slip resistance, a textured type of finish is created on the top surface of the polyethylene sheet.



View of nail sealability of rubberized underlayment.



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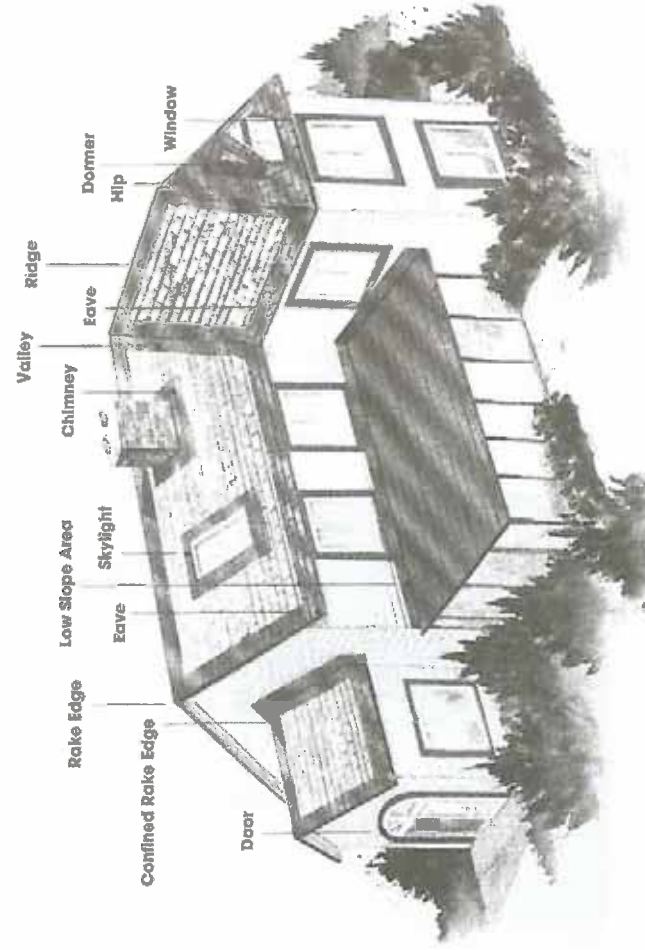


Diagram depicting typical locations for ice dam protection.

Other variations of this type of product have either granules embedded in the top surface, a sanded finish, or some type of fabric (polyester) that is exposed in lieu of the polyethylene film, in order to provide both slip and weather resistance qualities. The granule-surfaced sheets are recommended primarily to be installed under tile roof coverings, and the fabric-surfaced sheets are recommended to be installed under metal panel roof coverings. The underside of this product typically has a polyethylene release film that is removed to expose the "tacky" side of the sheet. The underlayment is currently manufactured with the release film split in half longitudinally down the middle of the sheet.

Some products also have a "pull" or "rip" cord incorporated at the split to provide ease of removal of the film. The product is typically non-reinforced except for the polyethylene-surfacing sheet.

However, other products have been developed that are produced with either a polyester scrim or a fiberglass mat/reinforcement in order to provide more durable sheets. This type of underlayment is manufactured and available for both "standard applications" and "high temperature" requirements. The "high temperature" products are commonly recommended to be installed under metal roof coverings or in certain geographic regions where rooftop temperatures of 260 degrees Fahrenheit may be experienced.

This product was originally utilized at eaves, valleys, and other locations where

possible ice dams or other water/moisture infiltration problems would most likely occur in certain geographic locations.

These products and variations thereof, however, have become somewhat of a standard for use as underlayments, based on their ability not only to adhere to the substrate, but also provide a relatively good weather barrier until the final roofing is installed, particularly in reroofing applications. These types of under-



Wrinkled rubberized underlayment due to overexposure.



Felt underlayment displaced by wind.

layments are commonly used under tile, metal panels, and shingles when climatic conditions warrant, extended warranties are required, or unique situations dictate.

Grace's "Ice & Water Shield" is considered to be the original standard for this type of product, and the name is commonly used generically in conversation and drawings in reference to this type of material. This product is available from various manufacturers in a variety of roll sizes with widths ranging from 36 inches to 39-3/8 inches; coverage rates from 1 square to 2 squares; and roll weights on the order of 55 pounds to 80 pounds.

Although these products have a proven track record for use as underlayments, there are several precautions to be adhered to during installation. Following are general guidelines to achieve optimum performance:

1. The top surface of these sheets, even granule-surfaced products, could become slippery.
2. The release paper could be a slip hazard upon removal from the sheet.

- These products are considered to be vapor retarders and when installed entirely across the substrate, special precautions should be taken to ensure that proper ventilation is available.
- The substrate should be clean and dry to achieve proper bond.
- These products typically have a low temperature (40 degrees F) requirement for installation to achieve proper "tackiness" of adhesive.
- Although considered to be a "waterproofing" layer, these products commonly have a time limitation for exposure varying, typically, from 30 to 90 days.

Synthetic, Non-bituminous Sheets

Spun bond polypropylene/polyethylene technology has created another type of product that has its origin in Europe and the packaging industry and is gaining popularity in the United States for use as an underlayment in steep-sloped roofing applications. The polypropylene/polyethylene sheets are woven polymer technology sheets that are non-asphaltic and available in various colors, including black, gray, and white. They are reported to be lightweight (3-6 pounds/square); high-strength (will not tear around nails and require fewer nails to hold in place); resistant to vermin, rot, and fungus; provide slip-resistant surfaces; lay flat (no formation of wrinkles) after installation; can remain exposed for extended periods (i.e., 6 to 12 months) without degradation; and are considered to be "breathable." These products are promoted to be a "premium" performance upgrade for an underlayment, compared to traditional felt products.

Common performance comparisons to ASTM #30 felt are shown in *Table 2*.

Some common named products include: "Roof-Top Guard II" by Classic Products/Drexel Metals, "Tri-Flex 30" by Grace Construction Products, and "Titanium-UDL" by Inter Wrap, Inc. These products are commonly available in rolls that are wider than traditional roofing roll goods, such as 4 inches to 60 inches, and provide coverage rates of 10 squares/roll. These rolls weigh on the order of 30 to 40 pounds.

Elk Premium Building Products, Inc. has developed a product called "Versi-Shield" that is a fiberglass-reinforced sheet with a non-asphaltic proprietary coating. This underlayment is designed primarily for use with metal roofing systems, but can

Physical Property	Synthetic Value	Organic Sheet Value
Tear strength	30-90 lbs.	4 lbs.
Tensile strength	143 lbs.	70 lbs.
Nail hold strength	132 lbs.	39 lbs.
Weight	2.5-4.5 lbs./sq.	27.5 lbs./sq.
Thickness	15 mils	60 mils

TABLE 2

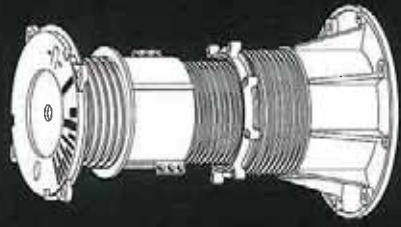
also be installed under other steep-slope fire rating when installed directly over a roof coverings, including, but not limited to, combustible deck. The product can also shingles and tile. This sheet can provide a provide water protection, is promoted to be

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