



Quality You Can Trust... From North America's Largest Roofing Manufacturer!™

Version 1.0

DRILL-TEC™ RHINO BOND® ATTACHMENT

Roofing System Overview & General Requirements Manual

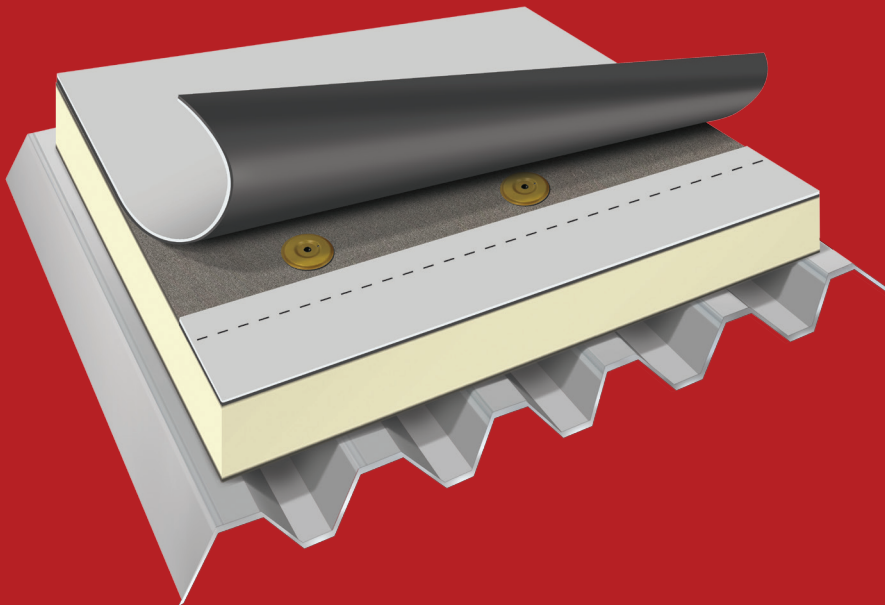


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Note: Refer to gaf.com for a complete list of Product Data Sheets and Chemical-Resistance Guides.

WELCOME

Thank you for consulting the 2014 Edition of the *Drill-Tec™ RhinoBond® Attachment System Overview & General Requirements Manual*. You can find further information at gaf.com, or contact GAF Technical Services at 1-800-ROOF-411 (1-800-766-3411).

WHO IS GAF?

Founded in 1886, GAF has grown to become North America's largest manufacturer of commercial and residential roofing.* Professional roofing contractors have long preferred the rugged, dependable performance that only a GAF roof can offer, and have made it the #1-selling brand in North America.* Our success in growing the company to \$3 billion in sales has been based on our unique philosophy of helping our customers.

For roofing contractors and distributors:

- Helping to build your business and avoid hassles

For property owners & architects:

- Helping to ensure your best and safest choice in roofing

WHAT IS IN THIS MANUAL?

This Manual contains the following sections:

- Welcome
- Guarantee Program
- Roof Design
- Design & Application Guidelines: Drill-Tec™ RhinoBond® Attachment Systems
- Roofing Details

WHAT ARE OUR PRODUCTS AND SERVICES?

No one offers a wider range of reliable, proven, cost-effective roofing solutions:

COMMERCIAL PRODUCTS

- EverGuard Extreme® TPO Single-Ply Roofing Systems
- EverGuard® TPO and PVC Single-Ply Roofing Systems
- EverGuard® Freedom™ TPO Self-Adhering Roofing Systems
- RUBEROID® SBS and APP Modified Bitumen Roofing Systems
- ROOFMatch™ SBS and APP Membranes in select colors

- Liberty™ SBS Self-Adhering Modified Bitumen Roofing Systems
- GAFGLAS® Fiberglass Built-Up Roofing Systems
- TOPCOAT® Liquid-Applied Roofing Systems
- GardenScapes™ Roofing... Hassle-free Garden Roofing System

RESIDENTIAL PRODUCTS

- Lifetime Designer Shingles... Camelot®, Camelot® II, Country Mansion® II, Slateline®, Grand Canyon®, Grand Sequoia®, Grand Sequoia® IR, Sienna®, Woodland®, and Monaco® Shingles
- Timberline® Lifetime Shingles... Timberline Ultra HD®, Timberline HD®, Timberline® Natural Shadow®, Timberline® American Harvest®, Timberline® Cool Series, and Timberline® ArmorShield™ II
- 3-Tab Shingles... Marquis WeatherMax® and Royal Sovereign®
- TruSlate® Roofing... Affordable Genuine Slate Roofing System

ACCESSORY PRODUCTS

- We offer an extensive line of accessory products for our roof systems, including: EverGuard® TPO and PVC Prefabricated Accessories; Single-Ply Adhesives, Primers & Sealants; Matrix™ Adhesives and Cements; EnergyGuard™ Insulations; Drill-Tec™ Fasteners; M-Weld™ Preflashed Accessories; Metalastic® Expansion Joint Covers; Lexsuo® Roof System Accessories; Cobra® and Master Flow® Ventilation Products; Timbertex® Premium Ridge Cap Shingles; WeatherWatch® and StormGuard® Leak Barriers; and Shingle-Mate® and Deck-Armor™ Roof Deck Protection.

SERVICES

- Every GAF roofing product benefits from the substantial resources available only from a multibillion-dollar corporation dedicated to roofing. Our 26 plants mean manufacturing expertise. Our extensive R&D organization means a constant focus on product and process improvement. GAF is a team of over 3,000 people dedicated to your roofing satisfaction.
- GAF has a network of sales representatives and distributors to supply and service its quality roofing systems throughout North America.

*Source: 2010 Freedonia Group Study

WELCOME

- Our Technical Helpline is a technical assistance service that allows you to contact us directly to speak with a technical representative about specifications, applications, code approvals, and product information. The Helpline number is 1-800-ROOF-411 (1-800-766-3411).
- Architectural Information Services (AIS) is a specification service that allows you to specify your exact roofing needs and will send you a general specification that outlines your job summary, application method, product description, and detail drawings. The phone number for AIS is 1-800-522-9224.
- Our Tapered Design Group (TDG) is one of the many services available to our customers to help reduce their hassles. We provide tapered insulation take-offs for architects, contractors, and distributors nationwide. Just send your roof plans and specifications to tdg@gaf.com.
- Visit GAF on the web at gaf.com for extensive product information, specifications, and technical literature.
- Under no circumstances does GAF have any liability for expenses arising out of or associated with the pre-existing presence of asbestos-containing materials or any other allegedly hazardous substances or materials upon the roof to which the new GAF roofing materials are being applied.
- Information contained in this Manual is presented in good faith and, to the best of GAF's knowledge, does not infringe upon any patents, foreign or domestic.
- As a part of its continuing efforts to improve the performance of its products, GAF periodically makes changes to its products and application specifications. The Company reserves the right to change or modify, at its discretion, any of the information, requirements, specifications, or policies contained herein. This Manual supersedes all catalogs and previous manuals.
- GAF is Your Best and Safest Choice!

A FEW THINGS TO CONSIDER...

- This Manual contains the latest information relating to the application of GAF's Drill-Tec™ RhinoBond® Attachment System and is based on our years of experience in the commercial roofing field. It has been prepared as a general guide to assist architects, engineers, roofing contractors, and owners in the use of our roofing systems.
- GAF manufactures and sells roofing materials and does not practice architecture or engineering. GAF is not responsible for the performance of its products when damage to its products is caused by such things as improper building design, construction flaws, or defects in workmanship.
- The design responsibility remains with the architect, engineer, roofing contractor, or owner, and construction details illustrated and described herein are furnished solely for guidance purposes. These guidelines should not be construed as being all-inclusive, nor should they be considered as a substitute for good application practices.

GUARANTEE PROGRAM

GENERAL

GAF offers roof guarantees for a fee for all roofing system specifications published in this Manual when installed by GAF Factory-Certified Low-Slope Roofing Contractors in accordance with the terms and conditions set forth in this Manual, and the procedures for obtaining a guarantee are followed. All GAF insulation, fasteners, preflashed details, expansion joint covers, cements, coatings, and accessory products as job appropriate are required for guarantees unless otherwise approved in writing by a Field Services Manager or Director prior to installation.

All guaranteed roofing systems must be flashed in accordance with the GAF flashing requirements and details included in this Manual.

GAF will be the sole judge as to whether or not a roofing guarantee will be issued to cover any proposed or completed roof. The issuance of a guarantee and its effectiveness or the continued liability thereunder is contingent upon payment of GAF's guarantee fee and payment in full to the roofing contractor and materials suppliers.

GAF has no obligation to issue a roofing guarantee on any roof. Any inspection prior to issuance is solely for the benefit of GAF and does not constitute a waiver of any terms or conditions in the guarantee. In the event that a roof system does not conform to GAF's standards and a guarantee is not issued, no portion of the guarantee fee is refundable.

GAF will not accept Notices of Award of Contract that indicate that the owner or architect has the option to accept or reject the guarantee upon completion of the roof.

Specifications not listed in this Manual may also be eligible for GAF guarantees. For further information on guarantee requirements and for approval of modifications to published specifications, consult with GAF at 800-766-3411.

GAF is not responsible for consequential damages in case of roof system failure. GAF has no control over a building's contents, type, quantity, positioning, or protection.

A GAF guarantee cannot be withdrawn once it has been issued, although it may be cancelled subsequently by GAF for violation of its terms and conditions.

EXTENDED-LENGTH (GREATER THAN 20-YEAR) COMMERCIAL GUARANTEES

EverGuard® TPO Roof Systems

The selection of membrane type, thickness, and attachment is the responsibility of the architect, engineer, owner, or roof consultant. GAF EverGuard® roof membranes must be used in roofing systems to be guaranteed by GAF. The following is a list of eligible membranes for Drill-Tec™ RhinoBond® Attachment Systems:

1. EverGuard® 25-year extended-length guarantee*
 - EverGuard® 60 mil TPO membrane (smooth)
 - EverGuard Extreme® 50 mil TPO membrane (smooth)

2. EverGuard® 30-year extended-length guarantee*
 - EverGuard® 80 mil TPO membrane (smooth)
 - EverGuard Extreme® 60 mil TPO membrane (smooth)
 - EverGuard Extreme® 70 mil TPO membrane (smooth)

3. EverGuard® 35-year extended-length guarantee*
 - EverGuard Extreme® 80 mil TPO membrane (smooth)*New construction or complete tear-off only

Roof Insulation

The selection of insulation type, thickness, and configuration is the responsibility of the architect, engineer, owner, or roof consultant. GAF reserves the right to accept or reject any roof insulation as an acceptable substrate for GAF roof systems. GAF EnergyGuard™ insulations must be used in roofing systems to be guaranteed by GAF.

1. For Drill-Tec™ RhinoBond® Attachment Systems, a minimum of two layers of insulation are required for extended-length guarantees.
2. For all systems, the top layer may be a cover board, as follows:
 - a. High-density fiber board
 - b. DensDeck® Roof Board
 - c. DensDeck® Prime Roof Board
 - d. SECUROCK® Roof Board
 - e. EnergyGuard™ HD and EnergyGuard™ HD Plus Polyiso

Additional Requirements

1. Building Height Limitations
 - a. Buildings greater than 100' (30 m) in height must have a minimum 3' (0.9 m) parapet wall to be eligible for an extended-length Diamond Pledge™ 25-, 30-, or 35-year NDL Roof Guarantee.
2. Construction Type
 - a. Diamond Pledge™ 25-, 30-, or 35-year NDL Roof Guarantees are available only for new construction or complete tear-off to the deck.
3. WellRoof® Guarantee Extension
 - a. Any issued guarantee up to 30 years in length is eligible for the GAF WellRoof® Guarantee Extension; maximum guarantee length, including WellRoof® Guarantee Extension, is 35 years.

GUARANTEE PROGRAM

Air/Vapor Retarders

For EverGuard® extended-length guarantees, air/vapor retarders are required, as follows:

- a. With mechanically attached installations with openings in the wall that exceed 10% of the total wall area.
- b. With installations of 10' (3 m) wide or greater membranes with side lap mechanical attachment that exceed 6" (150 mm) o.c. [For 10' (3 m) wide sheets, the requirements for an air retarder are dependent upon building height and fastener density. Contact your local GAF Field Services Manager for air retarder requirements.]

Roof Flashings

1. For EverGuard® extended-length guarantees, separate counter flashing or cap flashing is required; exposed termination bars are not acceptable.

Roof Edges

1. For EverGuard® extended-length guarantees, use EverGuard Extreme® TPO Cover Tape Heat Weld. This is a hybrid cover tape consisting of 6" (150 mm) of .045 reinforced TPO membrane with 3" (76 mm) butyl tape on half of the back surface.
2. Galvanized-based metal edging is not acceptable for extended guarantee lengths. It may be flashed using EverGuard® TPO Cover Tape after priming both the metal and the TPO membrane for guarantee lengths up to 15 years.

Flashing Accessories

1. For EverGuard Extreme® extended-length guarantees, regardless of the membrane type, EverGuard Extreme® flashing accessories are required.
2. Unsupported EverGuard Extreme® flashing membrane is available and required on areas where prefabricated accessories cannot be used or are unavailable.

SPECIAL CONDITIONS

A guarantee will not be issued to cover less than the entire roof area of a single building.

A GAF roofing system guarantee will not be issued for the following without prior written approval from the Field Services Manager or Director:

- over any surface or deck not covered in this Manual
- over a cold storage building, unless a ventilated plenum isolates the cold storage area from the roofing system and substrate
- on storage silos, heated tanks, or domed structures
- on structures having conduit or piping between the roof deck and roofing membrane, unless the conduit or piping is installed in channels below the top deck surface
- on roofs that have an inadequate number and spacing of expansion joints or curbs
- on systems constructed with insulation not approved by GAF
- on any structure where there is limited or no access to the roof
- on a roof designed for or used as a water-insulated or spray roof
- on promenade or parking roofs
- on waterproofing applications

- for any structure where high-heat or humidity conditions exist such as, but not limited to, breweries, creameries, laundries, textile mills, pulp and paper plants, swimming pools, shower rooms, and canneries
- when roofing over an existing roof system that contains moisture, is not adhered to the substrate or roof deck, and/or provides an improperly prepared surface
- on plywood decks without continuous solid end blocking
- on roofs containing sprayed-in-place polyurethane foam
- any unusual condition not specifically approved by GAF
- on any high-temperature condition that allows the roof membrane temperature to exceed 160°F (71°C); or 195°F (90°C) for EverGuard Extreme® roofing systems.

GAF CERTIFIED CONTRACTOR PROGRAM

GAF does not install roofing systems. GAF does not own roof contracting companies, or have any interest in companies installing roofing systems. Accordingly, GAF shall not be responsible for any roofing contractor's workmanship except as specifically covered under the terms and conditions of the GAF roofing guarantee.

The term "GAF Factory-Certified Low-Slope Roofing Contractor" only identifies a contractor eligible to apply for a GAF roofing guarantee and is not intended to convey any other meaning. GAF Factory-Certified Low-Slope Roofing Contractors are not employees, agents, or representatives of GAF.

GAF will issue a roofing system guarantee only for roofs applied by a GAF Factory-Certified Low-Slope Roofing Contractor. The responsibility for proper application of the roof lies with the Factory-Certified Low-Slope Roofing Contractor alone. It is the responsibility of the building owner and his designated representatives, as the employer of the Factory-Certified Low-Slope Roofing Contractor, to enforce the compliance with specifications and good workmanship practices, and such enforcement is not an obligation of GAF.

INSPECTIONS

GAF will inspect only those roofs where a guarantee is to be issued or where special inspection services have been agreed to be purchased prior to the start of the roof construction, and the current charge for the guarantee or inspection services has been paid. If an inspection is requested and the job is not ready or the owner's representative is not available, an extra billing will be made at consultation fee rates.

GAF reserves the right to waive inspection of guaranteed roofs when, in its opinion, inspection is not necessary. In such cases, the owner or designer may request a special inspection for which an additional charge may be made.

Any inspections made by GAF are for its own use only and do not constitute a waiver of any of the terms and conditions of the guarantee.

Should a GAF Field Services Representative observe conditions on the job site that do not conform to the requirements of this Manual or standard good roofing practices, such conditions will be brought to the attention of the roofing contractor. GAF, at its sole discretion, has the right to require corrective action as it deems necessary to conform to the requirements of this General Requirements Manual and the requirements for the issuance of the GAF roofing system guarantee.

ROOF DESIGN

Provides a quick reference of technical requirements for Drill-Tec™ RhinoBond® Attachment System design

- General
- Sustainable Design
- Building Utilization
- Tear-off or Re-cover
- Roof Decks
- Parapet Walls
- Roof Drainage
- Expansion Joints
- Area Dividers
- Equipment Mountings
- Fire Resistance
- Wind Performance
- Energy Efficiency
- Water Vapor Transfer

ROOF DESIGN

GENERAL

Proper roofing system design and selection requires the consideration of many factors. Although GAF's expertise is in materials manufacturing, and not in engineering, architecture, or specialized roof consulting, our company has decades of extensive experience in the practical aspects of roofing.

Our experience suggests that careful consideration of the following will provide a fundamentally sound basis for design and selection of EverGuard® single-ply roofing systems.

SUSTAINABLE DESIGN

ENERGY STAR® is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. It is designed to help our nation save energy and money, and to protect the environment through energy-efficient products and practices. Energy-efficient choices can save building owners significantly on their energy bills with similar savings of greenhouse gas emissions, without sacrificing features, style, or comfort. ENERGY STAR® helps consumers, contractors, architects, and property owners make more knowledgeable, energy-efficient choices.

The LEED® (Leadership in Energy and Environmental Design) Green Building Rating System is a voluntary standard for developing high-performance, energy-efficient sustainable buildings. The LEED® Certification System is a program that awards building points for satisfying specified green-building criteria and requirements.

Green Globes® is a web-based program for green building guidance and certification that includes an onsite assessment by a third party and is an alternative to the LEED® rating system.

GAF's EverGuard® TPO is the first to be certified by NSF International for the NSF/ANSI 347 *Sustainability Assessment for Single-Ply Roofing Membranes*. This Standard is the evaluation of the sustainability of single-ply roofing membranes. The Standard includes criteria across the product life cycle from raw material extraction through manufacturing, use, and end-of-life management. Go to www.nsf.org for details.

GAF's EverGuard Extreme® TPO Roofing Membrane was engineered with energy efficiency and sustainability in mind. This high-performance, reflective roof membrane is also geared for solar roof installations. The increasing use of building integrated photovoltaics (BIPV) has highlighted the challenges faced by roofing membranes exposed to concentrated heat, sunlight, and UV. GAF scientists have created a new grade of TPO single-ply membrane that is built to handle the extreme demands that new rooftop applications can place on roofing membranes. EverGuard Extreme® TPO uses proprietary stabilizers and UV absorbers to achieve weathering performance far beyond current standards.

- EverGuard Extreme® TPO can be installed up to 10 years prior to the installation of solar overburden.
- Installation of overburden will not affect the membrane performance or warranty coverage of EverGuard Extreme® TPO.
- Please contact GAF before installing any overburden on the roof.

BUILDING UTILIZATION

Building utilization can have a significant impact on roofing system selection and design. The most common building utilization considerations are as follows: extremes in internal temperature/humidity; positive internal pressure; rooftop traffic/abuse; rooftop-exhausted contaminants; and the use of the roof as living space.

Internal Temperature/Humidity

Extremes in internal temperature/humidity are most often associated with cold storage/freezer buildings, swimming pool facilities, drying

kilns, food processing plants, paper/pulp mills, and smelting/blow furnace facilities. What makes these building applications unusual is that the pronounced difference in vapor pressure between the building interior and the exterior can cause a pronounced vapor flow through the roof assembly. This can result in a significant build-up of condensation within the roof assembly, and severe deterioration of both the roof assembly itself and the structural deck.

Relevant design considerations include:

- Incorporation of a vapor retarder at deck level to control vapor flow into and through the roof assembly;
- Attention to a vapor-tight seal between the roof and side walls/penetrations;
- Utilization of closed-cell foam insulation and stainless steel fasteners to minimize potential for condensation-related degradation of the roof system;
- Limitation of penetrations through the roof deck;
- Avoidance of roof system attachment that will puncture the vapor retarder.

Positive Internal Pressure

Positive internal pressure is most often associated with manufacturing/clean-room facilities, mechanical air-handling rooms, aircraft hangars, distribution centers with multiple overhead doors, and high-rise office/residential towers. In all these instances, positive internal pressures can adversely act on the underside of the roof system.

Conditions where the positive internal pressure is constant, as in the case of clean-room facilities and high-rise towers, may cause the roof system to billow up in a mechanically attached system, i.e., form a mattress effect, and may reduce the overall uplift resistance of the roofing system.

This effect can cause attachment concerns with other types of roof system installations including ballasted systems. Conditions where the positive internal pressure is applied suddenly, as in the case of aircraft hangars and distribution centers, may cause failure of the roofing system due to pressure impact.

Relevant design considerations include:

- Use of air-impermeable deck construction, such as poured-in-place concrete or insulating cellular concrete over a steel pan;
- Alternatively, installation of an air barrier, such as polyethylene sheeting, at deck level beneath mechanically attached insulation with attachment sufficient to balance positive pressure;
- Attention to an air-tight seal between roof and side walls/penetrations.

Rooftop Traffic/Physical Abuse

Roofing installations that can be expected to experience a high degree of roof traffic due to equipment maintenance, vandalism, or other unauthorized access, frequent hailstorms or high winds, and prolonged periods of temperature extremes or rapid fluctuations in temperature will require a more durable roofing system.

Relevant design considerations include:

- Use of thicker membrane or multiple-ply system, e.g., GAF TriPosite XL™;
- Use of a higher compressive strength insulation substrate;
- Application of a concrete paver or insulated paver overlay for extreme conditions.

ROOF DESIGN

Contamination

Many roofing installations are exposed to oil, grease, and chemical contamination in excess of normal airborne contaminants. These conditions are most often associated with restaurants, food processing plants, chemical and pharmaceutical plants, refineries, machining and manufacturing facilities, and airports. Most roofing materials are degraded by certain families of contaminants, and will become brittle, swell and soften, or dissolve, depending on the material formulation and contaminant type.

Long-term exposure, i.e., 28-day immersion testing of roofing material and specific contaminant, remains the preferred method of determining material resistance. Even then, unforeseen combinations of contaminants, environmental exposure effects, and variation in contaminant concentration prevent an absolute prediction of resistance to contamination in all but the most common situations.

Relevant design/maintenance considerations include:

- Isolation of contaminated roof area with expectation of more frequent roof membrane replacement;
- Periodic power washing of roofing membrane with moderate pressure;
- Limitation of rooftop spillage/exhaust of contaminating materials, i.e., grease traps.

Please refer to gaf.com for detailed TPO and PVC Chemical-Resistance Charts.

NOTE: GAF guarantees on any GAF membrane, including TPO and PVC, do not cover damage due to chemical contamination.

TEAR-OFF OR RE-COVER

The decision to tear-off/replace or to repair/re-cover an existing roofing system before installing a new roofing system is not always clear-cut.

Although not an exhaustive list, the following additional design elements typically require consideration for any reroofing project:

- Replacement of damaged roof decking or structural components;
- Improvement of roof access;
- Removal of unused rooftop equipment and associated equipment mountings;
- Remounting of rooftop equipment to allow proper roofing and flashing technique;
- Matching of architectural elements such as special perimeter metalwork;
- Repair of deteriorated parapet and penthouse walls;
- Protection of roofing membrane by means of concrete paver overlay or walkway pad system.

Tear-off/Replace

Factors that support the tear-off approach include:

- Two or more existing roofs (building code restriction);
- Structural weight limitation;
- More than 25% of existing roof area is wet;
- Flashing height limitations;
- Need to maximize long-term performance.

The basis for any tear-off project is to provide a sound substrate for the installation of a new roofing system and minimize potential damage from tear-off activities. *At a minimum, attention to the following considerations is recommended:*

- Thoroughly inspect decking, flashing substrates, and wood nailers before installing new materials;
- Plan a tear-off strategy so that roof drainage patterns are never blocked, and so that construction traffic is directed away from new roof areas;
- Protect new roof areas adjacent to tear-off areas from dirt, debris, and damage.

Re-cover

Factors that support the re-cover approach include:

- Need to minimize cost;
- Disposal restrictions;
- Difficult access to the roof.

The basis for any re-cover project is to eliminate defects in the existing roof assembly so that their effect on the new roofing system is minimized. *At a minimum, attention to the following considerations is recommended:*

- Raise all perimeter flashings, penetrations, and equipment to provide required flashing heights;
- Address drainage deficiencies to provide positive drainage;
- Remove and replace all wet roofing materials;
- Concentrate on thorough surface preparation.

Re-covering Over Coal Tar Pitch Roofing

Coal tar pitch has oils and vapors that can be harmful to various roofing membranes and may discolor white thermoplastic membranes. Coal tar pitch may also “cold flow.” For these reasons, GAF does not recommend re-covering over existing coal tar pitch roofs.

ROOF DECKS

Most common structural roof deck types are suitable substrates for the installation of an EverGuard® roofing system. It is the responsibility of the engineer, architect, building owner, or roofing contractor to determine the fitness of a deck for a specific roofing system installation.

Structural Steel

- Min. 22 gauge (standard FM-approved steel decking is 22 gauge in thickness).
- 24-26 gauge decks require a GAF Field Services Manager’s or Director’s approval. Thinner-gauge steel decks usually require additional mechanical fasteners to achieve comparable roof attachment performance.
- 18 gauge, 20 gauge, and 22 gauge Grade E high-strength steel decks usually require fewer mechanical fasteners to achieve comparable roof attachment performance.

Structural Concrete

- Min. 2,500 psi compressive resistance (98,066 kilogram-force/square centimeter).
- Min. 2" (51 mm) thickness (pre-cast), min. 4" (102 mm) thickness (poured-in-place).
- Cannot be wet or frozen. If the deck is determined to be wet, it must be allowed to dry.
- For insulated decks, wood nailers of equivalent thickness to the roof insulation must be provided at perimeters and projection openings

ROOF DESIGN

to act as an insulation stop and to provide for the nailing of the flanges of metal flashing.

- Ridges and other irregularities require grinding to provide a smooth and even substrate surface.
- For non-insulated decks, nailers must be flush with deck surfaces.
- When applying insulation directly to the deck in hot asphalt, prime with asphalt/concrete primer, meeting ASTM D41, at a rate of 1 gal/square (3.8 m/liter) and allow the primer to dry prior to the application of the roofing system.

Pre-cast Concrete Decks

- These decks are usually manufactured as planks or slabs and constructed of steel-reinforced Portland cement and solid aggregate; often they are made with hollow cores to minimize their weight.
- All deformed panels must be replaced.
- Joints must be filled with a masonry grout to correct imperfections between slabs and feathered to provide a slope not greater than $\frac{1}{8}$:12 adhered insulated assemblies.
 - If the joints cannot be grouted and finished smooth, then a leveling course of lightweight insulating concrete (minimum 2" [51 mm] thickness) must be applied. Do not seal joints between the slabs; leave open to permit venting and drying of the roof fill from below.

Pre-stressed Concrete Decks

- GAF recommends a minimum 2" (51 mm) cellular lightweight concrete fill be installed over all pre-stressed concrete decks prior to installation of the roof system and/or insulation because variations in camber and thickness of pre-stressed concrete members may make securement of the roof system difficult.
- Provisions must be made for the curing or drying of the fill installed over the top of the pre-stressed deck members. Do not seal joints between the slabs; leave open to permit venting and drying of the roof fill from below.

Poured Structural Concrete Decks

- Must be properly cured prior to application of the roofing system; twenty-eight (28) days is normally required for proper curing. Check curing agents for compatibility with roofing materials. Prior to the installation of the roof assemblies, GAF recommends the evaluation of surface moisture and deck's dryness through the use of ASTM D4263 or a hot bitumen test.
- Must be poured over removable forms or must provide for bottom side drying. Poured-in-place structural concrete decks that are poured over non-vented metal decks or pans that remain in place can trap moisture in the deck under the roof system and are not acceptable.
- The underside of the concrete decks, either the vented metal forms or exposed concrete, must remain unobstructed to allow the escape of water vapor. Materials that retard the flow of vapor must not be installed directly below the deck. Foil-faced insulation secured to the bottom of the deck, spray-on fireproofing, or paint, which obstruct the venting of the concrete, are just three examples of unacceptable deck assemblies.
- Roofing professionals must take care with lightweight structural concrete decks. The selection of the deck material and its suitability for use is the responsibility of the designer of record, who must make appropriate design accommodations to address

high moisture content encountered in lightweight structural concrete. GAF is not responsible for moisture-related problems associated with any deck material.

Wood Planking

- Min. 2" (51 mm) nominal thickness.
- Tongue & groove or splined edges required.
- All boards must have a bearing on rafters at each end and be securely fastened.
- Lumber should be kiln-dried.
- Check compatibility of preservatives or fire retardants used to treat decking with roofing materials.
- Decking should be kept dry and roofed promptly after installation.
- Tape and staple fastening systems may be used on wood decks when they comply with local building codes and agencies.

Plywood/Oriented Strand Board (OSB)

- Oriented strand board (OSB) decks are not acceptable unless the RhinoBond® fasteners are fastened into joists per GAF requirements.
- Plywood sheathing must be exterior grade, minimum 4 ply, not less than $\frac{3}{4}$ " (19 mm) thick.
- Standard FM-approved plywood decking is fire-rated at $\frac{3}{4}$ " (19 mm) thickness.
- Tongue & groove edges or full blocking required.
- Must be installed over joists not greater than 24" (610 mm) o.c.
- Must be installed so that all four sides of each panel bear on, and are secured to, joists and cross blocking; the panels must be secured in accordance with APA—The Engineered Wood Association recommendations. "H" clips are not acceptable.
- Panels must be installed with a $\frac{1}{8}$ " to $\frac{1}{4}$ " (3.1 mm to 6.3 mm) gap between panels and must match vertically at joints to within $\frac{1}{8}$ " (3.1 mm).
- Decking should be kept dry and roofed promptly after installation.
- Deck shall be attached with approved fasteners at required spacing. Consult local building codes for specific requirements.

Gypsum Concrete

- Not an acceptable substrate.

Cementitious Wood Fiber

- Not an acceptable substrate.

Insulating Concrete

- Min. 2" (51 mm) thickness.
- Cellular concrete decks may be installed over permanent venting steel forms.
- Aggregate lightweight insulating concrete decks must be installed over permanent venting steel forms.
- Insulating concrete installed over structural concrete or existing roof membrane substrates requires GAF Technical Services approval.
- Lightweight insulating concrete decks are required to have a minimum compressive strength of 125 psi (9kg/cm) and a density of 22 pcf (208 grams/cubic meter). Individual deck manufacturers' standards apply when their specifications exceed these GAF minimum thicknesses, compressive strengths, and density requirements.

ROOF DESIGN

- Where the Mean January Temperature (reference current ASHRAE Fundamentals Handbook) is below 40°F (4.4°C), lightweight insulating concrete decks must be poured and roofed between April 1st and October 31st; this type of deck is unacceptable in Alaska.
- Lightweight insulating concrete should not be poured during rainy periods; deck areas that have frozen before they have cured must be removed and replaced. Check decks for moisture content and dryness, if exposed to precipitation prior to installation of roof membrane.
- Solid metal decking and structural concrete decks are among those not acceptable to receive an aggregate-based lightweight insulating concrete mix.
- Cellular lightweight insulating concrete decks can be installed over non-slotted, galvanized metal decking designed for cellular lightweight insulating concrete or structural concrete.

Loadmaster Decks

- Not an acceptable substrate.

PARAPET WALLS

Most common structural wall types are suitable substrates for the installation of EverGuard® membrane flashing.

Brick/Block Masonry

- Standard-finish brick and concrete block with standard tooled mortar joints.
- Split-face block, textured block and brick, and deeply tooled mortar joints require a cementitious coating or plywood facing to provide a smooth and even substrate surface.

Structural Concrete

- Steel trowel, wood float, or removable form finish.
- Ridges and other irregularities require grinding to provide a smooth and even substrate surface.

Stucco/EIFS

- Stucco finish and EIFS systems must be removed to the underlying substrate surface.

Plywood/Oriented Strand Board (OSB)

- Plywood must be exterior grade, minimum 4 ply and not less than $1\frac{5}{32}$ " (12 mm) thick.
- OSB must comply with Structural 1 rating and be not less than $\frac{7}{16}$ " (11 mm) thick.
- Tongue and groove edges or full blocking required.
- Adhesives should only be used with untreated plywood/OSB.

Sheet Metal

- Min. 24-gauge steel.
- Min. .032" (8 mm) aluminum.
- Corrugated panels require overlay of $1\frac{5}{32}$ " (12 mm) plywood/oriented strand board or silicone-impregnated gypsum panel.

Gypsum Panel

- Min. $\frac{1}{2}$ " (13 mm) thickness.
- Silicone-impregnated fiberglass-faced panels.
- Underlying substrate must allow securement of flashing at prescribed spacing. Mechanical attachment to gypsum panels is not acceptable.
- Use of gypsum panel decks requires GAF Field Services Area Manager's approval.

ROOF DRAINAGE

Providing positive roof drainage is important. Standing water can result in deck deflection and possible structural damage. In addition, in the event of an opening through the roofing membrane, standing water can significantly worsen damage to the roof system, the building itself, and interior contents by providing a reservoir of water ready to gravitate through the membrane opening. Providing structural slope in the deck assembly, installing a tapered lightweight cellular concrete overlay, installing a tapered insulation system, or adding additional drains are the most common methods of achieving positive drainage.

National building codes generally require a minimum $\frac{1}{4}$:12 slope to drain in order to provide positive drainage and accommodate deck irregularities. Although existing buildings may or may not be required by code to achieve this degree of roof slope, providing positive slope to drain remains an important design consideration.

In situations where roof edge conditions, window/door height above the roof surface, parapet wall height, weep hole locations, rooftop equipment mountings, or other factors prevent the installation of a full slope-to-drain system, a combination of additional drain locations, tapered saddles, and crickets to direct drainage to drain points should be considered.

EXPANSION JOINTS

The function of a structural expansion joint is to minimize the effect of stresses and movements on building components and to prevent these stresses from adversely affecting the roof. The design, location, and use of building structural expansion joints must be considered at the time of original building design and are the responsibility of the architect, engineer, and building owner.

Expansion Joints:

- Must be continuous along the break in the structure and not terminated short of the end of the roof deck.
- Should never be bridged with insulation or roofing membrane.
- Construction ties must be removed in order for expansion joints to function properly.
- Extend expansion joints at least 8" (203 mm) above the roof surface on curbs and use either Metalastic® Flexible Expansion Joint Covers or metal caps or covers. Alternately, a low profile expansion joint can be used; see EverGuard® details for construction.
- Design drainage flow patterns so they are not blocked by any structural expansion joints.
- Where possible, position walkways on roof access points to limit roof traffic over expansion joints; provide protective coverings for expansion joints at locations of anticipated roof traffic.
- EverGuard® Pre-Fab Expansion Joint Covers are available.

AREA DIVIDERS

Area dividers are not considered structural expansion joints. They can be installed to separate different roofing systems and can be either a curb or low-profile type. Contact the GAF Technical Helpline (1-800-ROOF-411) for recommendations regarding area dividers.

EQUIPMENT MOUNTINGS

Proper mounting of equipment is an important consideration. In general, rooftop equipment should be mounted in such a way as to provide adequate flashing height for both new and anticipated re-cover roof system applications; sufficient clearance around and beneath the

ROOF DESIGN

equipment to facilitate roof system installation; and compatibility with roofing and flashing materials so that standard flashing methods can be readily applied.

Alternately, lightweight equipment and gas/conduit lines can be installed on wood blocking or other prefabricated devices that do not penetrate the roofing system. Do NOT use this type of application for heavy equipment or gas conduit line; or where excessive movement can damage the substrate or membrane.

FIRE RESISTANCE

Resistance by the roofing system to fire applied to the exterior roof surface is important. Typically, a UL Class A or B rating is required by building code. Occasionally, depending on the use of the building, special resistance to fire applied from within the building is required. This is normally expressed in the form of hourly ratings, and usually requires the use of a specialized roof assembly. Refer to current EverGuard® listings in the appropriate UL directory to verify roof assembly requirements for specific fire ratings.

WIND PERFORMANCE

Ideally, roofing systems should be capable of resisting the forces generated by the maximum anticipated wind speed for a specific building. One widely accepted method for specifying wind performance is to require the appropriate FM 1-60, 1-90, or other rated system as appropriate for a specific building based upon location and exposure.

The following are common wind codes and approvals typically used in conjunction with EverGuard® roofing systems:

- **FM Global (Factory Mutual)**
 - Testing based on method described in Approval Standards 4450 and 4470.
 - Measures resistance to upward pressure applied to the roof system.
- **American Society of Civil Engineers (ASCE) document ASCE 7-10, “Minimum Design Loads for Buildings and Other Structures”**
 - A comprehensive analysis of wind forces acting on buildings. Requires detailed calculations to determine actual wind pressures at different regions of the roof.
 - Referenced by building codes.

Refer to Factory Mutual Loss Prevention Data Sheets 1-28 and 1-29 for specific installation guidelines.

ENERGY EFFICIENCY

Thermal transmission standards have been established by building codes for most buildings. Roof insulation installed above the roof deck is a practical means of achieving the necessary energy efficiencies. In addition, the use of white-colored reflective membranes can reduce the heat load on air conditioning equipment, as well as provide a moderating effect on the temperature in proximity to the building.

- **U-Value**
 - Thermal Transmittance: The number of BTUs (energy) that pass through a 1-square-foot (0.0929 sq. m.) sample of a total material assembly in one hour with a temperature difference between the two surfaces of 1 degree F (5/9 degree C).
 - Thermal Transmittance applies to an actual total material assembly, and as such is a quantitative physical property that can be used to represent the overall thermal performance of a system.

- **R-Value**

- Thermal Resistance: The number of degrees difference between two surfaces (energy difference) that is required to obtain an energy flow of 1 BTU through a 1-square-foot (0.0929 sq. m.) sample of a given material thickness in one hour.

- The R-value is the reciprocal of the C-value.

- Thermal Resistance applies to an actual thickness of a material, and as such is a quantitative physical property that can be used for determining insulation requirements.

- **Reflectance**

- A measure of the % of solar energy that is reflected away from a surface.

- Dark materials absorb more heat from the sun and can be up to 70°F (39°C) hotter than a reflective white surface given the same outside temperature and conditions such as wind speed, location, etc.

- **Emittance**

- A measure of the infrared radiation emitted from a roof surface. Unlike reflectance, infrared emissivity may not be affected by dirt or discoloration of the surface of a material.

The following references provide useful information regarding energy efficiency:

- **ASHRAE Fundamentals Handbook**

- Provides detailed design calculations and material energy transfer information utilized by mechanical engineers in the design of heating, ventilation, and air-conditioning systems.

- Suitable for complex energy evaluation considerations such as solar heat gain, exterior shading, total building envelope, building usage, and lighting.

- **NRCA Energy Manual**

- Provides a simplified method for determining the amount of insulation necessary to construct an energy-efficient low-slope roof system.

- Provides a simplified method for determining the energy cost savings resulting from the installation of additional roof insulation.

- Suitable for most roofing-related energy evaluations.

- **DOE Energy Calculator**

- Go to www.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm to find the Cool Roof Calculator.

- This tool measures the energy savings for low-slope roofs with non-black roof surfaces.

WATER VAPOR TRANSFER

Typical single-ply roof assemblies do not include vapor retarders as a standard assembly component. For these applications, there is a natural transfer of water vapor into the roof assembly during a portion of the year, followed by a natural transfer of water vapor out of the roof assembly during the balance of the year. Under normal conditions, this type of cyclical water vapor flow does not cause a significant deterioration of the roof insulation or reduction in insulation thermal performance.

ROOF DESIGN

However, for projects where there is a significant difference in vapor pressure between building interior and exterior, the volume of water vapor flow is much greater, and control of water vapor transfer into and through a roof system becomes an important consideration. Without adequate control provisions, the roof insulation can become saturated with water, with a corresponding reduction in insulation thermal performance. Structural deck damage and/or condensation into the building interior may also occur. Vapor flow is referenced in various ways. The following is a description of common terminologies:

• Permeance

- The time rate of vapor transmission through a flat material or construction induced by vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions.
- Units of permeance are expressed as: (gr.) / (h) (sq.ft.) (in Hg).
- The permeance, or perm rating, of a material is a performance evaluation specific to a sample of material, and not a specific property of the material.

• Relative Humidity

- Relative humidity is the ratio of the pressure of water vapor present in air to the pressure of fully saturated water vapor at the same temperature.
- Relative humidity is expressed as a percentage.

• Dew Point Temperature

- The temperature at which air becomes saturated with saturated vapor (100% relative humidity) and condensation begins to form.
- Dew Point Temperature is expressed as °F or °C.

• Temperature and Relative Humidity

- Vapor flows due to a difference in vapor pressure between two locations, and flows from higher to lower pressure regions.
- Normally, the higher the temperature, the higher the vapor pressure, and this is typically called the “warm side.”
- In determining the need for a vapor retarder for most typical conditions, the exterior winter temperature and the interior winter relative humidity are the most critical factors.
- Temperature information is readily available from the National Weather Service.
- Relative humidity information is typically available from the building HVAC design professional or the building operations manager. Relative humidity can also be field measured.

• Vapor Retarder Location

- A number of basic considerations factor into the need and location of a vapor retarder. Determining the need and location of the vapor retarder is the responsibility of the design professional.
- Vapor retarders are intended to be installed as close to the “warm side” as possible. Normally, this places the vapor retarder directly on the structural deck or directly over a minimal layer of EnergyGuard™ insulation or fire barrier.
- A sufficient amount of EnergyGuard™ insulation must be installed over the vapor retarder to raise the location of the dew point temperature above the level of the vapor retarder.

• Sealing At Perimeter And Penetrations

- Vapor retarders shall be completely sealed at all perimeter and penetration locations.
- Sealing methods shall be selected in accordance with type of vapor retarder being installed.
- Air leakage at perimeter and penetrations will significantly reduce the effectiveness of the vapor retarder by allowing moist air to penetrate into the roof assembly, where it can condense and cause roof deterioration.

• Building Usage

- Normal building usage such as offices, schools, retail, warehousing, etc., will not typically require the use of a vapor retarder except when located in the most northerly climates.
- Building usage such as swimming pools, food processing, paper manufacturing, foundries, etc., that result in increased internal temperatures and humidity conditions will likely require the use of a vapor retarder (except when located in the most southern climates).
- These generalizations are not intended to substitute for actual vapor flow calculations based upon specific building and climatic conditions.

• The Case For The Use Of A Vapor Retarder

- A vapor retarder can protect the long-term thermal resistance of insulation sandwiched between the vapor retarder and the membrane.
- A vapor retarder provides a good safeguard against vapor migration in case a building’s use changes from a “dry” use to a “wet” use.

• The Case Against The Use Of A Vapor Retarder

- The vapor retarder, together with the roofing membrane, may seal entrapped moisture within the roof system that can eventually destroy the insulation, wrinkle the membrane, or, in gaseous form, blister it.
- In the event of a roof leak through the membrane, the vapor retarder will trap the water in the insulation and release it through punctures, breaks, or poor seals in the vapor retarder. This water may move some lateral distance from the roof leak, thus making leak discovery more difficult. A large area of insulation may be saturated before the punctured roof membrane is discovered and repaired.
- A vapor retarder is a disadvantage in summer, when vapor migration is generally downward through the roof. Hot, humid air can infiltrate the roofing “sandwich” through vents, or via diffusion through the roof membrane itself. If this occurs, moisture can condense within the roofing system.

The following resources may provide useful information regarding vapor retarders:

- NRCA Energy Manual
- ASHRAE Fundamentals Handbook

TPO OR PVC DESIGN TABLE - NEW CONSTRUCTION OR TEAR-OFF - RHINO BOND®

Deck	Membrane Type	Insulation/Substrate							Insulation/ Substrate Attachment
		ISO	Gypsum Board	Wood Fiber/ Perlite	EPS/ XPS ⁴	VersaShield® Solo™	None	Mechanically ⁵	
Steel ¹	Smooth	X	X	X	X		X		X
Wood ²	X	X	X	X	X	X		X	X
Structural Concrete ³	X	X	X	X	X		X		X
Insulating Concrete ⁶	X	X	X	X	X		X		X

1. Minimum 22-gauge steel deck required.

2. Minimum 3/4" (19 mm) plywood or 2" (51 mm) wood plank required.

3. Extreme care must be taken to remove all concrete debris and dust prior to roof system installation.

4. Cover board required for EPS/XPS. The use of this board in the assembly is acceptable, but not as the top layer.

5. Insulation is mechanically attached using the Drill-Tec™ RhinoBond® Attachment System.

6. Fastener must penetrate through metal pan or into structural concrete. Refer to Drill-Tec™ RhinoBond® Attachment System Attachment Table for specific requirements.

TPO OR PVC DESIGN TABLE - RE-COVER - RHINO BOND®

Existing Roofing System Type	Membrane Type	Insulation/Substrate								Insulation/Substrate Attachment
		ISO	Gypsum Board	Wood Fiber/ Perlite ¹	EPS/XPS ²	Fanfold ³	VersaShield® Solo™	None		
Smooth BUR/MB	X	X	X	X	X	X	X	X		Mechanically ⁵
Single-Ply Membrane	X	X	X	X	X	X	X	X		X
Granule-Surfaced BUR/MB	X	X	X	X	X	X	X	X		X
Gravel-Surfaced BUR/MB ⁴	X	X	X	X	X	X	X	X		X
Standing Seam Metal (22 ga.)	X	X	X	X	X	X	X	X		X

1. Roof moisture scan required for use of perlite/wood fiber in re-cover systems.

2. Cover board required for EPS/XPS. The use of this board in the assembly is acceptable, but not as the top layer.

3. Cover board required for Fanfold. The use of this board in the assembly is acceptable, but not as the top layer.

4. All loose gravel must be removed.

5. Insulation is mechanically attached using the Drill-Tec™ RhinoBond® Attachment System.

DRILL-TEC™ RHINO BOND® ATTACHMENT SYSTEM – ATTACHMENT TABLE

Deck Type ¹	Min. Pull-out Values ²	Fastener Type	Plate Type ³	Min. Penetration	Fastening Pattern ⁴ (Field, Perimeter, Corner)		
					GAF Guarantee	60 psf Uplift 90 psf Uplift	105 psf Uplift 120 psf Uplift
3/4" (19mm) Plywood	525 lbf (238 kgf)	Drill-Tec™ HD #14	3" (76 mm) Drill-Tec™ RhinoBond® XHD	1" (25 mm) Thru Deck	8, 12, 16	N/A	N/A
2" (51mm) Wood Plank	800 lbf (363 kgf)	Drill-Tec™ HD #14	3" (76 mm) Drill-Tec™ RhinoBond® XHD	1" (25 mm) Into Deck	8, 12, 16	N/A	N/A
22-ga. Steel Deck (33 ksi)	450 lbf (204 kgf)	Drill-Tec™ XHD #15	3" (76 mm) Drill-Tec™ RhinoBond® XHD	3/4" (19 mm) Thru Deck	6, 9, 12	6, 10, 15	N/A
22-ga. Steel Deck (80 ksi)	600 lbf (272 kgf)	Drill-Tec™ SXHD #21	3" (76 mm) Drill-Tec™ RhinoBond® XHD or SXHD	1" (25 mm) Thru Deck	6, 9, 12	6, 10, 15	N/A
22-ga. Steel Deck (80 ksi)	450 lbf (204 kgf)	Drill-Tec™ XHD #15	3" (76 mm) Drill-Tec™ RhinoBond® XHD or SXHD	3/4" (19 mm) Thru Deck	6, 9, 12	N/A	8, 15, 20
22-ga. Steel Deck (80 ksi)	750 lbf (340 kgf)	Drill-Tec™ SXHD #21	3" (76 mm) Drill-Tec™ RhinoBond® XHD or SXHD	1" (25 mm) Thru Deck	6, 9, 12	6, 10, 15	8, 15, 20
Structural Concrete ⁵ [Min. 2,500 psi (98,066 kilogram-force/ cm ²)]	700 lbf (317 kgf)	Drill-Tec™ HD #14	3" (76 mm) Drill-Tec™ RhinoBond® XHD	1" (25 mm) Into Deck [3/16" (4.7 mm) Pre-drilled hole required]	6, 9, 12	6, 10, 15	8, 15, 20
Lightweight Insulating Concrete, 22 ga. standard metal form	900 lbf (408 kgf)	Drill-Tec™ CD-10	3" (76 mm) Drill-Tec™ RhinoBond® XHD	1" (25 mm) Into Deck [7/32" (5.5 mm) Pre-drilled hole required]	6, 9, 12	6, 10, 15	8, 15, 20
Lightweight Insulating Concrete, 22 ga. standard metal form	450 lbf (204 kgf)	Drill-Tec™ HD #15	3" (76 mm) Drill-Tec™ RhinoBond® XHD	3/4" (19 mm) Thru Form	6, 9, 12	6, 10, 15	8, 15, 20
Lightweight Insulating Concrete, 24 ga. standard metal form	350 lbf (159 kgf)	Drill-Tec™ HD #14	3" (76 mm) Drill-Tec™ RhinoBond® XHD	3/4" (19 mm) Thru Form	6, 9, 12	6, 10, 15	8, 15, 20
Lightweight Insulating Concrete, 24 ga. standard metal form	350 lbf (159 kgf)	Drill-Tec™ HD #15	3" (76 mm) Drill-Tec™ RhinoBond® XHD	3/4" (19 mm) Thru Form	6, 9, 12	N/A	N/A
Lightweight Insulating Concrete, 24 ga. standard metal form	350 lbf (159 kgf)	Drill-Tec™ HD #14	3" (76 mm) Drill-Tec™ RhinoBond® XHD	3/4" (19 mm) Thru Form	6, 9, 12	N/A	N/A

- The Drill-Tec™ RhinoBond® Attachment System is not acceptable over gypsum, cementitious wood fiber, or OSB substrates, but is acceptable over structural or lightweight insulating concrete decks. However, other methods of attachment may be more appropriate, depending on the project type. Contact your local GAF Field Services Area Manager for possible alternatives.
- Pull tests should always be conducted to determine proper fastener selection.
- The Drill-Tec™ RhinoBond® Plate is used to attach rigid insulation to roof decks. The special TPO coating on the plates allows for EverGuard® TPO membrane to be welded to each plate using the RhinoBond® magnetic induction welding tool. Drill-Tec™ RhinoBond® Plates are different in type and color: TPO plates are a yellow/green, while the PVC plates are black in color. The appropriate plate must be used with the appropriate membrane type.
- Consult FM-Approvals, ROOFNAV listings, and FM LPDS 1-28 and 1-29 for detailed installation requirements and recommendations for FM-approved installations.
- When installing Drill-Tec™ RhinoBond® Fasteners into lightweight insulating concrete that is poured over structural concrete, the fastener must penetrate a minimum of 1" (25 mm) into the structural concrete deck. A 7/32" (5.5 mm) pre-drilled hole is required.

DRILL-TEC™ RHINO BOND® ATTACHMENT TABLE – METAL ROOF RETROFIT

Max. Purlin & Fastener Row Spacing	Uplift ¹	Purlin Type ²	Drill-Tec™ Purlin Fastener & Drill-Tec™ RhinoBond® TPO XHD Plate Spacing (o.c.) ³		
			Field	Perimeter	Corner
5 ft. (1.52 m)	60 psf	Min. 16 ga. (50 ksi)	18" (452 mm)	10.5" (267 mm)	7" (178 mm)
		Min. 16 ga. (50 ksi)	12" (305 mm)	7" (178 mm)	4.5" (114 mm)
	75 psf	Min. 14 ga. (50 ksi)	18" (452 mm)	10.5" (267 mm)	7" (178 mm)
		Min. 12 ga. (36 ksi)	12" (305 mm)	7" (178 mm)	4.5" (114 mm)
6 ft. (1.83 m)	90 psf	Min. 14 ga. (50 ksi)	6" (152 mm)	Additional purlins may be required	
		Min. 12 ga. (36 ksi)	6" (152 mm)	Additional purlins may be required	
	135 psf	Min. 14 ga. (50 ksi)	6" (152 mm)	Additional purlins may be required	
		Min. 12 ga. (36 ksi)	6" (152 mm)	Additional purlins may be required	

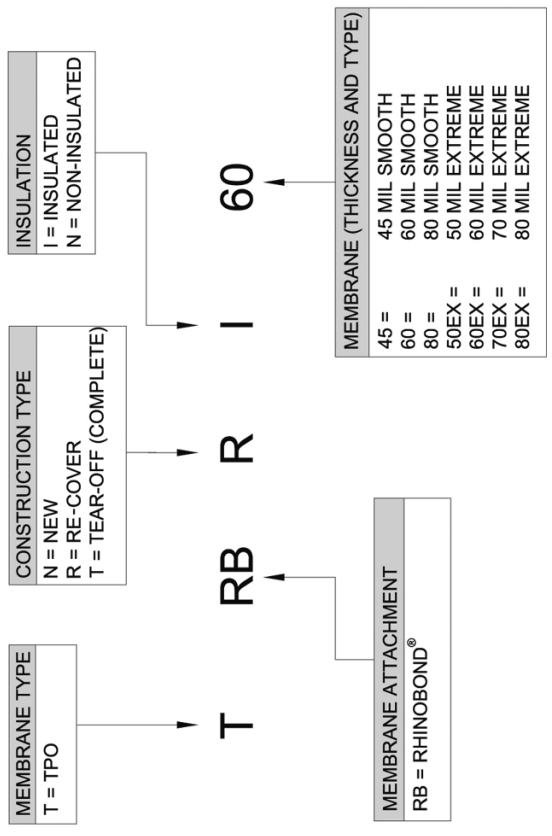
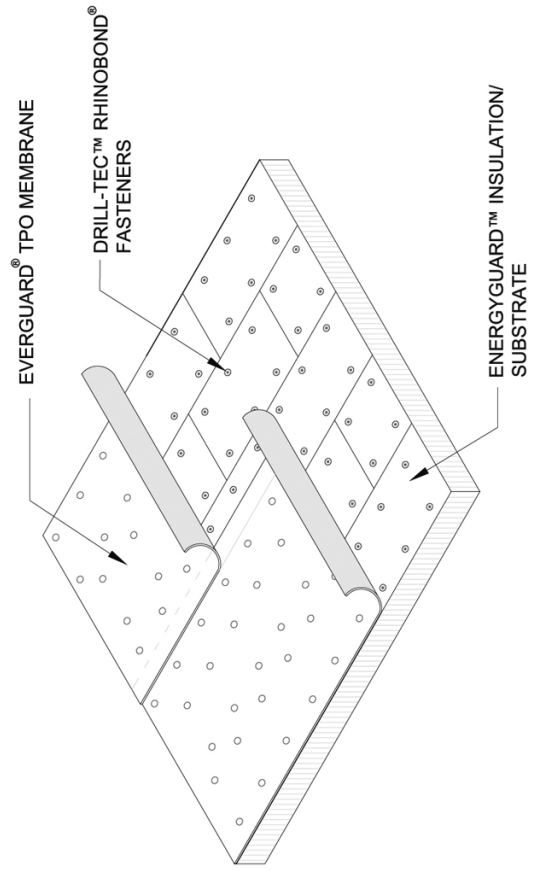
1. Consult FM Approvals, ROOFNAV listings, and FM LPDS 1-28 and 1-29 for detailed installation requirements.
2. Membrane must be attached to the Drill-Tec™ RhinoBond® Plates that are installed directly into structural purlins with appropriate Drill-Tec™ Purlin Fastener. The special TPO coating on the plates allows for EverGuard® TPO membrane to be welded to each plate using the RhinoBond® magnetic induction welding tool. Drill-Tec™ RhinoBond® Plates are different in type and color: TPO plates are a yellow/green, while the PVC plates are black in color. The appropriate plate must be used with the appropriate membrane type.
3. Fastener pull-out testing must be conducted by the roof fastener manufacturer. Minimum 1" (25 mm) Drill-Tec™ Purlin Fastener embedment is required.

DRILL-TEC™ RHINO BOND® ATTACHMENT TABLE – WOOD PURLINS

Fastener Spacing Along Wood Joist	Wood Joist Spacing ¹	Plate ²	Contributory Area Per Fastener	Fastener	Fastener Embedment ³	Uplift	Membranes Qualified
12 in. (305 mm)	96 in. (2.44 m)	Drill-Tec™ RhinoBond® TPO XHD	8 ft ² (.743 m ²)	Drill-Tec™ #14	1.0 in. (25 mm) into 2 x 8 in. (51 x 203 mm) support [1.5 in. (38 mm) through plywood decking joint and into lumber]	60 psf	EverGuard® TPO, EverGuard Extreme® TPO
24 in. (610 mm)	48 in. (1.22 m)	Drill-Tec™ RhinoBond® TPO XHD	8 ft ² (.743 m ²)	Drill-Tec™ #14	1.0 in. (25 mm) into 2 x 8 in. (51 x 203 mm) support [1.5 in. (38 mm) through plywood decking joint and into lumber]	75 psf	EverGuard® TPO, EverGuard Extreme® TPO
36 in. (914 mm)	24 in. (610 mm)	Drill-Tec™ RhinoBond® TPO XHD	6 ft ² (.557 m ²)	Drill-Tec™ #14	0.75 in. (19 mm) into 2 x 8 in. (51 x 203 mm) support [1.25 in. (32 mm) through plywood decking joint and into lumber]	105 psf	EverGuard® TPO, EverGuard Extreme® TPO
24 in. (610 mm)	24 in. (610 mm)	Drill-Tec™ RhinoBond® TPO XHD	4 ft ² (.372 m ²)	Drill-Tec™ #14	0.75 in. (19 mm) into 2 x 8 in. (51 x 203 mm) support [1.25 in. (32 mm) through plywood decking joint and into lumber]	150 psf	EverGuard® TPO, EverGuard Extreme® TPO
18 in. (452 mm)	24 in. (610 mm)	Drill-Tec™ RhinoBond® PVC XHD	3 ft ² (.279 m ²)	Drill-Tec™ #14	0.75 in. (19 mm) into 2 x 8 in. (51 x 203 mm) support [1.25 in. (32 mm) through plywood decking joint and into lumber]	165 psf	EverGuard® PVC Smooth, EverGuard® PVC XK, EverGuard® TPO, EverGuard Extreme® TPO

1. Drill-Tec™ RhinoBond® test results with fasteners driven into 2 x 8 in. (51 x 203 mm) wood joists over ¹/₃₂" (1.9 mm) plywood.
2. Membrane must be attached to the Drill-Tec™ RhinoBond® Plates that are installed directly into structural wood joists with Drill-Tec™ #14 Fasteners. The special TPO coating on the plates allows for EverGuard® TPO membrane to be welded to each plate using the RhinoBond® magnetic induction welding tool. Drill-Tec™ RhinoBond® Plates are different in type and color: TPO plates are a yellow/green, while the PVC plates are black in color. The appropriate plate must be used with the appropriate membrane type.
3. Fastener pull-out testing must be conducted by the roof fastener manufacturer.

INSULATED & NON-INSULATED TPO DRILL-TEC™ RHINO-BOND® ATTACHMENT SYSTEM SPECIFICATION PLATE

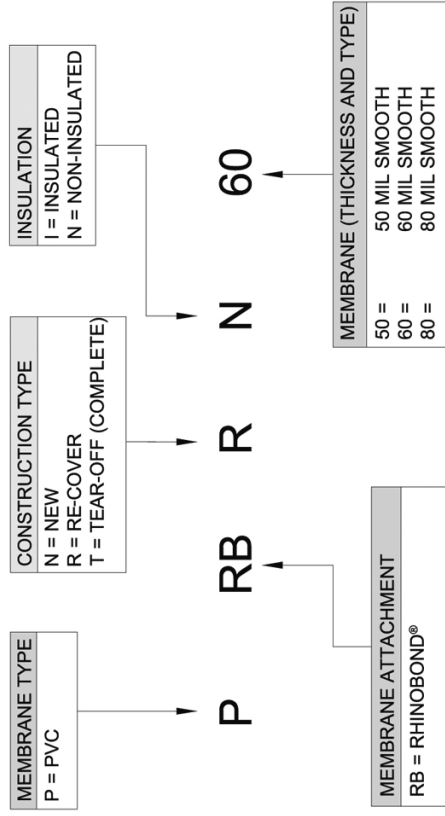
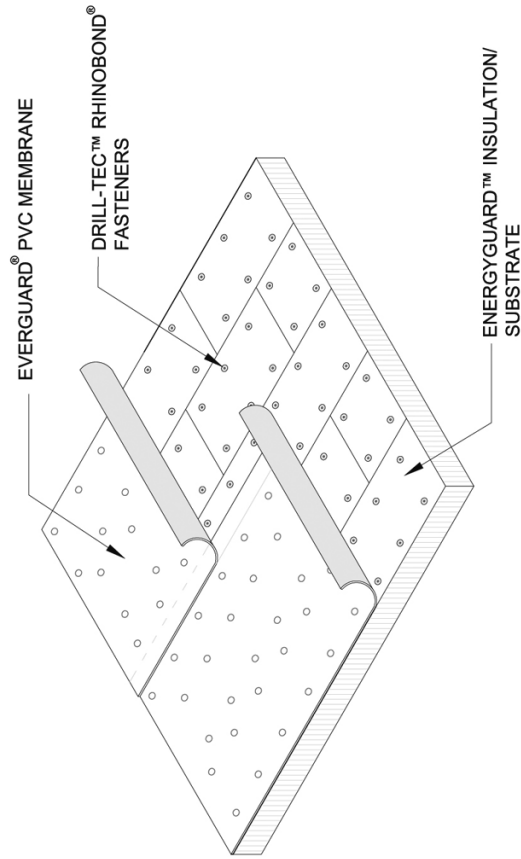


MEMBRANE TYPE	MEMBRANE ATTACHMENT	CONSTRUCTION TYPE	INSULATION	GUARANTEE LENGTH UP TO (YEARS)			
				20	25 ¹	30 ¹	35 ¹
T	RB	N	I	45	60	80	80EX
		R	N	45	50EX	60EX	70EX
		T	N	45	50EX	60EX	70EX
				MINIMUM MEMBRANE REQUIREMENTS			

1. New & Tear-off only. Minimum 2 layers of insulation. Refer to Guarantee Program section for additional requirements.



INSULATED & NON-INSULATED PVC DRILL-TEC™ RHINOBOND® ATTACHMENT SYSTEM SPECIFICATION PLATE



MEMBRANE TYPE	MEMBRANE ATTACHMENT	CONSTRUCTION TYPE	INSULATION	GUARANTEE LENGTH UP TO (YEARS)		
				12	15	20
P	RB	N R' T	I N	50	60	80
MINIMUM MEMBRANE REQUIREMENTS						

1. For a non-insulated re-cover with smooth membrane only: VersaShield Solo™ Fire-Resistant Slip Sheet or approved coverboard required.

DESIGN & APPLICATION GUIDELINES: DRILL-TEC™ RHINOBOND® ATTACHMENT SYSTEM

Contents

- TPO/PVC Installation Specifications

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**DESIGN & APPLICATION GUIDELINES:
DRILL-TEC™ RHINO BOND® ATTACHMENT SYSTEM**
TPO & PVC

PART 1 – GENERAL

1.01 System Description

- A. The Drill-Tec™ RhinoBond® Attachment System is an easy-to-use system that fastens EverGuard® TPO and PVC thermoplastic membranes to the substrate below using a microprocessor-controlled induction welding machine. The thermoplastic roof membrane is welded directly to the specially coated, 3" (76 mm) diameter Drill-Tec™ RhinoBond® fastening plate.
- B. EverGuard® PVC and EverGuard® TPO materials are not compatible with one another. DO NOT combine EverGuard® PVC and EverGuard® TPO membranes, flashings, and flashing accessories together in the same roofing system.

1.02 Specification Designations

- A. See Specification Plates in this Manual.

1.03 Regulatory Requirements & Pre-Job Conference

- A. Conform to all applicable building and jurisdictional codes, including roof assembly wind uplift and fire resistance requirements and slope limitations. GAF recommends at least ¼:12 per foot of slope with proper grading and placement of drainage outlets.
- B. Follow your local jurisdiction requirements for disposing of used or expired adhesives, sealants, and other products subject to disposal regulations.
- C. Potential problems in roofing applications, as well as potential conditions that may be detrimental to installation and performance of the roof system, should be resolved prior to the start of the application. This can best be accomplished by a pre-job meeting with the architect; roofing contractor; general contractor; all other subcontractors whose work will involve the roof system/related systems; and the GAF representative.
- D. The following are common items of discussion at a pre-job conference:
 - 1. Roof deck conditions.
 - 2. Flashing and expansion joint details.
 - 3. Insurance underwriters or building code requirements.
 - 4. Unusual project conditions.
 - 5. Protection of the roof, building, building occupants, and contents during and after application.
 - 6. Application techniques.
 - 7. Coordination and scheduling of other trades that will be working on the project.
 - 8. Designation by the roofing contractor of a qualified person responsible for quality control. This person must be on the project full time during application of the roof system, and must not be changed without the approval of GAF.
 - 9. Scheduling of material shipments, material storage, and rooftop loading.
 - 10. Submittals of materials, drawings, and project documents.

1.04 Delivery, Storage, and Protection

- A. Deliver products to site in original containers with seals unbroken and labeled with manufacturers' names, product brand name, and type.
- B. Store materials in a weather-protected environment, clear of the ground and moisture, in accordance with GAF instructions. Store all adhesives, coatings, and sealants/caulks to protect them from freezing. Frozen material must be discarded and replaced. Properly seal all liquid material containers after use.
- C. Outside storage of roofing materials
 - 1. All materials stored outside must be raised above ground or roof level on pallets and covered with a tarpaulin, or other waterproof and "breathable" material. Insulation products should be properly stored and weighted to avoid weather and wind damage.
 - 2. Factory-installed plastic wrapping is not designed as protective covering for insulation materials and should be removed. Use "breathable" type covers, such as canvas tarpaulins to allow venting and protection from weather and moisture.
 - 3. Cover and protect materials at the end of each day's work.
 - 4. Do not remove any protective tarpaulins until immediately before material will be installed. Extreme heat or cold conditions may require special storage requirements. Reference product data sheets for product storage requirements.
- D. Follow GAF directions and requirements for protection of roofing materials prior to and during installation.
- E. Do NOT use materials that are wet or damaged to the extent that they will no longer serve their intended purposes. All roof insulation that has been wet is considered damaged, even if later dried out. Remove all damaged materials from the job site.
- F. When staging materials on the roof during application, ensure the deck and structure are not temporarily overloaded by the weight of construction materials.
- G. At the job site, no more material should be stored than what will be used within two weeks. For periods longer than two weeks, the materials should be properly warehoused; i.e., dry ventilated, on pallets, etc. No more material should be stored on the rooftop than can be used within five days. When prolonged inclement weather threatens, i.e., rainy seasons, no more roofing materials should be supplied to the rooftop than can be used within two days.

1.05 Environmental Requirements & Restrictions

- A. Do not apply roofing materials during inclement or threatening weather.
- B. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during the same day.
- C. Be aware that high or gusting winds make the installation of some materials more difficult.
- D. Material installation during periods of high ambient temperature and/or humidity levels (typically above 90°F (32°C) and/or 90% relative humidity) can result in poor installation quality due to condensation on the membrane surface, or excessively fast adhesive drying rates in hot, dry

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weather. Do not install materials when moisture, in any form, is present on the roof deck or substrate to which the materials are to be applied.

- E. Material installation during periods of low ambient temperatures, typically below 30°F (0°C), can result in poor installation quality. To avoid these problems:
1. Store accessory materials in a warming box.
 2. Use as soon as possible.
 3. Allow adhesives to properly cure.
 4. Adjust welder settings to ensure proper welds for applicable ambient conditions.

1.06 Working Environment

- A. Work should only begin when the contractor has decided to his/her satisfaction that all specifications are workable as specified, and that the contractor can meet project and code requirements.
- B. The contractor should only begin roofing work when the substrates have been prepared as necessary, and are ready to accept the roofing materials installed as specified.
- C. Provide a safe working environment, including, but not limited to, adequate fall protection, restriction of unauthorized access to the work area, and protection of the building and its occupants.
- D. Safe work practices should be followed, including, but not limited to, keeping tools in good operating order; providing adequate ventilation if adhesives are used; and daily housekeeping to remove debris and other hazards. See Section 1.07 for further details on safety.
- E. Protect the building, contents, surrounding area, building occupants, and contractor personnel during work. Coordinate all work operations with the building owner and building occupants so that adequate interior protection, as necessary, is provided and disruption to normal building operations is minimized.
- F. Where heavy wheeled or other traffic over the partially completed roofing is unavoidable, provide and use adequate plank or plywood, set over a minimum thickness of rigid board insulation to protect the newly installed roof.
- G. Provide temporary water cut-offs and tie-ins at the end of each workday. Remove all temporary work at the beginning of the next workday.
- H. When tearing off an existing membrane, limit removal to the area that will be completely reroofed that day with the new roofing system.
- I. If conditions are uncovered or created that would be detrimental to the proper conduct of specified work, immediately notify the building owner and GAF of these conditions for consultation on acceptable treatments.

1.07 Safety Considerations and Warnings

- A. As with any construction process, safety is a key element. All applicable safety standards and good roofing practices must be followed. Read and understand the Design & Application Guidelines in this Manual before starting application. Follow all precautions and directions.

- B. Only properly trained and professionally equipped roofing contractors experienced in the installation of each TPO and PVC roofing application should install these systems. Never allow contact between the heated surface of a hot welder or other tool and the applicator's hair, skin, or clothing. Always wear protective gear, including but not limited to: hardhats, goggles, heavy-duty gloves, and snug-fitting clothing.
- C. Solvent-containing accessories may be combustible and should always be kept from heat, flame, or any source of ignition. Empty containers must be disposed of in posted toxic substance landfills in accordance with local, state, and federal regulations.
- D. Thoroughly train all personnel in first aid procedures, and always comply with all OSHA safety standards and fire codes. Also, use extreme caution when working around equipment, such as gas lines or HVAC units, which have electrical or gas connections.

PART 2 – PRODUCTS

2.01 Membrane

- A. EverGuard® TPO (smooth) thermoplastic polyolefin membrane.
- B. EverGuard Extreme® TPO (smooth) thermoplastic polyolefin membrane.
- C. EverGuard® PVC (smooth) polyvinyl chloride membrane.

2.02 Flashing

- A. EverGuard® membrane flashing should be of the same type and thickness as the roofing membrane. EverGuard® Freedom™ TPO can be used with EverGuard® TPO membrane for flashing in the same thickness as the field membrane.
- B. Because colored TPO membranes may exhibit different welding characteristics, test welds should be performed to determine best weld speeds and temperatures to ensure a good weld bond before attempting to weld different colored TPO membranes with white membranes or flashings.
- C. EverGuard® TPO and PVC FB membranes may be used as optional flashing membranes for all TPO and PVC roof systems, respectively. These substrates may also be a solution when a contaminated substrate is encountered.

2.03 Flashing Accessories

- A. EverGuard Extreme® accessories must be used when installing EverGuard Extreme® on guaranteed jobs. Please visit gaf.com for a complete listing of EverGuard® accessories.
- B. For a full listing and descriptions of the latest EverGuard® TPO and EverGuard Extreme® TPO preformed flashing accessories, see the appropriate Product Data Sheets for the specific membranes you are working with.
- C. All EverGuard® accessories must be stored indoors and protected from moisture and extreme temperatures. See specific instructions on packaging for further details.

Note: EverGuard Extreme® flashings and accessories are required for use with EverGuard Extreme® membranes.

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2.04 Fasteners

- A. Drill-Tec™ RhinoBond® Fastening Plates and Screws. Refer to the Drill-Tec™ RhinoBond® Attachment Table for GAF guarantee requirements. For enhanced specifications requirements, contact GAF Technical Services.
- B. Use fasteners that are suitable for the deck type, and ensure the deck is of the required thickness and condition to ensure reliable installation and performance.
- C. Fasteners used in flashings should be dictated by the substrate.

2.05 Adhesives, Sealants, Primers, and Cleaners

- A. Adhesives (Vertical Flashings Only)
 - 1. Solvent-based
 - a. EverGuard® TPO Bonding Adhesive (1121) for TPO smooth membranes and insulation.
 - b. EverGuard® PVC (Low VOC) Bonding Adhesive (2331) for PVC smooth membranes.
 - c. EverGuard® TPO Low VOC Bonding Adhesive for TPO smooth membranes.
 - 2. Water-based
 - a. EverGuard® WB181 water-based bonding adhesive for smooth TPO membranes, TPO FB membranes, and PVC FB membranes.
- B. Sealants
 - 1. EverGuard® Two-Part urethane-based sealant for use in sealant (pitch) pans.
 - 2. TOPCOAT® FlexSeal™ Caulk Grade, a white, solvent-based synthetic elastomeric sealant for use behind termination bars, stainless steel clamps, drain bowls, and other areas between the substrate and membrane.
 - 3. EverGuard® TPO Cut Edge Sealant.
- C. Primers
 - 1. EverGuard® TPO Primer.
- D. Cleaners
 - 1. EverGuard® CleanWeld™ Conditioner (a low VOC cleaner).
 - 2. EverGuard® TPO Seam Cleaner.

2.06 Traffic Protection

- A. EverGuard® TPO Walkway Roll. This product is designed to be heat-welded to the top of GAF TPO roofing membranes. The Walkway Roll is available in standard gray or “safety” yellow color with a “diamond tread” pattern, and comes in 34.25" x 50" (870 mm x 15.2 m) rolls. The EverGuard® TPO Walkway Roll features a 2" (51 mm) welding strip (smooth border) along each longitudinal edge that is compatible with hand- or automatic welders.
- B. EverGuard® PVC Walkway Pads. This product heat-welds directly to GAF EverGuard® PVC roofing membranes. The Walkway Pad is available in standard gray with a “herringbone” traction surface, and comes in 30" x 36" (762 mm x 914 mm) pads.

2.07 Insulation

- A. The selection of insulation type, thickness, and configuration is the responsibility of the architect, engineer, owner, or roof consultant. GAF reserves the right to accept or reject any roof insulation as an acceptable substrate for GAF roof systems. GAF EnergyGuard™ insulations must be used in roofing systems to be guaranteed by GAF.
- B. EnergyGuard™ foam insulations of the types listed below are acceptable. The actual minimum thickness of insulation will depend on flute spacing. Refer to specific Product Data Sheets for further information. Board size can be 4' x 4' or 4' x 8' (1.2 m x 1.2 m or 1.2 m x 2.4 m) panels for mechanical attachment.
 - 1. EnergyGuard™ Polyisocyanurate Insulation with glass-based facer meeting or exceeding the requirements of ASTM C1289 (min. 16 psi [1.1 kg/cm²] compressive strength).
 - 2. EnergyGuard™ Extruded Polystyrene Insulation meeting or exceeding the requirements of ASTM C578, Type II nominal 1.5 pound (42 gram/cubic cm) density and minimum 15 psi (1.0 kg/cm²) compressive strength (requires cover board).
 - 3. EnergyGuard™ Expanded Polystyrene Insulation with plastic facer meeting or exceeding the requirements for ASTM C578, Type II nominal 1.5 pound (42 gram/cubic cm) density and minimum 15 psi (1.0 kg/cm²) compressive strength (requires cover board).
- C. The following additional insulations are acceptable for use in roofing systems to be guaranteed by GAF:

Perlite

(ASTM C728/FS HH-1-529)
EnergyGuard™ Perlite Roof Insulation
EnergyGuard™ Perlite Re-cover board
EnergyGuard™ Perlite Roof Insulation (tapered)
EnergyGuard™ Tapered Edge Strip

Fiber Board

(ASTM C208/FS LLL-1-535b, Class C)
Blue Ridge Structodek® High Density Fiber Board Roof Insulation

Polyisocyanurate

(ASTM C1289/FS HH-1-972, Class 1)
EnergyGuard™ Polyiso Insulation, as above
EnergyGuard™ Tapered Polyiso Insulation

Perlite/Polyisocyanurate/Wood Fiber Composites

(FS HH-1-1972, Gen./FS HH-1-1972, 3)

EnergyGuard™ Composite Board Polyiso Insulation

EnergyGuard™ Tapered Composite Board Insulation

2.08 High Traffic Applications

- A. EnergyGuard™ foam insulation of the following types in a minimum 1" (25 mm) thickness. However, actual thickness will be dependent on flute spacing. Board size can be 4' x 4' or 4' x 8' (1.2 m x 1.2 m or 1.2 m x 2.4 m) panels for mechanical attachment, and 4' x 4' (1.2 m x 1.2 m) for adhered attachment and tapered panels.
 - 1. EnergyGuard™ polyisocyanurate insulation with glass-based facer meeting or exceeding the requirements for ASTM C1289, (min. 25 psi [1.8 kg/cm²]) compressive strength.
 - 2. EnergyGuard™ extruded polystyrene insulation meeting or exceeding the requirements of ASTM C578, Type II nominal 1.5 (42 gram/cubic cm) pound density and minimum 15 psi (1.0 kg/cm²) compressive strength (requires cover board).

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3. EnergyGuard™ expanded polystyrene insulation with plastic facer meeting or exceeding the requirements for ASTM C578, Type II nominal 1.5 (42 gram/cubic cm) pound density and minimum 15 psi (1.0 kg/cm²) compressive strength (requires cover board).

2.09 Cover/Re-cover Boards

- A. EnergyGuard™ Perlite Insulation, minimum ½" (13 mm) ASTM C728.
- B. Blue Ridge Structodek® High Density Fiber Board Roof Insulation, minimum ½" (13 mm), meeting or exceeding the requirements of ASTM C208, Class E.
- C. EnergyGuard™ Foam Re-cover Board of the following types: board size can be 4' x 4' or 4' x 8' (1.2 m x 1.2 m or 1.2 m x 2.4 m) panels for mechanical attachment and 4' x 4' (1.2 m x 1.2 m) for adhered attachment and tapered systems.
 1. EnergyGuard™ HD ½" (13 mm) Polyisocyanurate Insulation Re-cover Board with glass-based facer meeting or exceeding the requirements of ASTM C1289 (> 80 psi [5.6 kg/cm²] compressive strength).
 2. EnergyGuard™ HD PLUS ½" (13 mm) Polyisocyanurate Insulation Re-cover Board with glass-based facer meeting or exceeding the requirements of ASTM C1289 (> 110 psi [7.7 kg/cm²] compressive strength).
- D. SECUROCK® Roof Board is available in ¼" (6 mm), ⅜" (9.5 mm), and ½" (16 mm) thicknesses. It can be used as a fire barrier, an overlay board, or as a re-cover board.
- E. DensDeck® and DensDeck® Prime (ASTM C1177) in ¼" (6 mm), ½" (13 mm), and ⅝" (16 mm) thicknesses.

2.10 Base Sheets

Not required.

2.11 Protection Layer

1. Fire Barrier: Silicone-treated fiberglass-faced gypsum panels, min. ¼" (6.3 mm) thick (gypsum board or DensDeck® Prime).
2. GAF VersaShield® Solo™ Fire-Resistant Slip Sheet or TOPCOAT® FireOut™ Fire Barrier Coating.

2.12 Other Accessories

- A. Subject to compliance with requirements, provide the following products not available from GAF:
 1. Wood Nailers: New wood nailers must be #2 or better lumber. Do NOT use asphaltic or creosote-treated lumber.
 2. Roofing Nails: Galvanized or non-ferrous type and size as required to suit application.
 3. Temporary Sealant: Polyurethane foam sealant or similar as required to provide temporary watertight sealing of roofing.
 4. Air/Vapor Barrier: Polyethylene sheeting, min. 6 mil. for TPO only.

PART 3 - EXECUTION

3.01 Site Conditions

- A. Obtain verification that the building structure can accommodate the added weight of the new roofing system.
- B. Confirm the adequacy of the new roofing system to provide positive slope to drain. Eliminate ponding areas by the addition of drainage locations or by providing additional pitch to the roof surface.
- C. Prepare substrate surfaces thoroughly prior to application of new roofing materials. This is particularly important for re-cover and reroofing applications. Providing a smooth, even, sound, clean, and dry substrate minimizes the likelihood that underlying deficiencies will cause premature deterioration or even failure of the new roofing system.
- D. All defects in the roof deck or substrate must be corrected by the responsible parties before new roofing work commences. Verify that the deck surface is dry, sound, clean, and smooth, free of depressions, waves, or projections.
- E. Protect building surfaces against damage and contamination from roofing work.
- F. Where work must continue over completed roof areas, protect the finished roofing system from damage.
- G. Deck preparation is the sole responsibility of the building owner or roofing contractor. All defects in the roof deck or substrate must be corrected before roofing work commences.

3.02 Preparation of Roofing Area – New and Tear-off Applications

- A. Remove all existing roofing materials to the roof decking, including flashings, metal edgings, drain leads, pipe boots, and pitch pockets, and clean substrate surfaces of all asphalt and adhesive contaminants.
- B. Confirm the quality and condition of the roof decking by visual inspection. Fastener pull-out testing must be conducted by the roof fastener manufacturer.
- C. Secure all loose decking. Remove and replace all deteriorated decking.
- D. Remove abandoned equipment and equipment supports.
- E. Confirm that the height of equipment supports will allow the installation of full-height flashings.
- F. Refer to Section 3.06A for air/vapor retarder requirements.
- G. For extended length guarantees, a new roof construction or tear-off is required. For tear-offs, remove all existing roofing materials to the roof deck. This includes flashings, metal edgings, drain leads, pipe boots, and pitch pockets.

3.03 Preparation of Roofing Area – Re-cover Applications

- A. Remove all stone ballast, loose gravel, and debris from the roof surface.
- B. Remove blisters and ridges from the roof membrane.
- C. When re-covering over an existing single-ply roof, that roof must be first cut into maximum 10'x10' (3 m x 3 m) areas first, before the application of new membrane. PVC must be separated from existing PVC roofs. This includes roofs that

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have active sealants, including asphalt cement or other non-compatible materials. This can be accomplished by installing insulation or a cover board.

D. Remove all existing flashings, including metal edgings, drain leads, pipe boots, and pitch pockets, and clean substrate surfaces of all asphalt and adhesive contaminants. Dry-hung wall flashings are an option if the wall/curb flashings are in good condition and tightly adhered to the substrate. Both TPO and PVC flashing materials may be installed over these to a height of 24" (610 mm); new PVC flashing materials may be installed over a layer of polymat or insulation board.

E. The existing roof surface must be free of visible moisture, such as ponding water, ice, or snow.

F. It is strongly recommended that the building owner have a moisture survey performed to ascertain the condition and suitability of the existing roofing materials to receive a re-cover system. A survey is required if perlite or wood fiber insulation is used in a re-cover system. GAF will not be responsible for damage to the roofing system from moisture in the existing roofing system. Remove and replace all existing roofing materials that contain moisture.

G. Confirm quality and condition of roof decking by visual inspection, if possible, and by fastener pull-out testing. Remove and replace all deteriorated decking.

H. Test cuts

1. There is no substitute for quality materials and workmanship. Should cuts be required for testing purposes, take cuts before the membrane is installed so that proper and adequate repairs can be made.

2. Take test cuts to verify the existing roof construction and condition. Three test cuts should be made for roofs under 100 squares (929 sq. m) and one test cut per 100 squares (929 sq. m) above the minimum amount.

3. GAF will not comment on the results of any test cut that cannot be shown to be statistically representative of the roofing system.

4. The party requesting test cuts from roof must assume all responsibility for any detrimental effects of said test cuts.

I. Remove abandoned equipment and equipment supports.

J. Raise equipment supports to allow the installation of full-height flashings.

K. The RhinoBond® Attachment System should not be used to re-cover over coal tar pitch roofs. The "cold flow" characteristics of coal tar can allow coal tar to flow through new holes and penetrations in the deck and/or to seep down around fasteners into the building.

L. Extended-length guaranteed systems are not permitted/allowed in re-cover applications.

3.04 Wood Nailer Installation

A. Acceptable Material

1. Solid Blocking: Non-pressure-treated wood as required; #2 Grade or better; nominal 1 1/4" (30 mm) x 4" (102 mm) with a minimum thickness of 3 1/2" (88 mm).

2. Shim Material: Plywood, 1/2" (13 mm) x width to match solid blocking.

B. Existing Nailers

Verify the condition of existing roof nailers and anchor to resist 250 lb. per ft. (372 kg/m) load applied in any direction.

1. Drill-Tec™ HD Screws 18" (457 mm) o.c. attachment to structural wood and steel decks with a minimum 1" (25 mm) thread embedment.

2. Drill-Tec™ Spikes or HD Screws 18" (457 mm) o.c. attachment to concrete decks. Min. 1" (25 mm) shank or thread penetration.

3. Wood nailers attached to concrete must be fastened 12" (305 mm) o.c., through the nailer into the substrate with substrate-approved Drill-Tec™ Fasteners.

4. Three anchors per length of wood nailer minimum.

C. New Nailers

Anchor to resist 250 lb. per ft. (372 kg/m) load applied in any direction.

1. Drill-Tec™ HD Screws 18" (457 mm) o.c. attachment to structural wood and steel decks. Min. thread embedment is 1" (25 mm).

2. Drill-Tec™ Spikes or HD Screws 18" (457 mm) o.c. attachment to concrete decks. Min. 1" (25 mm) shank or thread penetration.

3. Wood nailers attached to gypsum, concrete, cellular concrete, and cementitious wood fiber must be fastened 12" (305 mm) o.c., through the nailer into the substrate with substrate-approved Drill-Tec™ Fasteners.

4. Three anchors per length of wood nailer minimum.

D. Shim Material

Secure simultaneously with overlying solid wood nailer.

1. Shim material must be continuous. Do NOT use spaced shims.

3.05 Gypsum Board Installation

A. General

1. Gypsum fire-barrier board must typically be installed when required by design professional or code authority to address code or approval requirements. For EverGuard® adhered systems, SECUROCK® Roof Board or DensDeck® Prime™ roof boards must be specified for a GAF guarantee.

B. Placement

1. Butt gypsum boards together with a 1/4" (6.3 mm) maximum space between adjoining boards. Fit gypsum boards around penetrations and perimeter with a 1/4" (6.3 mm) maximum space between board and penetration.

2. Install gypsum boards in pieces a minimum of 2' x 2' (610 mm x 610 mm) in size.

3. Gypsum boards installed over steel decking must have boards placed perpendicular to deck flutes with edges over flute surface for bearing support.

4. Do NOT use gypsum boards that are wet, warped, or buckled; they must be discarded. Insulation boards that are broken, cracked, or crushed must not be installed unless the damaged area is first removed and discarded.

5. Remove and replace gypsum boards that become wet or damaged after installation.

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6. Install no more gypsum board than can be properly covered by the end of each day with roofing membrane.

C. Securement

1. Mechanical Attachment of Insulation

- a. Use appropriate type and length of Drill-Tec™ Fastener for the structural deck type. Refer to the Drill-Tec™ RhinoBond® Attachment System Attachment Table on page 15 of this Manual.

3.06 Air/Vapor Retarder Installation

A. General

1. Air/vapor retarder components must typically be installed when required by design professional to address internal building air pressure or humidity conditions.
2. Designers should consider requiring air retarders:
 - a. On all air porous decks, with openings in the walls or area directly below the roof deck that exceeds 10% of the total wall area.
 - b. When the internal pressurization of the building is in excess of 5 lbs. per sq. ft. (239 Pa).
 - c. When the building height exceeds 50 ft. (30.5 m).
 - d. When buildings have large openings or overhangs.
 - e. In conditions where positive internal pressure is applied suddenly, as may be the case at aircraft hangers or distribution centers—otherwise, the roofing system may fail due to pressure impact.
3. Refer to FM Global Loss Prevention Data Sheets 1-28 and 1-29 for specific installation procedures for all roofs with large openings.
4. For roofs to be guaranteed by GAF:
 - a. Air retarders are required for all extended-length guarantees on buildings where large wall openings greater than 10% of the total wall area can be open during a windstorm, including opening due to storm damage.

B. Air/Vapor Retarder Application – Loose-Applied

1. Install the air/vapor retarder components loose-applied to the deck or fire-barrier board so that wrinkles and buckles are not formed.
2. Overlap air/vapor retarder components per applicable installation recommendations of the supplier. If minimum 6 mil polyethylene is used, overlap a minimum of 6" (152 mm).
3. Seal perimeter and penetration areas with foam sealant.
4. Seal all perimeter nailers with adhered roof membrane placed over the nailer and covering the exterior face of the nailer by 1" (25 mm).
5. Install insulation boards over the air/vapor retarder and mechanically attach the boards to the deck.

C. Air/Vapor Retarder Application – Adhered (if specified)

1. General

- a. Apply compatible adhesive to the structural deck or fire barrier board per air vapor retarder manufacturers' recommendations.

- b. Install the air/vapor retarder components loose applied to the deck or fire barrier board so that wrinkles and buckles are not formed. Broom air/vapor barrier components to ensure embedment into the adhesive.
- c. Overlap air/vapor retarder components a minimum of 6" (152 mm) for side and end laps. Adhere laps together with compatible adhesive.
- d. Seal perimeter and penetration areas with foam sealant.
- e. Install insulation boards over the air/vapor barrier and mechanically attach the boards to the deck or adhere the boards to the air/vapor retarder with compatible adhesive to achieve the desired roof system uplift resistance.

3.07 Slip Sheet Installation

Do not use *polyester* slip sheets with the Drill-Tec™ RhinoBond® Attachment System.

3.08 Fire-Resistant Slip Sheet/GAF TOPCOAT® FireOut™ Coating Installation

A. General

1. GAF VersaShield® Solo™ protection layer must typically be installed when required by design professional or code authority to address code or approval requirements, or as a slip layer in accordance with the Design Table on page 13 of this Manual.
 - a. Install GAF VersaShield® Solo™ protection layer loose-applied over substrate surface so that wrinkles and buckles are not formed.
 - b. Overlap GAF VersaShield® Solo™ protection layer a minimum of 2" (51 mm) for side and 4" (102 mm) for end laps.
 - c. GAF VersaShield® Solo™ protection layer should be installed perpendicular to the direction of the TPO membrane.
2. GAF TOPCOAT® FireOut™ Fire Barrier coating is installed at an application rate of one gallon per 100 sq. ft. (9.2 sq. m) via spray, brush, or roller. The substrate must be clean, dry, and free of foreign matter.

3.09 Re-cover Board/Insulation Installation

A. General

1. Refer to Section 2.09 of this Manual for specific GAF requirements on cover/re-cover boards.
2. Install insulation board and re-cover board as required in accordance with the Design Tables starting on page 13 of this Manual.

B. Placement

1. Butt insulation boards together with a ¼" (6.3 mm) maximum space between adjoining boards. Fit insulation boards around penetrations and perimeter with a ¼" (6.3 mm) maximum space between board and penetration. Do not kick insulation boards into place.
2. Install insulation boards in pieces a minimum of 2' x 2' (610 mm x 610 mm) in size. Every piece must be properly secured to the substrate.
3. Insulation boards installed in multiple layers must have the

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joints between boards staggered in all directions a minimum of 6" (152 mm) between layers.

4. Insulation boards installed over steel decking must have boards placed perpendicular to deck flutes with edges over flute surface for bearing support.
5. Install tapered insulation to provide a sump area a minimum area of 36" x 36" (910 mm x 910 mm) where applicable.
6. Do NOT install insulation boards that are wet, warped, or buckled; they must be discarded. Insulation boards that are broken, cracked, or crushed must not be installed unless the damaged area is first removed and discarded.
7. Remove and replace insulation boards that become wet or damaged after installation.
8. Install no more insulation than can be properly covered by the end of each day with roofing membrane.
9. EPS, XPS, or polyiso insulation may be used to fill in flutes of steel decking. Cover board required for EPS/XPS.

C. Securement

1. Mechanical attachment of insulation
 - a. Use appropriate type and length of Drill-Tec™ RhinoBond® Fastening Plates and Screws for structural deck type. See the Drill-Tec™ RhinoBond® Attachment System Attachment Table on page 15 of this Manual.
 - b. Install fastener so as to firmly imbed the plate to the insulation surface without overdriving or underdriving.

3.10 Drill-Tec™ RhinoBond® Attachment System

A. Insulation, Overlay/Re-cover Board Layout for New Construction

1. For new construction over a metal deck or tear-off down to a metal deck, install insulation boards so that all edges are supported by the high flutes of the decking with no more than ¼" (6.3 mm) gap between adjoining boards. Butt the insulation and overlay/re-cover boards tightly together with no more than a ¼" (6.3 mm) gap between boards.
2. Overlay/re-cover boards may be installed using all full-size overlay boards in a staggered pattern. These overlay/re-cover boards include gypsum (DensDeck® and SECUROCK® roof board). If plywood or OSB is specified, it must be a minimum thickness of ¾" (19 mm). Overlay/re-cover boards are required when using EPS or XPS as the insulation system.
3. When installing the Drill-Tec™ RhinoBond® Attachment System over tapered insulation, it is critical the RhinoBond® plates are flat or flush against the insulation surface to ensure proper welding of the plate to the membrane. For this reason, it is preferable to install the tapered insulation first and cover the tapered system with an overlay/re-cover board.
4. Do NOT install insulation boards that are wet, warped, or buckled; they must be discarded. Insulation boards that are broken, cracked, or crushed shall not be installed unless the damaged area is first removed and discarded.
5. Remove and replace insulation boards that become wet or damaged after installation.
6. Install no more insulation than can be properly covered by the end of each day with roofing membrane.

7. Do not align seams with rows of plates, as the step-down that is created will cause an incomplete weld of the Drill-Tec™ RhinoBond® Fastening Plate. Keep a 2" (51 mm) separation between the Drill-Tec™ RhinoBond® Fastening Plate and membrane seam.

8. Do not straddle plates over insulation joints, as the gaps will create an incomplete weld of the RhinoBond® Plate.

B. Insulation, Overlay/Re-cover Board Layout in a Re-cover Application

1. When re-covering over an existing single-ply roof with no additional insulation or overlay/re-cover board specified, the existing membrane must be cut. Cut the field of the roof into 10' x 10' (3 m x 3 m) sections and cut all base flashings at their transitions.

Note: When installing EverGuard® PVC, an approved separation board must first be installed, separating the existing roof from the new installation.

2. Install new insulation, overlay/re-cover board, staggering a minimum 6" (152 mm) to prevent continuous vertical joints through the full new insulation thickness. Butt the insulation and overlay/re-cover boards tightly together with no more than a ¼" (6.3 mm) gap between boards.
3. Do NOT install insulation boards that are wet, warped, or buckled; they must be discarded. Insulation boards that are broken, cracked, or crushed shall not be installed unless the damaged area is first removed and discarded.
4. Remove and replace insulation boards that become wet or damaged after installation.
5. Install no more insulation than can be properly covered by the end of each day with roofing membrane.

3.11 Drill-Tec™ RhinoBond® Attachment System Installation

A. Use the appropriate length and type of Drill-Tec™ RhinoBond® Fasteners and Plates for the structural deck. See the Drill-Tec™ RhinoBond® Attachment System Attachment Table on page 15 of this Manual.

B. Drill-Tec™ RhinoBond® Fastening Plates are different in type and color: **TPO plates are a yellow/green**, while the **PVC plates are black in color**. The appropriate plate must be used with the appropriate membranes.

C. Mechanical attachment for the three distinct areas or zones of a roof:

1. Roofs have three distinct areas or zones. They are corners (either inside or outside); roof perimeter; and the field of the roof. Each of these areas have their own attachment rates.
2. These zones or areas have to be determined before the insulation, cover, or overlay board's fasteners are installed. A building's perimeter edges and corner areas or zones are determined by the height and width and other conditions referenced by ASCE 7-10 and FM Global 129.

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D. Securing the Drill-Tec™ RhinoBond® Attachment System

1. Insulation and overlay/re-cover boards are to be mechanically attached to the structural deck in accordance with the Drill-Tec™ RhinoBond® Attachment Table. Install the proper number of fasteners per insulation and overlay/re-cover board per roof zone or area.
2. Fasteners installed in a straight row in one direction with even spacing makes locating fasteners under the membrane easier and speeds installation in the field of the roof.
3. Snap chalk lines to lay out prescriptive grid pattern for field, perimeters, and corners. Fabricate a “template” with a termination bar marked with grid measurements to speed up chalk-lining of the grid patterns. Install the fasteners into the substrate using the appropriate grid pattern as established by the Drill-Tec™ RhinoBond® Fastener Patterns on page 38 and 39 of this Manual.
4. Fasteners must be tight enough that the Drill-Tec™ RhinoBond® Fastener Plate doesn't turn or rock.
5. Overdriven fasteners that distort the face or top of the plate must be removed and discarded. A new Drill-Tec™ RhinoBond® Fastener and Plate must be reinstalled next to the original, but not into the same space and hole.
6. Underdriven or “high” fasteners must be re-driven to proper depth.
7. When installation of the Drill-Tec™ RhinoBond® Fasteners and Plates are complete, the area should be blown or broomed clean to remove any dirt or debris from the substrate surface or contaminates from the plate's bonding surface. This is critical so as not to have debris puncture the membrane from beneath or to impair the welding of the membrane to the Drill-Tec™ RhinoBond® Fastener Plate.

3.12 EverGuard® Membrane Installation

A. Substrates must be inspected and accepted by the contractor as suitable to receive and hold roof membrane materials.

Note: EverGuard Extreme® has a light gray backer sheet to distinguish it from regular TPO membranes. It is the contractor's responsibility to install EverGuard Extreme® where specified on the roof; i.e., under highly reflective glass or metal, or wherever the high temperature performance of the membrane is required.

B. Placement

1. Place roof membrane so that wrinkles and buckles are not formed. Any wrinkles or buckles must be removed from the sheet prior to permanent securement.
2. Full-width rolls can be installed throughout the field and perimeter of the roof. Half sheets are not necessary.
3. Overlap roof membrane a minimum of 3" (76 mm) for end laps of EverGuard® PVC and TPO membranes. Membranes are provided with lap lines along the side laps; the red line is for the Drill-Tec™ RhinoBond® Attachment System. PVC does not have an adhered line.
4. Best practice is to install membrane so that the side laps run across the roof slope lapped toward drainage points.
5. All exposed sheet corners must be rounded a minimum of 1" (25 mm).
6. All cut edges of reinforced TPO membrane must be sealed with EverGuard® TPO Cut Edge Sealant.

C. Membrane Securement

1. Roof membrane must be mechanically secured at the perimeter, at the base of internal walls and curbs, and at all penetrations with Drill-Tec™ RhinoBond® Plates and Fasteners at 12" (152 mm) o.c. maximum spacing. Membrane may be heat-welded to coated metal flanges. A minimum of 4 fasteners per penetration is required. Note: This assembly must be placed no closer than 4.5" (113 mm) from vertical flashings and a maximum of 6" (152 mm) away to facilitate the proper placement of the RhinoBond® induction welder. Specific details are available for these conditions in this Manual. Alternatively, standard mechanical base attachment can be used 12" (152 mm) o.c.
2. The metal plates must be placed within ¼"– ¾" (6.3 mm – 19 mm) of the membrane edge. Plates must not be placed closer than ¼" (6.3mm) to the membrane edge.
3. Fasteners must be installed to achieve the proper embedment depth. Install fasteners vertical to the deck, without lean or tilt.
4. Since fastening patterns are different in the field, perimeter and corner areas, treat each as a separate zone and weld each zone separately. This helps ensure that all plates are welded as you move from zone to zone. Refer to the Drill-Tec™ RhinoBond® Attachment System Attachment Table on page 15 of this Manual.

D. Membrane Surface Preparation for Seaming

1. Membrane must be clean of dirt and contaminants, and free from dew, rain, and other sources of moisture. Factory-fresh membrane typically will not require cleaning prior to automatic welding, provided that welding is performed immediately after placement and securing of the membrane.
2. Membrane that has been exposed for more than 12 hours or has become contaminated will require additional cleaning methods.
3. Light Contamination - Membrane that has been exposed overnight up to a few days to debris, foot traffic, or dew or light precipitation can usually be cleaned with a white cloth moistened with EverGuard® TPO Cleaner (or EverGuard® CleanWeld™ Conditioner, a low-VOC cleaner) for TPO membranes. For PVC, acetone or MEK (Methyl Ethyl Ketone) may be used. Be sure to wait for solvent to flash off prior to welding.
4. Dirt-Based Contamination - Membrane that is dirt encrusted will require the use of a low-residue cleaner, such as Formula 409® and a mildly abrasive scrubbing pad to remove the dirt. This must be followed by cleaning with a white cloth moistened with EverGuard® TPO Cleaner (or EverGuard® CleanWeld™ Conditioner) for TPO membranes. For PVC, acetone or MEK may be used. Be sure to wait for solvent to flash off prior to welding.
5. Exposure-Based Contamination - Membrane that is weathered or oxidized will require the use of EverGuard® TPO Cleaner, EverGuard® CleanWeld™ Conditioner, or acetone for PVC and a mildly abrasive scrubbing pad to remove the weathered/oxidized top surface layer. This must be followed by cleaning with a white cloth moistened with EverGuard® TPO Cleaner (or EverGuard® CleanWeld™ Conditioner) for TPO membranes. For PVC, acetone or MEK may be used. Unexposed membrane left in inventory for a year or more may need to be cleaned as instructed above. Be sure to wait for solvent to flash off prior to welding.

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6. Chemical-Based Contamination - Membrane that is contaminated with bonding adhesive, asphalt, flashing cement, grease and oil, and most other contaminants usually cannot be cleaned sufficiently to allow an adequate heat weld to the membrane surface. These membranes should be removed and replaced.

E. Field Seaming

1. Fabricate field seams using a current-generation automatic hot-air welding machine and a 10,000-watt voltage-controlled generator at minimum. In addition, fabricate detail seams with automated hot-air welders where possible. Outdated welding equipment and inadequate or fluctuating electrical power are the most common causes of poor seam welds.
2. Equipment Settings - The correct speed and temperature settings for automatic welders are determined by preparing test-welds at various settings. The welds are tested by application of pressure causing the seam to peel apart. A satisfactory weld will fail by exposing the scrim reinforcement, which is called a "film-tearing bond." A deficient weld fails by separating between the two layers of the membrane.
3. Adjustments to Equipment Settings - Many factors will affect the settings: thicker membranes, lower air temperatures, and overcast skies will generally require a slower speed than would be required with thinner membranes, higher air temperatures, and sunny skies. The slower speed provides additional heat energy to compensate for heat-draining conditions. The test weld procedure should be conducted at the beginning of every work period (i.e., morning and afternoon) using bag-fresh material and following a significant change in weather (i.e., air temperature, wind speed, cloud cover).
4. Membrane laps must be heat-welded together. All welds must be continuous, without voids or partial welds. Welds must be free of burns and scorch marks.
5. The weld width must be a minimum 1" (2.5 mm) to a maximum 1.5" (38 mm) in width for automatic machine-welding (robotic welders) for standard GAF guarantees. A minimum welding width of 1.5" (38 mm) is required to comply with FM Global, Miami-Dade County (Florida), and other specifications. In addition, the field seams of *all* TPO membranes should be made using a robotic welder in the field of the roof.
6. All TPO cut edges must be sealed with EverGuard® TPO Cut Edge Sealant.

F. Cautions and Warnings:

1. Any attempt to run a robotic welder at a speed greater than 16' (5 m) per minute may result in defective seam welds.
2. Setting the speed of the welder too fast can also pose potential problems with the ability of the operator to maintain control of the welder. This is particularly true in reroofing or over uneven substrates.
3. Robotic welders running too fast may not allow the operator to monitor the 1.5" (38 mm) minimum weld and ensure that critical T-joint areas have been correctly creased.
4. The operator must keep in mind the relationship between ambient temperature and robotic welding speed in order to achieve a spec weld.

5. Increasing the speed of the robotic welder can also compromise the appearance of a non-bonded system.

3.13 Induction Welding of the EverGuard® Membrane

Follow RhinoBond® tool manufacturer's printed guidelines.

A. Equipment

1. RhinoBond® Portable Bonding Machine (a minimum of two machines is recommended per project)
2. Minimum 5,000-watt, continuous generator per two RhinoBond® Portable Bonding Machines
3. 100' (2.5 m) max length, #12 minimum gauge electrical cords
4. Six (6) cooling clamps (stand-up magnets that put pressure on the newly-welded plate)
5. Pliers
6. Heavy duty plunger
7. Lumber crayon

B. Equipment settings

1. IMPORTANT: As with any electrical tool, it is imperative that the tool receives the recommended amount of current for its proper operation. Damage could result from both overload (surge), as well as a low-voltage situation. No other electrical devices can be run at the same time as the RhinoBond® Portable Bonding Machines.
2. The RhinoBond® tool must be adjusted to achieve the maximum bond strength with most roofing membranes between 0°F to 120°F (-18° to 49°C).

C. Calibration and use of the RhinoBond® Tool

1. Refer to the RhinoBond® Tool Instruction Manual provided with the tool for specific instructions.

D. When using the RhinoBond® Portable Bonding Machine on a *sloped surface*, it is imperative that the induction welder sit flat against the membrane. This will help ensure an even and consistent 360° weld of the membrane to the plate. The plate will also leave an impression in the membrane. This is one indication of a spec weld.

3.14 RhinoBond® Purlin Attachment Metal Retrofit System

A. General

1. The Drill-Tec™ RhinoBond® Fastener System can be used for metal retrofit applications. The RhinoBond® Purlin Attachment Metal Retrofit System secures the membrane to the purlins without penetrating the roofing material.
2. The fasteners are installed into the purlins for maximum uplift resistance without being placed in the seams of the membrane. Once the fasteners are in place, unroll the membrane and weld the membrane to the specially coated RhinoBond® plates using the Drill-Tec™ RhinoBond® induction welding tool. Then, hot air weld the membrane seams.

B. Approved insulation fill must be of the same size and inserted in the existing metal standing seam roof panel to provide a

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level substrate for installation of the approved cover board or insulation boards. For FM Global insured buildings where insulation is being applied directly to a steel deck, refer to FM Global specifications.

C. The selection of insulation type, thickness, and configuration is the responsibility of the architect, engineer, owner, or roof consultant. GAF reserves the right to accept or reject any roof insulation as an acceptable substrate for GAF roof systems. GAF EnergyGuard™ insulations must be used in roofing systems to be guaranteed by GAF.

D. See section 3.04 in this Manual.

E. Placement of insulation. See section 3.05 B 1-9 in this Manual.

F. Standard Insulation Attachment Requirements

1. Mechanical attachment of insulation

- a. For installation of Drill-Tec™ insulation fasteners and plates, refer to the insulation attachment table in this Manual.
- b. Use fasteners that are suitable for the deck type, and ensure the deck is of the required thickness and condition to ensure reliable installation and performance.

G. Purlin Membrane Attachment requirements

1. RhinoBond® plates to be mechanically attached to purlins with EverGuard® fasteners. See the Drill-Tec™ RhinoBond® Membrane Purlin Attachment Table in this Manual.

H. Purlins of 18 gauge weight or heavier require Drill-Tec™ Purlin Fasteners.

I. Fastener pull-out testing must be conducted by the roof fastener manufacturer.

J. Perimeter and corner areas

1. Use the Formula calculation, as follows: Perimeter area width is throughout the perimeter and corner region. The width of this region is defined as the least of the following two measurements: 0.1 x Building Width or 0.4 x Building Height. The minimum width is 5' (1.5 m). FM Global requires the Formula calculation.

K. Notes and Definitions

1. The ridge area is defined as the high point in the roof area formed by two intersecting planes. When the sum of the slopes is a minimum of 4" (102 mm) in 12" (305 mm) or 30°, each side of the ridge shall be treated as a perimeter area.
2. The high point of the roof that forms the ridges requires special attention and should be treated as a perimeter area.

L. Over- and under-driving of fasteners. Special care should be taken when fastening plates, so as not to overdrive or under-drive the fasteners into the purlin. Overdriving the fasteners will result in a deformation or "cupping" of the plate and will result in an uneven or inadequate bond to the membrane when welded. Under-driving the fastener will result in a loose plate with insufficient clamping force and a protruding fastener head that could cause damage to the membrane during welding and through normal roof traffic.

Note: Newly installed seams should be oriented to allow the robotic welder to run down-slope.

M. Supplemental Securement

1. Roof membrane must be mechanically secured at the perimeter, at the base of internal walls and curbs, and at all penetrations with Drill-Tec™ Membrane Fasteners and Plates at a 12" (305 mm) o.c. maximum spacing. Membrane may be heat welded to coated metal flanges.

Note: A minimum of 4 fasteners per penetration is required.

2. Alternatively, membrane may be extended vertically 3" (76 mm) up walls and curbs and secured to the wall/curb substrate within 2" (51 mm) of the plane of the roof with Drill-Tec™ Membrane Fasteners and inverted Termination Bar at a 12" (305 mm) o.c. maximum spacing. This detail is required to be used for all pressurized buildings.

3. Mechanically attach membrane with screws and plates to the roof deck at locations of deck angle changes in excess of 1:12.

4. Fasteners must be installed to achieve the proper embedment depth. Install fasteners vertical to the deck, or horizontal to the wall/curb without lean or tilt.

5. Install fasteners so that the plate is drawn down tightly to the membrane surface. Properly installed fasteners will not allow the plate/termination bar to move (under-driving), but will not cause wrinkling of the membrane (over-driving).

6. Alternatively, utilization of Roof Transition Anchor (R.T.A.) Strip may be installed as the method of supplemental securement per details.

7. Drill-Tec™ SHD (#15) Fasteners and the appropriate RhinoBond® plate may be used for base attachment. Membrane attachment may also be run vertically. Consult the details in this Manual for further instructions.

N. Membrane Surface Preparation for Seaming. See section 3.12 D in this Manual.

O. Field Seaming and Cautionary Warnings. See section 3.13 E in this Manual.

3.15 Flashing Installation

Refer to the construction details at the end of this Manual, which depict flashing requirements for typically encountered conditions. Install flashing materials as shown in the construction details.

A. General

1. Flash all perimeter, curb, and penetration conditions with coated metal, membrane flashing, and flashing accessories as appropriate to the site condition.

2. All coated metal and membrane-flashing corners must be reinforced with pre-formed corners or non-reinforced membrane.

3. All flashing membranes and accessories are to be heat-welded to achieve a minimum 2" (51 mm) wide using a hand welder. The weld width must be a minimum 1" (25 mm) to a maximum 1.5" (38 mm) in width for automatic machine-welding (robotic welders) for standard GAF guarantees. When using robotic welders, refer to Section 3.13 E.

4. All cut edges of reinforced TPO membrane must be sealed with EverGuard® TPO Cut Edge Sealant.

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5. When using bonding adhesive, be sure to use adhesive specific to membrane and ambient weather conditions.
6. Minimum flashing height is 8" (203 mm).
7. The maximum distance from the wall that horizontal mechanical attachment is installed is 6" (152 mm). When you must go past 6" (152 mm), move the attachment to the vertical substrate.
8. Installation of EverGuard® PVC flashing membrane over asphalt-based substrates must have a slip sheet, approved insulation boards, metal, wood, etc., under the PVC flashing membrane.
9. EverGuard Extreme® membrane flashings must be of same type, thickness, and color as the roofing membrane.
10. EverGuard Extreme® is available with a variety of accessories specific to these roofing membranes.
11. For existing granulated modified bitumen flashings, a separator sheet must be installed for dry-hung flashings.

Note: EverGuard Extreme® flashings and accessories are required for use with EverGuard Extreme® membranes.

B. EverGuard® Coated Metal Flashings

1. Coated metal flashing allows much of the metal-work used in typical roofing applications to benefit from the security of heat-welded membrane seaming, with a corresponding reduction in required metal-work maintenance during the life of the roofing system.
2. EverGuard® coated metal must be formed in accordance with construction details and SMACNA guidelines.
3. Coated metal sections used for roof edging, base flashing, and coping must be butted together with a ¼" (6.3 mm) gap to allow for expansion and contraction. Heat-weld a 6" (152 mm) wide non-reinforced membrane strip to both sides of the joint, with approximately 1" (25 mm) on either side of the joint. A 2" (51 mm) wide aluminum tape can be installed over the joint as a bond-breaker, to prevent welding in this area.
4. EverGuard® coated metal used for sealant pans and scupper inserts, and corners of roof edging, base flashing, and coping must be overlapped or provided with separate metal pieces to create a continuous flange condition, and pop-rieveted securely. PVC and TPO coated metal flashings must be stripped in using 6" (152 mm) non-reinforced membranes.
5. EverGuard® coated metal base flashings must be provided with minimum 4" (102 mm) wide flanges screwed to wood nailers. Coated metal base flashings must be formed with a 1" (25 mm) cant.
6. Provide a ½" (13 mm) hem for all exposed metal edges to provide corrosion protection and edge reinforcement for improved durability.
7. In addition, provide a ½" (13 mm) hem for all metal flange edges whenever possible to prevent wearing of the roofing and flashing membranes at the flange edge.
8. EverGuard® coated metal flashings are attached to wood nailers or otherwise mechanically attached to the roof deck, or to the wall or curb substrate, in accordance with construction detail requirements.

9. When installing coated metal on walls or curbs that completely cover the existing flashing, the flashing does not need to be removed provided it is in good condition and tightly adhered.

C. Adhered Reinforced Membrane Flashings - Smooth Surface

1. The thickness of the flashing membrane must be the same as the thickness of the roofing membrane.
2. When using EverGuard® TPO or PVC adhesives, use any one of the following substrates: polyisocyanurate insulation (without foil facer); high-density wood fiber board; gypsum roof board; cured structural concrete absent of curing and sealing compound; untreated OSB; untreated CDX plywood; Type X gypsum board; and dry, sound masonry absent of curing or sealing compounds.
3. Use appropriate bonding adhesive for flashings.
4. Application of bonding adhesive.
 - a. Adhesives can be applied using a roller, brush, or spray equipment. Use of a ⅜" (9.5 mm) solvent-resistant nap roller or brush is recommended. When using a roller, avoid taking the roller head out of the bucket, dropping it in one place, and beginning to roll. Instead, remove the roller filled with adhesive and drop the roller on three areas to be glued, and then connect the adhesive drop areas. This will avoid an excess amount of adhesive in one place, and it will flash off faster and more uniformly. When spraying bonding adhesive, refer to the GAF adhesive product data sheets for viscosity and then contact spray equipment manufacturer for proper nozzle tip sizes and flow rates. Apply bonding adhesive to both the substrate surface and the underside of the flashing membrane.
 - b. GAF EverGuard® Low VOC bonding adhesive for smooth TPO membranes features a coverage rate of 500-600 square feet (47-56 sq. m) per five-gallon (19 liter) bucket. This adhesive features a fast-drying solvent system, which is typically 10-20 minutes at typical application temperatures.
 - c. EverGuard® 1121 and 2331 solvent-based bonding adhesives for TPO and PVC smooth membranes feature a coverage rate of about 120 sq. ft./gal. (11.2 sq. m/ 4 liters). This will cover both surfaces, yielding 60 square feet (5.6 sq. m) of finished, mated surface per gallon for standard solvent-based bonding adhesives.
 - d. EverGuard® WB181 water-based bonding adhesive for EverGuard® TPO smooth membranes, and TPO and PVC fleece-back membranes is applied at a rate of 200 sq. ft./ gal. (7.4 sq. m/liter). Covering both surfaces will yield 100 square feet (9.2 sq. m) of finished, mated surface area per gallon.
5. Apply the adhesive only when the adhesive, substrate, membrane, and outside temperatures are above 40°F (4.4°C) and rising. Application temperatures above 50°F (10°C) are recommended to allow easier adhesive application. Water-based adhesives are approved for use with smooth TPO membranes for flashings only.
6. Carefully position the membrane flashing prior to application to avoid wrinkles and buckles.
 - a. Please note that solvent-based adhesives must be allowed to dry until tacky to the touch before mating flashing membrane. Water-based adhesive must be allowed to

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flash off completely. Typically, it is required that the flashing be installed within one hour of applying the water-based adhesive. However, this may vary depending on ambient temperature conditions.

7. Heat-weld all laps in EverGuard® smooth-reinforced flashing membrane in accordance with heat-welding guidelines.
 8. Porous substrates may require double application of adhesive.
 9. Prevent seam contamination by keeping the adhesive application a few inches back from the seam area.
 10. For standard solvent-based adhesives, mate membrane to the substrate coated with adhesive once the bonding adhesive has flashed off and is tacky to the touch. Water-based adhesives must be allowed to flash off completely; install membrane within one hour of drying, depending on ambient temperature conditions.
 11. Roll membrane with a silicone roller to ensure complete bonding between adhesive and membrane.
 12. For extended length guarantees, separate counter flashing is required; exposed termination bars are not acceptable.
 13. Alternatively, the Freedom™ System can be used for flashings. Consult the Freedom™ Specifications Manual for installation instructions.
 14. Also available are Corner Curb Wraps, consisting of a pre-formed combination corner and flashing pieces that are 12" (305 mm) in height and can be ordered in various lengths. These pre-fabricated corners can be configured to fit 13.5" x 13.5" (338 mm x 338 mm); 19.5" x 19.5" (500 mm x 500 mm); 25.5" x 25.5" (638 mm x 638 mm); and 31.5" x 31.5" (800 mm x 800 mm) curb flashings.
 15. Never use TPO Primer or TOPCOAT® Surface Seal SB Primer to prime walls to accept adhesives; only use the adhesive you are using for a primer to prime the walls.
- D. Loose Reinforced Membrane Flashings
1. For extended length guarantees, a counterflashing must be used. Exposed termination bars are not acceptable.
 2. Carefully position the EverGuard® smooth reinforced flashing membrane or fleece-back membrane prior to application to avoid wrinkles and buckles.
 3. All laps in EverGuard® smooth reinforced flashing membrane must be heat-welded in accordance with heat-welding guidelines. All seams in fleece-back membrane and smooth field sheet must be stripped in with 8" (203 mm) flashing strip.
 4. Maximum flashing height is 24" (610 mm) with incremental attachment.
- E. Non-reinforced Membrane Flashings
1. Non-reinforced membrane can be used as a field-fabricated penetration/reinforcement flashing only where pre-formed corners and pipe boots cannot be properly installed.
 2. Penetration flashings constructed of non-reinforced membrane is typically installed in two sections: a vertical piece that extends up the penetration and a horizontal piece that extends onto the roofing membrane. The two pieces are overlapped and heat-welded together.
3. The non-reinforced vertical membrane flashing may be adhered to the penetration surface. Refer to section 3.14 C for bonding adhesive application instructions.
 4. Finish the pipe penetration with TOPCOAT® FlexSeal™ Caulk Grade sealant between the pipe and the membrane; install clamping band, and TOPCOAT® FlexSeal™ Caulk Grade.
 5. T-joint Patches
 - a. T-joint patches are to be minimum 4" (102 mm) in size and made of non-reinforced membrane material. They must be completely hot-air welded over the T-joint at the intersection of the three pieces of reinforced membrane. During installation, care must be taken to "crease-in" the unsupported membrane at the entire three step-off locations.
 - b. Prefabricated or field-fabricated non-reinforced membranes that match the membrane being used in the field of the roof are acceptable for T-joints.
 - c. T-joint patches must be made from TPO non-reinforced membrane, EverGuard Extreme® TPO non-reinforced membrane, or PVC non-reinforced membrane.
 - d. T-joint patches are required on 60, 70, and 80 mil TPO membranes, and on 80 mil PVC membrane only.
- F. Roof Edging
1. Roof-edge flashing is applicable for both gravel stop/drip edge conditions, as well as exterior edges of parapet walls. For guarantees up to 20 years or greater, use EverGuard® Cover Tape Heat Weld (HW), EverGuard® TPO Coated Metal, or the EverGuard® EZ Fascia prefabricated extruded aluminum fascia system. For extended length guarantees, use weldable metal, EverGuard Extreme® Cover Tape HW, or EverGuard® EZ Fascia system only.
 2. Flash roof edges using TPO-coated metal flanged edging with a minimum 3" (76 mm) wide flange nailed 4" (102 mm) o.c. to wood nailers. Then heat-weld 8" (203 mm) membrane strip to metal flanges and field membrane.
 3. Metal roof edging must be provided with a continuous metal hook strip to secure the lower fascia edge. Secure the continuous hook strip to the building a minimum of 12" (305 mm) o.c.
 4. A second option is to flash roof edges with a two-piece snap-on fascia system, adhering roof membrane to metal cant with bonding adhesive and face-nailing the membrane 8" (203 mm) o.c. prior to installing the snap-on fascia.
 5. Galvanized-based metal edging may be flashed using EverGuard® HW TPO Cover Tape. EverGuard® TPO Cover Tape is a 6" (152 mm) wide, non-reinforced TPO membrane backed with a butyl tape adhesive. Clean the entire surface to be covered, metal, and roof membrane with soap and water and dry entire area. Wipe area to be primed with a damp wipe of EverGuard® TPO Cleaner (or EverGuard® CleanWeld™ Conditioner).
 6. Prime surfaces mating with the butyl tape with EverGuard® TPO Primer, keeping primer only on the surface receiving the tape. After primer has flashed off, pull release paper on the back of the tape, exposing the butyl adhesive, and mate the two surfaces. Roll the tape portion of the cover strip at a 45-degree angle to ensure a good bond. Seal all end laps, miters, and T-joint intersections with EverGuard® TPO Cut Edge Sealant 6" (152 mm) past the intersection in all directions.

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Note: For slopes greater than 1/2" (13 mm) in 12" (305 mm), Cover Tape Heat-Weld or EverGuard Extreme® Cover Tape Heat-Weld must be used.

7. For guarantees up to 20 years, use EverGuard® TPO Cover Tape Heat Weld (HW). For warranties 25 years and over, use Extreme Cover Tape (HW). This is a hybrid cover tape consisting of 6" (152 mm) of .045 reinforced TPO membrane with 3" (76 mm) butyl tape on half of the back surface. Refer to step 6. (above) and follow procedures for the butyl tape preparation and installation. Then heat-weld the cover tape to the field membrane with a 2" (51 mm) hand-weld or 1.5" (38 mm) auto-weld, to all membrane-to-membrane surfaces.

Note: Any overlap ends must be stripped in with flashing detail membrane and welded completely to finish the detail.

8. Flash roof-edge scuppers with EverGuard® TPO or PVC coated metal that is mechanically attached to the roof edge and integrated as part of the metal edging.

G. Parapet and Building Walls

1. There are three options for flashing parapet and building walls: adhered membrane flashings, metal flashings, and loose-hung flashings.
2. Secure membrane flashing at the top edge with a termination bar. Apply TOPCOAT® FlexSeal™ Caulk Grade sealant between the wall surface and membrane flashing underneath all termination bars. For guarantees of less than 20 years, exposed termination bars must be mechanically fastened 6" (152 mm) o.c.; for guarantees of 20 years or greater, termination bars that are counter-flashed must be fastened 12" (305 mm) o.c.
3. Flash wall scuppers with a scupper insert of coated metal that is mechanically attached to the wall and integrated as part of the wall flashing. Refer to scupper section (3.14 M) for other detail options.
4. Maximum flashing height without intermediate fastening:
 - 24" (610 mm) Loose-Applied Flashing
 - 54" (1.4 m) Adhered Flashing
5. Metal cap flashings must have continuous cleats or be face-fastened 12" (305 mm) o.c. on both the inside and outside of the walls.
6. Utilization of Roof Transition Anchor (R.T.A.) Strip may be installed as the alternate method of base securement for a RhinoBond® non-penetrating base attachment detail.

Note: For curbs, walls, expansion joints, penetrations, or pre-targeting of drains, standard base attachment or RhinoBond® base attachment may be used.

7. DensGlass® Gold gypsum board is NOT to be used as a substrate for fully adhered attachment on parapet walls, according to the manufacturer.
8. Fire-treated plywood/wood cannot be used for parapet walls unless covered with an approved gypsum board for (fully) adhered or Freedom™ materials.

H. Round and Square Tube Penetrations

1. Four options are available for penetration flashings. These are stepped pipe boots; split pipe boots; square tube wraps; and field fabrication with unsupported membrane and target.

2. All flashings require the installation of a stainless steel draw band around the top of the flashing.

- a. Seal the top edge junction between the substrate and the membrane with TOPCOAT® FlexSeal™ Caulk Grade sealant and add draw band with TOPCOAT® FlexSeal™ Caulk Grade caulking.

3. Roof membrane must be mechanically attached at the base of each penetration with screws and plates a maximum of 12" (305 mm) o.c., with a minimum of four fasteners per penetration.

I. Irregularly Shaped Penetrations

1. Flash irregularly shaped penetrations with flanged sealant pans formed of coated metal, secured to the deck through the roof membrane with screws 12" (305 mm) o.c. or a minimum of 4 fasteners per penetration.
2. Strip in metal flanges and the vertical pop riveted seam with 8" (203 mm) wide membrane flashing strips heat-welded to both the roof membrane and the metal flanges.
3. Fill sealant pans with non-shrink quick-set grout, and top off sealant pans with a 2" (51 mm) minimum thickness of EverGuard® Two-part Pourable Sealant. When using TOPCOAT® FlexSeal™ Caulk Grade sealant, after priming, increase the grout to within 1/2" (13 mm) from the top of the pocket, and install the FlexSeal™ to the very top or overfill the pocket.
4. Preformed sealant pans/vent boots made of PVC and TPO are also available.

- a. For PVC: Installation of preformed PVC sealant pans require the flange of the PVC sealant pan to be fastened with a minimum of 4 fasteners per penetration. A PVC membrane target is installed around the base of the sealant pan over the flanges of the PVC sealant pan and heat-welded to the flanges. Install the fasteners near the outside edge of the flanges to allow for proper heat-welding of the target. The outside edge of the target membrane is heat-welded to the field membrane.

- b. For TPO: Installation of preformed TPO sealant pans requires field membrane securement around the penetration. A minimum of four (4) system-appropriate screws and plates are required around the penetration. A membrane target must be installed prior to the installation of the TPO sealant pan if the location of the plates does not allow for a continuous 2" (51 mm) weld of the TPO sealant pan flange. Properly heat-weld the flange of TPO sealant pan to the field/target membrane.

- c. If the sealant pan is cut to install around the penetration, the cut must be stripped-in with a minimum 4" (102 mm) wide non-reinforced membrane. The non-reinforced strip-in membrane must extend a minimum of 2" (51 mm) beyond the outside edge of the sealant pan flange and be fully welded.

- d. Prior to filling the TPO sealant pan, the inside vertical pan sides must be primed with GAF TPO primer. Fill the base of the pans with non-shrink grout and top off with a minimum 2" (51 mm) thickness of GAF Two-Part Pourable Sealer. When using TOPCOAT® FlexSeal™ Caulk Grade sealant, after priming, increase the grout to within 1/2" (13 mm) from the top of the pocket, and install the FlexSeal™ to the very top or overfill the pocket.

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- e. Reinforced targets must be sealed as the particular roof system requires with EverGuard® TPO Cut Edge Sealant.

J. Curbs

1. Flashings can be applied in two different ways; either with adhesive applied to the membrane and substrate, or loose-applied up to 24" (610 mm) high. EverGuard® Coated Metal flashings must be fastened at 4" (102 mm) o.c.
2. Secure membrane flashing at the top edge with a termination bar, flat stock, or counter-flashing. Apply TOPCOAT® FlexSeal™ Caulk Grade sealant between the curb surface and membrane flashing. Exposed termination bars must be mechanically fastened 6" (152 mm) o.c.; termination bars that are counter-flashed must be fastened 12" (305 mm) o.c. If wood is present at the top of the curb, install ring shanks 12" (305 mm) o.c. after wrapping the membrane to the inside of the curb. This can be used in lieu of the termination bar if nailed on the top or preferably the back side of the wood.
3. Roof membrane must be mechanically attached along the base of curbs and ducts that are flashed with membrane flashing with screws and plates/termination bar at 12" (305 mm) o.c.
4. Metal counterflashing may be needed for extended guarantee lengths. All termination bars must be sealed with TOPCOAT® FlexSeal™ Caulk Grade caulking.

K. Expansion Joints

1. Install expansion joint covers at all flat type and raised curb-type expansion joints. There are currently three types of expansion joints approved for EverGuard® Systems. There are two prefabricated expansion joints - one each for TPO and PVC. TPO and PVC can also be field fabricated to meet expansion joint needs. For PVC, any prefabricated expansion joint metal nailing strips must be fastened to wood nailers, curbs or secured to walls with appropriate nails or EverGuard® Drill-Tec™ Fasteners.
2. Roof membrane must be mechanically attached along the base of raised curb-expansion joints with screws and plates a minimum of 12" (305 mm) o.c.
3. Expansion-joint bellows must be twice the width of the expansion-joint opening to allow for sufficient expansion and contraction.
4. Metal nailing strip must be set in TOPCOAT® FlexSeal™ Caulk Grade sealant and secured with fasteners and neoprene washers fastened 6" (152 mm) o.c.

L. Roof Drains

1. Roof drains must be fitted with compression clamping rings and strainer baskets. Both traditional cast iron and aluminum drains, as well as retrofit-type cast aluminum and molded plastic drains, are acceptable.
2. Roof drains must be provided with a min. 36" x 36" (914 mm x 914 mm) within a sumped area if possible. Slope of tapered insulation within the sumped area must not exceed 4" in 12" (102 mm in 305 mm).
3. Extend the roofing membrane over the drain opening. Locate the drain and cut a hole in the roofing membrane directly over the drain opening. Provide a 1/2" (13 mm) membrane flap extending past the drain flange into the drain opening. Punch holes through the roofing membrane at drain bolt locations.

4. For cast iron and aluminum drains, the roofing membrane must be set in a full bed of TOPCOAT® FlexSeal™ Caulk Grade sealant on the drain flange prior to securing with the compression clamping ring. Typical TOPCOAT® FlexSeal™ Caulk Grade sealant application rate is one 10.5-oz. (298 gr.) cartridge per drain.

5. Do NOT locate lap seams within the sump area. Where lap seams must be located within the sump area, a separate, smooth, reinforced membrane drain flashing a minimum of 12" (305 mm) larger than the sump area must be installed. The membrane flashing must be heat-welded to the roof membrane. Alternately, if the seam does not run under the clamping ring, it can be covered with a 6" (152 mm) wide reinforced-membrane strip heat-welded to the membrane.

6. Tighten the drain compression clamping ring in place.

M. Scuppers

1. Coated-metal roof-edge scuppers must be provided with a min. 4" (102 mm) wide flange nailed to wood nailers, with hemmed edges and secured with continuous clips in accordance with the gravel stop assembly.
2. Coated-metal wall scuppers must be provided with 4" (102 mm) wide flanges, with additional corner pieces pop-riveted to the flanges to create a continuous flange. All flange corners must be rounded.
3. Install wall scuppers over the roof and flashing membrane and secure to the roof deck/wall with Drill-Tec™ Fasteners 6" (152 mm) o.c., a minimum of 2 fasteners per side.
4. All corners must be reinforced with EverGuard® PVC or EverGuard® TPO Universal Corners or field-fabricated from EverGuard® non-reinforced materials.
5. Strip-in scupper with flashing membrane target sheet.
6. Alternately, a wall scupper box may be field-flashed using non-reinforced flashing membrane heat-welded to membrane on the wall face and roof deck. Fully adhere to the scupper box and terminate on the outside wall face with a termination bar and TOPCOAT® FlexSeal™ Caulk Grade sealant.
7. EverGuard® TPO has prefabricated scuppers in standard and custom sizes available. Consult your Territory Manager or local distributor for details.

N. Heater Stacks

1. Field-fabricated two-piece membrane flashings of EverGuard® non-reinforced flashing are typically installed at heater stacks. EverGuard® TPO and PVC have cone-type prefabricated pipe flashing that may work in these applications. If not, then field-fabricated membrane flashings, such as EverGuard® Detailing Membranes, may be used. The temperature of any heater stack that comes into contact with the EverGuard® membrane or flashings should not exceed 160°F (71°C) or a post-installation sustained temperature of 195°F (87°C) for EverGuard Extreme® roofing systems.
2. Heat stacks must be equipped with either cone-shaped or vertical tube-type flashing sleeves so that the membrane flashing is not directly in contact with the heater stack.

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- All stack flashings must be secured at their top edge by a stainless steel clamping band over TOPCOAT® FlexSeal™ Caulk Grade sealant. The detail should then be sealed with TOPCOAT® FlexSeal™ Caulk Grade sealant.

- Field-fabricated membrane flashings may be adhered to the flashing sleeve with EverGuard® TPO or EverGuard® PVC Low VOC Bonding Adhesive.

O. Retrofit Drain Inserts

- EverGuard® PVC roofing membrane is typically terminated at PVC drain inserts by heat-welding the membrane to the PVC coated drain flange (if available), or by securing the membrane between the drain flange and the clamping ring.
 - EverGuard® TPO drain inserts have an integral TPO target membrane for welding to the field membrane.
- Drain inserts may only be used in the event the original drain is damaged and cannot be repaired without complete replacement of the drain.
- Follow retrofit drain insert instructions shipped with the drain insert.

P. Wood Support Blocking

- Wood support blocking, typically 4" x 4" (102 mm x 102 mm), is usually installed under light-duty or temporary roof-mounted equipment, such as electrical conduit, gas lines, condensation and drain lines.
- Install wood support blocking over a protective layer of EverGuard® TPO walkway rolls or PVC walkway pads. Place wood blocking on oversized slip sheet, fold two sides vertically, and fasten with roofing nails into the blocking.

Q. Satellite Dish Support Bases

- Install satellite dish support bases over a protective layer of TPO/PVC membrane.

R. Lightning Suppression Clips

- Secure lightning suppression clips to the roof surface by means of 2" (51 mm) wide EverGuard® PVC or EverGuard® TPO Flashing membrane strips heat-welded to the roof membrane.

3.16 Traffic Protection

- Walkway rolls or pads must be installed at all roof access locations, including ladders, hatchways, stairs, and doors. Install walkway rolls or pads at other designated locations, including roof-mounted equipment work locations and areas of repeated rooftop traffic.
- Walkway rolls or pads must be spaced 6" (152 mm) to allow for drainage.
- Heat-weld walkway rolls or pads to the roof membrane surface continuously around the walkway roll perimeter.
- EverGuard® TPO walkway roll may also be installed with TPO primer and 3" (76 mm) seam tape. First, roll or brush the TPO primer on the back of the TPO roll along the edges and down the middle of length of the roll. Clean and prime the roof membrane where the roll will be installed. Install tape to the back of the roll where cleaned (edges and middle) and roll-in with a silicone hand-roller. Remove the release paper and install the taped rolls directly onto the roof membrane. Secure the rolls by rolling into place.

3.17 Temporary Closures

- The roofing installation must be made watertight at the end of each day's activity to prevent water infiltration into the completed roofing system installation.
- Complete all flashings and terminations as the roofing installation progresses.
- At the edge of the completed roofing system installation, extend the roofing membrane a minimum of 6" (152 mm) beyond the edge. Seal the roofing membrane to the surrounding deck or substrate surface with hot asphalt or foam sealant.
- Remove, and properly dispose of, all temporary night seal materials prior to continuing with the roof installation.

3.18 Field Quality Control

- Inspect completed roof sections on a daily basis. It is the contractor's responsibility to probe all heat-welded seams and perform an adequate number of seam cuts to ascertain seam consistency.
- Immediately correct all defects, irregularities, and deficiencies identified during inspections. All voids that are found must be patched over per specifications. Do NOT re-weld seam voids more than 24 hours after initial welding of the seam.
- Remedial work must be performed with like materials and in a manner consistent with the balance of the roofing installation so as to minimize the number of repair patches.
- Excessive patchwork will require replacement of the entire affected membrane section from lap to lap.

3.19 Cleaning

- Remove bonding adhesive, bituminous markings, and other contaminants from finished surfaces. In areas where finished surfaces are soiled by asphalt or any other source of soiling caused by work of this or other sections, consult manufacturer of surfaces for cleaning advice and conform to those instructions.
- Cut out and remove any sheet membrane contaminated with solvent-based adhesive, bituminous markings, and other contaminants from finished surface. Consult GAF Technical Services for appropriate insulation repair methods.

3.20 Maintenance

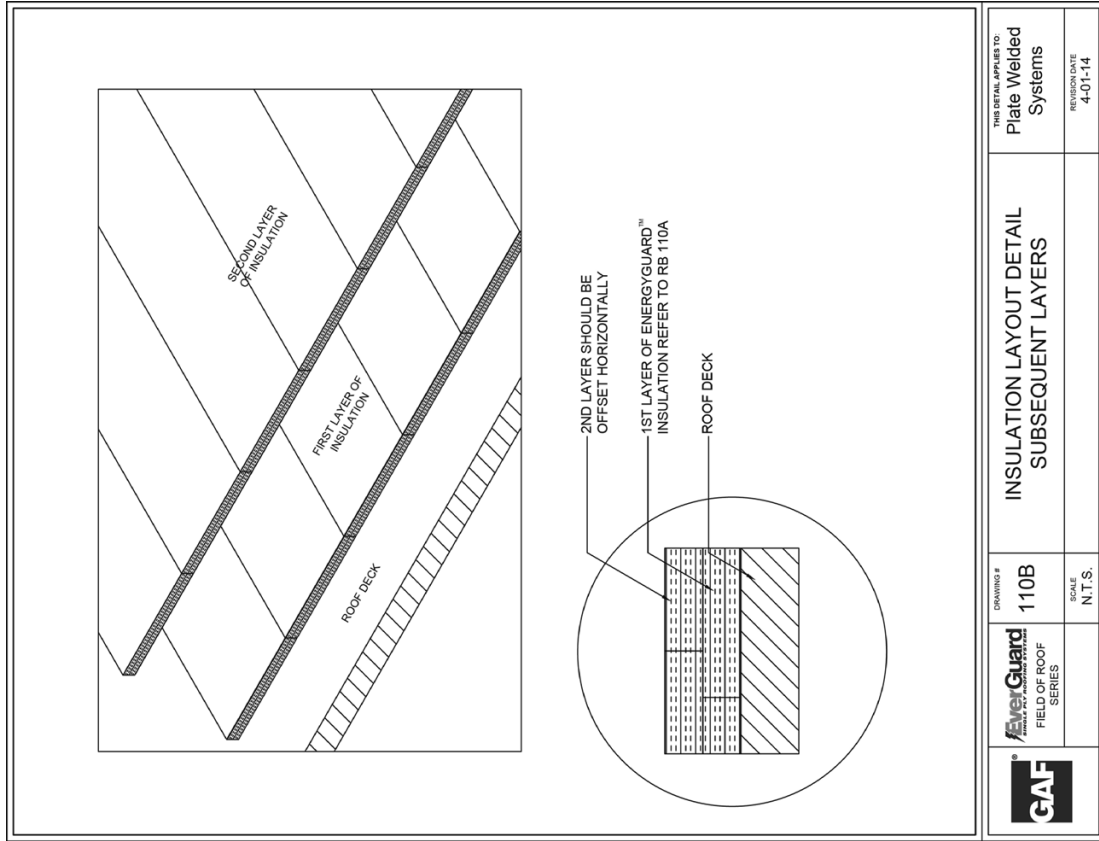
- Upon completion of the roofing system, the owner should establish a semi-yearly inspection and maintenance program in accordance with standard good roofing practice and guarantee requirements.
- Repair cuts, punctures, and other membrane damage by cleaning membrane (see Section 3.12 D), followed by heat-welding a membrane repair patch of sufficient size to extend a minimum of 2" (51 mm) beyond the damaged area. If heat-welding to the top surface of the existing membrane is ineffective, the patch must be heat-welded to the underside of the existing sheet after proper preparation.
- Any damage to adhered membrane areas or at locations of mechanical attachment, including insulation, must be repaired so that the repaired area remains adhered or mechanically attached.

ROOFING DETAILS

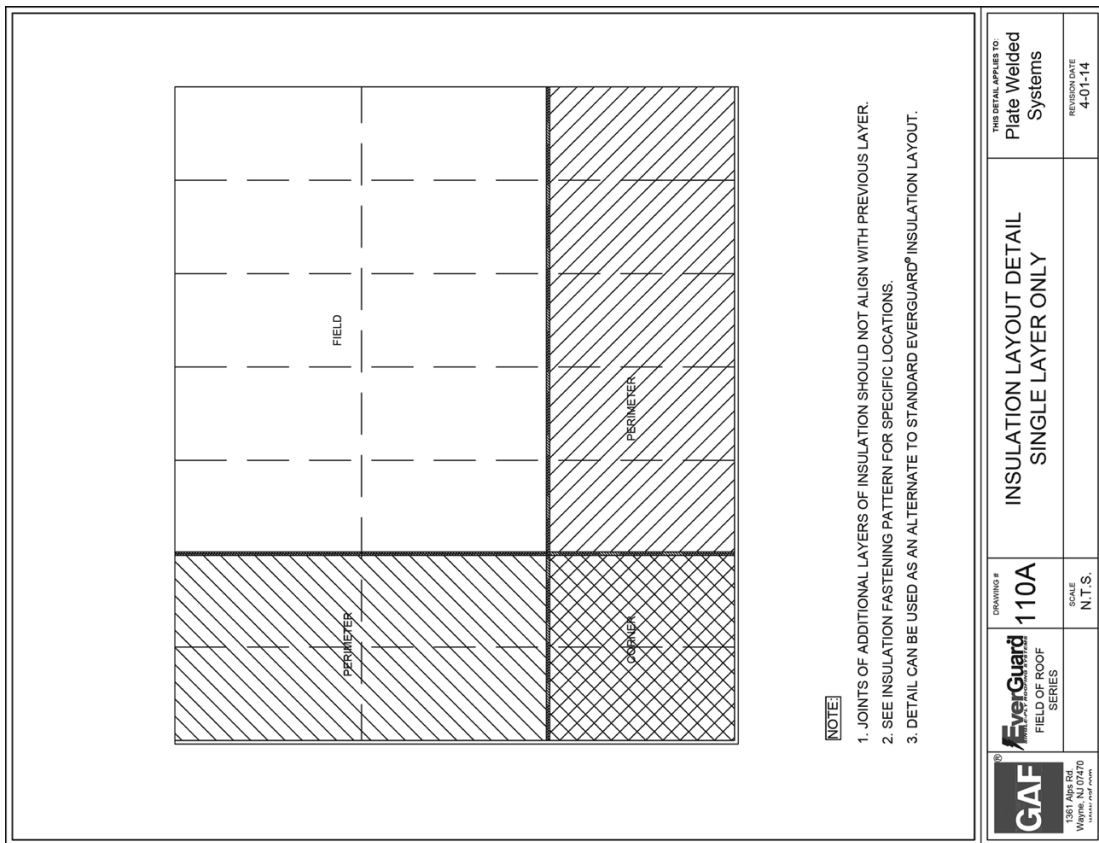
DETAIL NAME	DETAIL NUMBER	PAGE
INSULATION LAYOUT DETAIL SINGLE LAYER ONLY	110A	37
INSULATION LAYOUT DETAIL SUBSEQUENT LAYERS	110B	37
STANDARD FASTENING PATTERN OVER APPROVED STEEL OR CONCRETE DECKS	111A	38
STANDARD FASTENING PATTERN OVER APPROVED WOOD DECKS	111B	38
90 PSF FASTENING PATTERN OVER APPROVED STEEL AND CONCRETE DECKS	112	39
120 PSF FASTENING PATTERN OVER APPROVED STEEL AND CONCRETE DECKS	113	39
ALTERNATE CURB BASE ATTACHMENT	300	40
ALTERNATE PIPE PENETRATION BASE ATTACHMENT	500	40

NOTE: REFER TO GAF.COM FOR ALL ACCEPTABLE GAF ROOFING DETAILS AND DRAWINGS FOR THE DRILL-TEC™ RHINOBOND® ATTACHMENT SYSTEM.

ROOFING DETAILS



	 FIELD OF ROOF SERIES	DRAWING # 110B	THIS DETAIL APPLIES TO: Plate Welded Systems
		SCALE N.T.S.	REVISION DATE 4-01-14
INSULATION LAYOUT DETAIL SUBSEQUENT LAYERS			

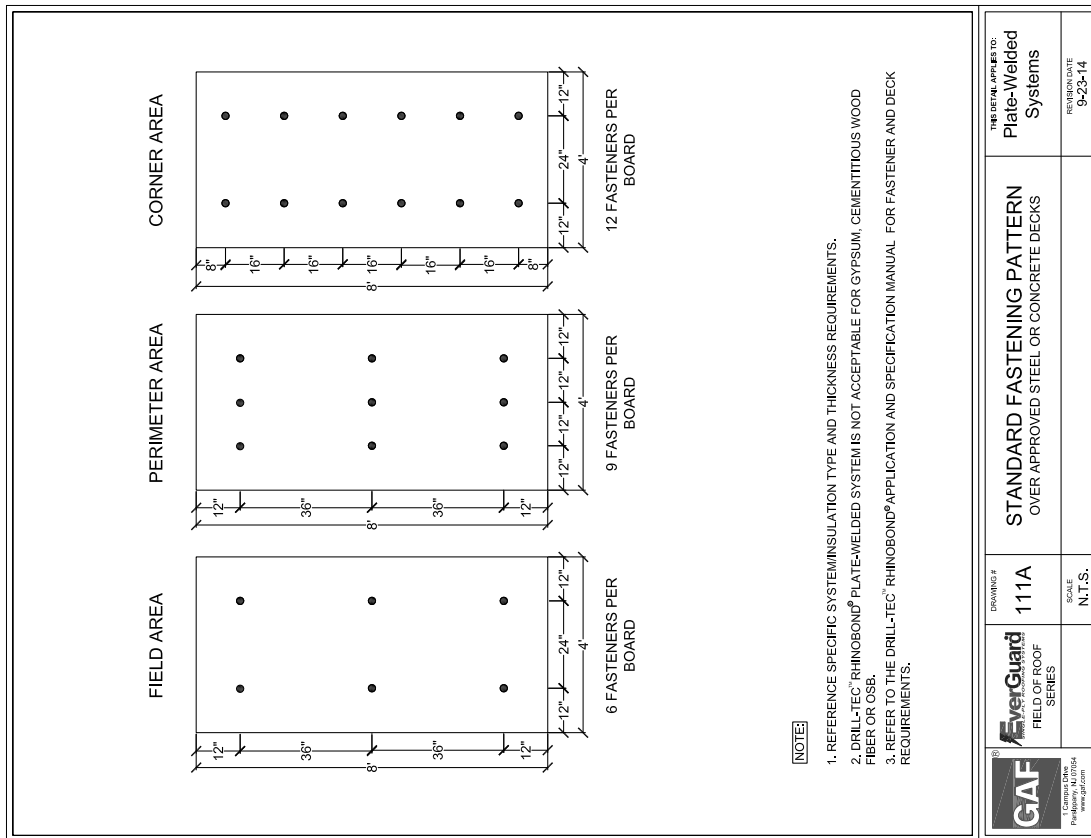
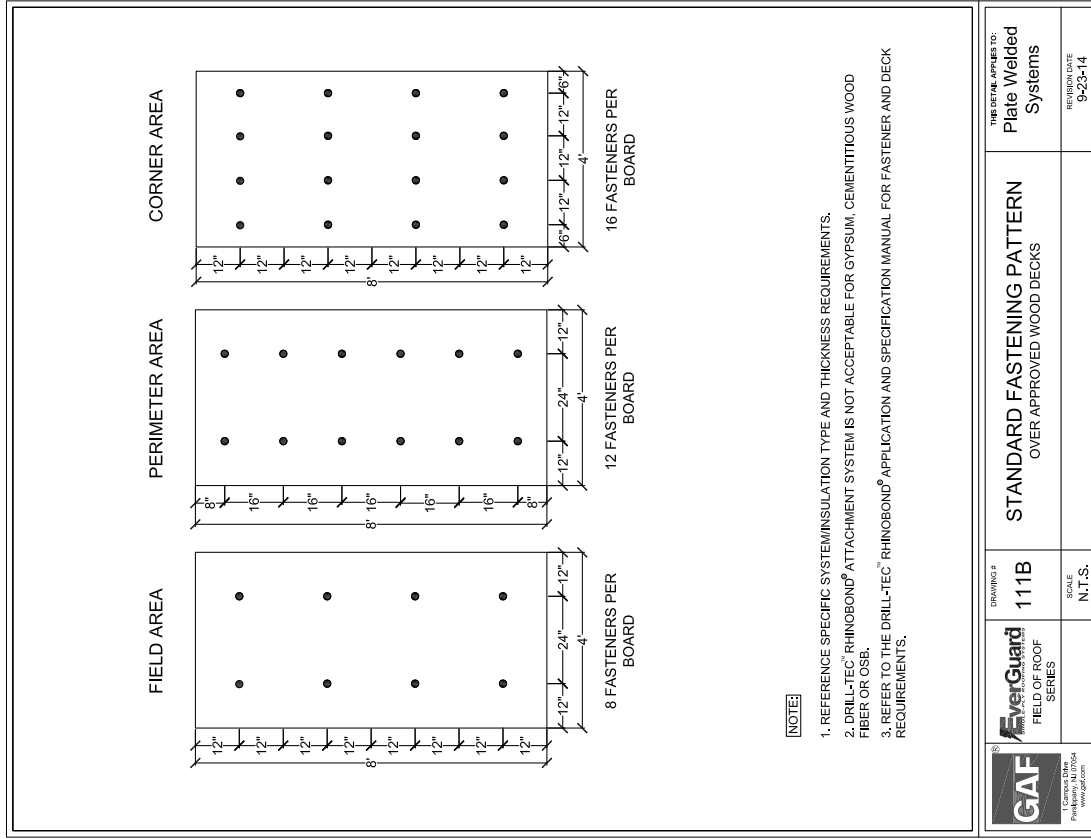


NOTE:

1. JOINTS OF ADDITIONAL LAYERS OF INSULATION SHOULD NOT ALIGN WITH PREVIOUS LAYER.
2. SEE INSULATION FASTENING PATTERN FOR SPECIFIC LOCATIONS.
3. DETAIL CAN BE USED AS AN ALTERNATE TO STANDARD EVERGUARD® INSULATION LAYOUT.

	 FIELD OF ROOF SERIES	DRAWING # 110A	THIS DETAIL APPLIES TO: Plate Welded Systems
		SCALE N.T.S.	REVISION DATE 4-01-14
INSULATION LAYOUT DETAIL SINGLE LAYER ONLY			

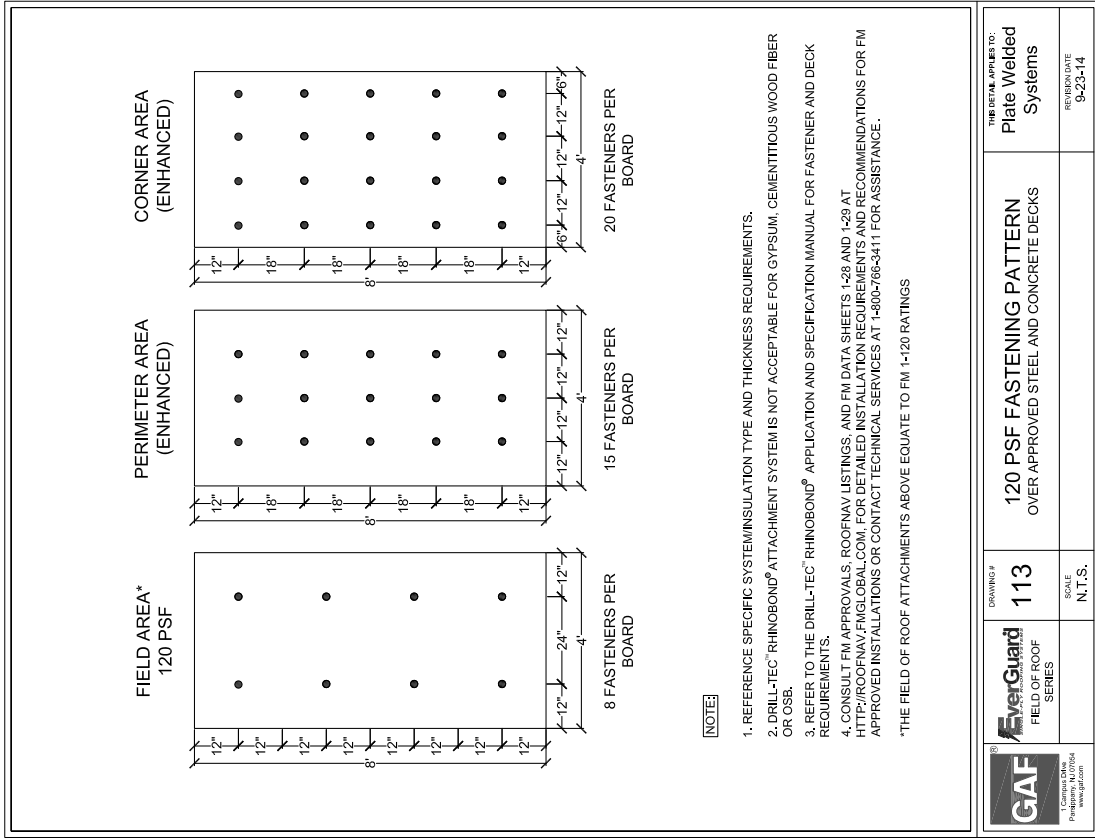
ROOFING DETAILS



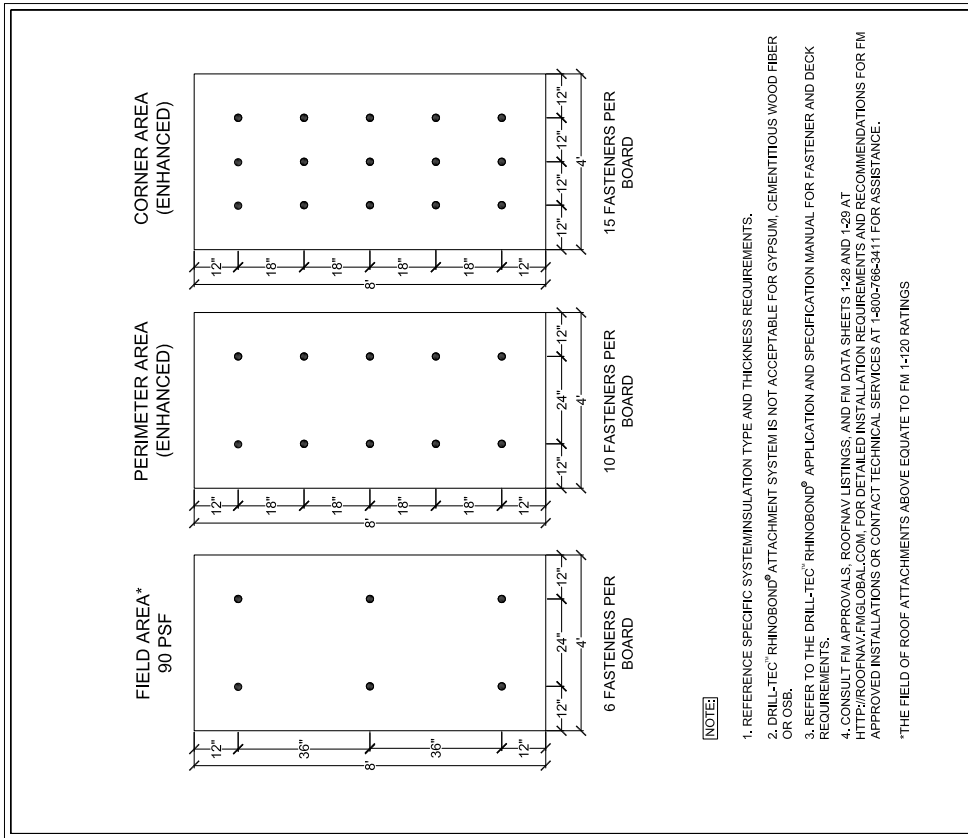
 GAF EverGuard FIELD OF ROOF SERIES Parkway, AL 37054 www.gaf.com	DRAWING # 111B	THE DETAIL APPLIES TO: Plate-Welded Systems
	SCALE N.T.S.	REVISION DATE 9-23-14

 GAF EverGuard FIELD OF ROOF SERIES Parkway, AL 37054 www.gaf.com	DRAWING # 111A	THE DETAIL APPLIES TO: Plate-Welded Systems
	SCALE N.T.S.	REVISION DATE 9-23-14

ROOFING DETAILS



 <small>GAF 1 Camino Drive Parsippany, NJ 07054 www.gaf.com</small>	 <small>EverGuard FIELD OF ROOF SERIES</small>	DRAWING # 113	THIS DETAIL APPLIES TO: Plate Welded Systems
	SCALE N.T.S.	120 PSF FASTENING PATTERN OVER APPROVED STEEL AND CONCRETE DECKS	REVISION DATE 9-23-14



 <small>GAF 1 Camino Drive Parsippany, NJ 07054 www.gaf.com</small>	 <small>EverGuard FIELD OF ROOF SERIES</small>	DRAWING # 112	THIS DETAIL APPLIES TO: Plate Welded Systems
	SCALE N.T.S.	90 PSF FASTENING PATTERN OVER APPROVED STEEL AND CONCRETE DECKS	REVISION DATE 9-23-14

ROOFING DETAILS

Labels in diagram:
 EVERGUARD® MEMBRANE OR ACCESSORY
 RHINO BOND® PLATES AND FASTENERS
 PIPE PENETRATION
 PENETRATION FLASHING REFERENCE EVERGUARD® 500 SERIES DETAIL

NOTE:
 1. BASE ATTACHMENT 12" O.C. AT CURB WITH RHINO BOND®
 2. DETAIL CAN BE USED AS AN ALTERNATIVE TO STANDARD EVERGUARD® CURB OR PENETRATION DETAIL.

	FIELD OF ROOF SERIES	DRAWING # 500	SCALE N.T.S.	THIS DETAIL APPLIES TO Plate Welded Systems
	ALTERNATE PIPE PENETRATION BASE ATTACHMENT		REVISION DATE 4-01-14	

Labels in diagram:
 EVERGUARD® MEMBRANE OR ACCESSORY
 RHINO BOND® FASTENERS AND PLATES
 CURB OR PENETRATION
 CURB OR PENETRATION FLASHING REFERENCE EVERGUARD® 300 OR 500 SERIES DETAIL

NOTE:
 1. BASE ATTACHMENT 12" O.C. AT CURB WITH RHINO BOND®
 2. DETAIL CAN BE USED AS AN ALTERNATIVE TO STANDARD EVERGUARD® CURB OR PENETRATION DETAIL.

	FIELD OF ROOF SERIES	DRAWING # 300	SCALE N.T.S.	THIS DETAIL APPLIES TO Plate Welded Systems
	ALTERNATE CURB BASE ATTACHMENT		REVISION DATE 4-01-14	



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