

Firestone

Firestone Building Products

UltraPly™ TPO InvisiWeld™ and
InvisiWeld-S Application Guide

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1.01 GENERAL

The following application guide provides the instructions for the installation of Firestone UltraPly TPO membranes, using Firestone's UltraPly TPO InvisiWeld and InvisiWeld-S system technology. Reference to the Thermoplastic Single-Ply Design Guide, Technical Information Sheets, RhinoBond® Tool Instruction manual (from OMG, Inc.), isoweld® 3000 tool (from SFS Intec, Inc.) and other sections of Firestone's Technical Specifications is necessary to ensure that the finished roof system is installed in compliance with Firestone requirements and, therefore, eligible to receive a Firestone Warranty.

The Firestone UltraPly TPO InvisiWeld roof system (using either Firestone UltraPly TPO InvisiWeld or InvisiWeld-S plates) refers to an alternate attachment method (other than fully adhered and mechanically attached) to affix Firestone's TPO membranes to various approved substrates. Following the installation of the approved roof insulation using approved Firestone fasteners and a special TPO coated InvisiWeld or InvisiWeld-S metal insulation plate, the membrane system is attached using a non-penetrating, induction welding technology, whereby the TPO membrane is welded to the plates using induction welding tools as provided by others. An example of these tools is shown in Figure 1a) RhinoBond Tool (from OMG, Inc) for welding InvisiWeld Plates, and Figure 1b) isoweld 3000 tool (from SFS Intec, Inc.) for welding of the Firestone UltraPly TPO membrane to the InvisiWeld-S plates. In doing so, the insulation plate acts as the point of attachment for both the membrane and the insulation.

NOTE: If a proposed application falls outside this specification, contact a Firestone Technical Services Advisor for additional information.

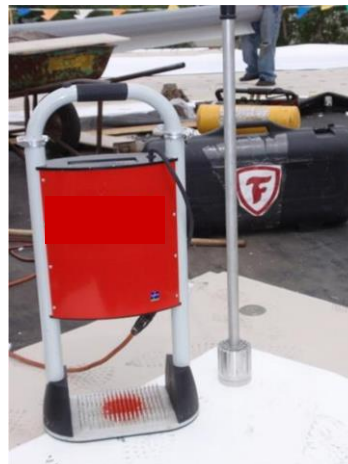


Figure 1a. RhinoBond Induction Welding Machine and Magnetic Cooling Clamp



Figure 1b. isoweld 3000 Induction Welding Machine (stand up and hand-held version) and Magnetic Cooling Clamps

1.02 JOB SITE CONSIDERATIONS (CAUTION AND WARNINGS)

- A. Safety
 - 1. Keep all adhesives, sealants and cleaning materials away from all ignition sources (i.e., flames, fire, sparks, etc.). Do not smoke while using these materials.
 - 2. Consult container labels, Material Safety Data Sheets and Technical Information Sheets for specific safety instructions for all products used on the project.
- B. Cautions
 - 1. Care must be used when installing fasteners to avoid possible conduits and other piping, both in and under the deck.
 - 2. Store Firestone UltraPly TPO membrane in the original undisturbed plastic wrap in a manner to protect it from damage.
 - 3. Do not use oil-based or bituminous-based roof cement, mastics or caulks in direct contact with Firestone UltraPly TPO membranes.
 - 4. Insulation must be properly stored and protected from ignition sources, moisture, and damage.
 - 5. Follow all Occupational Safety and Health Administration (OSHA), National Roofing Contractors Association (NRCA) and other industry recommendations for fire and fall protection.

1.03 ROOF SUBSTRATE PREPARATION

- A. Correct Substrate Defects
 - 1. Defects in the substrate that require corrective action before work can commence should be brought to the attention of the General Contractor or Owner in writing and addressed by them.
 - 2. For re-roofing applications, remove existing roof system components as specified by the project designer and documents. Components or conditions that are discovered during installation that could be detrimental to the performance of the new roof system should be brought to the attention of the project designer for corrective action.
 - 3. Good roofing practice requires a complete removal of the existing roof to the structural deck if soundness and integrity of the existing roof system cannot be verified. Recovering an existing roof system with a new roof is an alternative to removing existing roof components. Nondestructive testing, however, in conjunction with examination of core cuts, must be performed to determine the condition of the existing roof system and decking.
 - 4. The building owner or project designer is responsible for assuring that all wet or damaged insulation and/or substrates are removed and replaced in re-roofing applications. A reliable diagnostic technique is taking and evaluating a series of roof core cuts. There are three other techniques available to make this determination by indirect means: nuclear moisture detection, infrared thermography, and electric capacitance. These techniques provide measurement of factors that can be associated with the presence of moisture, which can then be correlated to the roofing cuts to verify the results of the nondestructive testing.
- B. Rooftop Moisture
 - Ponding water, snow, frost, dew, and ice must be removed from the substrates/work surfaces before installing the UltraPly TPO InvisiWeld system.
- C. Prepare Surfaces
 - Acceptable substrates to receive the UltraPly TPO InvisiWeld system must be properly prepared before membrane installation. The surface(s) must be relatively even, clean, dry, smooth, and free of sharp edges, fins, loose or foreign materials, oil, grease, and other materials that may damage the membrane. Rough surfaces that could damage the membrane must be overlaid with acceptable insulation.
- D. Fill Voids
 - All surface voids of the immediate substrate to receive UltraPly TPO InvisiWeld system greater than ¼" (6 mm) wide must be filled with insulation or other approved filler.
- E. Vapor Retarder
 - Install vapor retarder as specified by the project designer.

1.04 WOOD NAILER LOCATION AND INSTALLATION

Wood nailers shall be installed as specified by the project designer or as noted in Firestone details and the system design guide. Install wood nailers as follows:

- A. **Chemical Treated Wood Nailers**
Chemical treating for fire resistance or other purposes (other than pressure treating for rot resistance, i.e. CCA, ACZA, CBA, ACQ or other copper treatments) may affect the performance of the Firestone membrane and accessories. Submit MSDS sheets with active ingredients listed for any chemically treated lumber not listed that will contact the membrane. Contact your Firestone Technical Services Advisor to evaluate compatibility.
- B. **Position Wood Nailer**
Total wood nailer height must match the total thickness of roof insulation installed, with a 1/8" (3 mm) gap between each nailer length and at each nailer intersection.
- C. **Secure Wood Nailer**
Wood nailers shall be firmly fastened to the deck or building. Mechanically fasten wood nailers to resist a minimum 200 lb (890 N) force in any direction typically 12" (305 mm) on center. Refer to attachment requirements as specified by the project designer.
- D. **Taper Wood Nailer**
The wood nailer shall be tapered (as required) so the top surface of the wood nailer abutting the insulation matches the height of the insulation.
- E. **Size of Wood Nailer**
All wood nailers shall extend into the field of the roof a minimum of 1/2" (13 mm) beyond any metal edged detail.
- F. **Wood Nailer by Others**
Make these specifications and details available when others will install nailers. Work that compromises the integrity of the system may jeopardize the warranty.
NOTE: Because of recent EPA regulations regarding treated wood, new treatments for lumber may be highly corrosive to fasteners. Contact the fastener manufacturer for recommendations on fasteners if attaching nailers that have been treated with corrosive materials.

1.05 INSULATION ATTACHMENT

- A. **Compatibility for Metal Decks**
Minimum 1 1/2" insulation thickness is required over metal decks to ensure proper operation of induction welding equipment.
- B. **Install Insulation**
Install only as much Firestone insulation as can be covered with roofing membrane and completed/made watertight before the end of the day's work and before the onset of inclement weather.
- C. **Fit Insulation**
Neatly fit insulation at all penetrations, projections, and nailers. Insulation should fit loosely; filling any gaps greater than 1/4" (6 mm) with acceptable insulation or filler. Edges of insulation boards running parallel with the deck should be fully supported by the deck's top flange. Under no circumstance should the membrane be left unsupported over a space greater than 1/4" (6 mm). Tapered insulation with acceptable facer for bonding must be installed around roof drains to provide proper slope for drainage as shown in Firestone details.
- D. **Stagger Insulation Joints**
When installing multiple layers of insulation, all joints should be staggered. Staggering of insulation joints is not required to receive a Firestone warranty.

1.06 MECHANICAL ATTACHMENT OF INSULATION

A. Insulation Installation

The insulation shall be attached to decking before installation of UltraPly TPO InvisiWeld Membrane System. This can be accomplished by the mechanical attachment of the insulation using an approved Firestone fastener and the InvisiWeld insulation attachment plate (as shown in Detail UT-IW-1A and UT-IW-1B). Refer to Firestone's Technical Information Sheet #1111 for product data and application data on the InvisiWeld and InvisiWeld-S plate. The fastener type and density are dependent on the deck type, wind uplift design requirements and the manufacturer's recommendations.

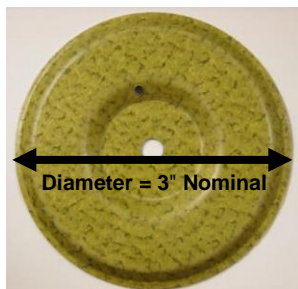


Figure 2a.
Firestone UltraPly TPO
InvisiWeld Plate



Figure 2b.
Firestone UltraPly TPO
InvisiWeld-S Plate

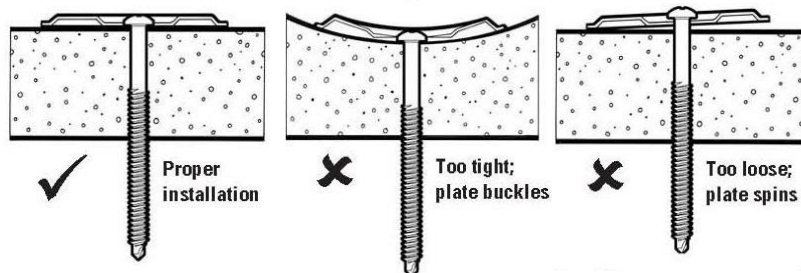


Figure 3. Proper Installation of Plate

B. Caution

Special care should be taken when fastening plates, so as not to overdrive or under-drive the fasteners into the structural deck (as illustrated in Figure 3). 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.

C. Mechanical Attachment

1. Attach Firestone approved insulation using Firestone InvisiWeld or InvisiWeld-S Insulation plates and Firestone approved fasteners as follows:
 - a) Refer to InvisiWeld Insulation attachment patterns, as shown in Detail # UT-IW-7 for the specific attachment pattern and fastening rates. Refer also to specific code requirement for project fastening requirements.
 - b) Refer to Technical Information Sheet of fastener selected for attachment to determine deck penetration requirements as shown in the cross section on Detail UT-IW-2.
 - c) When installing a multilayer insulation assembly, the fastening pattern is determined by the type and thickness of the top layer of insulation.

C. Mechanical Attachment Continued

- d) Ensure that the fasteners are fully seated, but not overdriven. Overdriven fasteners will “cup” insulation plates, reducing their effectiveness.
- e) Multiple layers of insulation may be installed using a common fastener. Fasteners should be sized to accommodate the total thickness of insulation plus any required substrate penetration.

NOTE: For easier plate identification beneath the TPO membrane when attaching insulation or cover board, follow a linear or grid pattern as shown in Detail UT-IW-7 or the Attachment Guide for the specified InvisiWeld fastening pattern. Additionally, fastening in a linear or grid pattern allows for easier induction weld inspection and quality control.

1.07 FACTORY MUTUAL (FM) REQUIREMENTS FOR INVISIWELD INSULATION ATTACHMENT

- A. For specific reference to the FM requirements for the InvisiWeld system, refer to FM Global Property Loss Prevention Data Sheets 1-29, Section 2.2.10.1 for the prescriptive enhanced fastening rates for corner and perimeter areas, as required for the FM insured building.
- B. Generally, for a point attached system, increased fastening density is obtained by decreasing the spacing between fastener points in one or both directions. Ensure that the total tributary area to each fastener is no more than 60% and 40% in the perimeter and corners, respectively, of the FM Approved roof field spacing.
- C. Table 1 below illustrates the InvisiWeld and InvisiWeld-S plate and fastener densities required to meet typical FM requirements for the field, perimeter and corner fastening of the roof system. Layouts for the fastening patterns are shown in Detail UT-IW-7 or in the Attachment Guide.

Table 1.07-1

FIRESTONE INVISIWELD SYSTEM INSULATION BOARD ATTACHMENT FM RATING

FM Global	Field	Perimeter	Corner	Assembly	RoofNav #
1-90	6	10	15	Field Rates based on listed tested assembly. Rates for specific assemblies should be validated.	250651-0-0
1-120	8	14	20		254071-0-0
1-150	12	20	30		253954-0-0

Note:

1. Validate all attachment rates against tested assemblies.
2. Rates above are based on contributory area rates.
3. 0.045" (1.14 mm) thick TPO approved for 15 year InvisiWeld system warranties.
4. 0.060" (1.52 mm) thick or greater required for 20 year or greater InvisiWeld system warranties.
5. 0.060" (1.52 mm) thick or greater required for any increased wind speed warranties.
6. 0.080" (2.03 mm) thick UltraPly TPO required for 25 and 30 year InvisiWeld system warranties.
7. If RoofNav listing has linear rows listed instead of contributory area, decrease the spacing between rows by a minimum 60% for the perimeters and 40% for the corners.

1.08 USE OF AIR OR VAPOR BARRIER WITH INVISIWELD SYSTEM

When an approved air or vapor barrier is used in conjunction with the Firestone UltraPly TPO InvisiWeld or InvisiWeld-S system, give special attention to the number of fasteners used in the system to secure the insulation. At a minimum, the fastener density for attaching insulation boards in systems with an air/vapor barrier is 1 per 4 ft² (1 per 0.4 m²), or 8 per 4' x 8' (1.2 m x 2.4 m) board. Since the wind load on the insulation board will be greater when an air/vapor barrier is used, the prescriptive perimeter and corner enhancements will follow those of fully adhered systems with the same number of fasteners per unit area but arranged in straight linear fashion (see Detail UT-IW-7 or the Attachment Guide).

Table 1.08-1

FIRESTONE MINIMUM FASTENING REQUIREMENTS for INVISIWELD SYSTEM with AIR/VAPOR BARRIER

Insulation Thickness	Attachment per 4' x 8' (1.2 m x 2.4 m) Insulation Board		
	Field	Perimeter	Corner
0.5" to 1.4" (13 to 36 mm)	16	16	16
1.5" to 1.9" (38 to 48 mm)	12	12	12
2" or greater (51 mm or greater)	8	8	8

NOTE: Minimum Fastening Requirements for field, perimeter, and corner areas using the prescriptive enhancements for insulation attachment – InvisiWeld System with air/vapor barrier (Refer to Firestone’s TPO Single Ply Design Guide – Table 1.08-6 or FM Approvals LPDS 1-29 Section 2.2.2.2)

1.09 ULTRAPLY TPO MEMBRANE ATTACHMENT

- A. Beginning at low point of roof, place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing. In colder weather allow for longer relax time.
- B. Lay out the membrane panels so that the field and flashing splices are positioned to shed water. Seam overlaps may be placed over InvisiWeld or InvisiWeld-S plate. Welding of the plate will not be affected. However, seaming of the involved area may be affected due to the robotic welder tracking over the plate.
- C. Install membrane without wrinkles and without gaps or fish-mouths in seams; complete splices and test all seams in accordance with published specifications and details.
- D. Welding equipment shall be provided by others but approved for use by Firestone Building Products for use with UltraPly TPO membrane. For information beyond the scope of this document, contact a Firestone Technical Services Advisor or local Field Technical Representative. We encourage roofing contractors intending to use the equipment to successfully complete a training course provided by Firestone Building Products prior to plate welding.
- E. Perform the tool calibration with the induction welding tool.
 1. **For OMG RhinoBond Tool:** make test welds with the UltraPly TPO membrane and InvisiWeld plate. Weld some spare membrane to the plates at various energy settings of the induction welder. Perform a peel test at the different energy settings. Then set the device at the lowest setting that creates a bond that covers 100% of the bonding area of the InvisiWeld plate.
 2. **For SFS Intec, isoweld 3000 Tool:** Perform the automatic calibration using the calibration template, a spare piece of the field TPO membrane, and an InvisiWeld-S plate. Ensure that the project parameters are set correctly, i.e. roof membrane thickness and type. With the thermal probe in place over the field membrane under the temperature conditions to be calibrated, follow the calibration function instructions in the tool’s operating manual. Move the tool setting to “Calibration”, with the welding inductor over the membrane piece, the InvisiWeld-S plate and calibration template, press “Start”. Once a beeping sound is heard, the tool has been calibrated.
 3. **NOTE:** Both tools require calibration:
 - Every morning before starting work.
 - When moving to another building site
 - When working with a different thickness material
 - Change from 110V to 230V, or vice versa
 - Change of electrical source.
- F. All membrane to be welded shall be clean and dry.

- G. Follow induction tool manufacturer's printed guidelines. Activate the weld between the UltraPly TPO membrane and InvisiWeld plate using the electromagnetic induction device as supplied by others. The induction coil, demarked by a red circle on the OMG RhinoBond tool, or by the area within the calibration template on the SFS isoweld 3000 tool, must be positioned over the center of the InvisiWeld plate, $\pm 1"$ (25 mm). Cycle time will be affected by available power. Use at least a 12-gauge power cord, no more than 100' (30.5 m) in length.
 - 1. Making a TPO template of the base of the OMG RhinoBond Welder and cutting out a plate sized hole in the center is helpful to ensure accuracy of the welder placement.
 - 2. Place hole over plate and make two (2) pencil marks on perpendicular edges of the outer edge of the template to properly position base of welder.
- H. When the induction welding cycle is complete, immediately place a magnetic cooling clamp over the welded UltraPly TPO membrane and plate assembly. This will ensure that there is adequate compression of the membrane to the plate during cooling, affecting a proper weld. The magnetic cooling clamp device must be left in place for at least 60 seconds while the weld cools and sets.
- I. Repeat steps G and H for every InvisiWeld plate in the roofing assembly.
- J. The bottom of the induction welder and the magnetic clamps must be frequently wiped clean of debris to prevent scarring of the UltraPly TPO membrane.
- K. Continuous welding operations will cause the temperature of the magnetic clamps to rise. Should the temperature build up to the point that surface melting of the TPO membrane becomes visually evident, cool the magnetic clamps by dipping them into a pail of clean water as often as required to avoid damaging the membrane.
- L. Secure membrane at all locations where membrane terminates at a roof edge as indicated or as recommended by published Firestone specification. **InvisiWeld Plates may be used for base tie-in securement. Do not use InvisiWeld Plates for roof edge securement.**

1.10 MEMBRANE SEAMING

- A. General

The following information provides for typical set up and heat welding of Firestone UltraPly TPO membrane. For information beyond the scope of this document, we encourage installers to contact their Firestone Technical Advisor or local Firestone Field Technical Representative.
- B. Equipment and Test Splice Requirements
 - 1. The air intake, temperature and speed of the welder shall be adjusted to provide proper seam strength.
 - 2. An ample power source shall be provided for all heat welding equipment. A dedicated generator must be provided for each robotic welder. For specifics on welding equipment and generator, consult the welder manufacturer's data sheets.
 - 3. Adjust the welding equipment according to membrane thickness and varying weather conditions. It is recommended that this be completed using spare material before starting welding of the finished roofing material. In addition, destructive tests shall be completed at the beginning of each day of welding and every time there is an interruption in the welding process (i.e. power failure, welder shut down, change in job site conditions, after lunch, etc.) to verify adequate seam strength.
 - 4. Automatic Welder Settings

Firestone UltraPly TPO allows for successful welding through a wide range of automatic welder settings for temperature and momentum. Typical settings near the center of this welding range are as follows (ambient temperatures between 20 °F to 90 °F and -6.7 °C to 32.2 °C):

 - a) Leister Varimat - Temperature: 1000 °F (538 °C) Air Flow: 80%, Speed: 11.5' (3.5 m) min.
 - b) Leister Varimat V2 - Temperature: 1100 °F (593 °C) Air Flow: 70%, Speed: 12.5' (3.8 m) min.
 - c) Contact your local Firestone Technical Representative for additional information.

C. Clean the Lap Splice Area

If membrane has been exposed for more than 12 hours or become contaminated with dirt, debris or moisture, it must be cleaned. Wearing chemical resistant gloves and using a clean white cotton rag dampened with Firestone SW-100 Splice Wash, thoroughly clean the involved area on both sheets at least 6 inches (15.24 cm) wide prior to any welding activity. For aged membrane, or when additional cleaning is desired, a Firestone QuickScrubber Plus pad moistened with Splice Wash may be used to clean the weld area, followed by wiping with a clean white cotton rag dampened with Splice Wash. Allow cleaner to flash off completely, as residual cleaner can contaminate the membrane bond.

D. Hot Air Weld Lap Splices

1. Horizontal field welds should be completed first. Wherever possible, field splices on the horizontal surface (including flashing) are to be completed using an automatic heat welder that has been designed for hot air welding of thermoplastic membranes. For specifics on welding equipment and generator, consult the equipment manufacturer's data sheet.
2. Seams made with the automatic welder shall be a minimum of 1.5" (38 mm) wide. Seams made with hand welders shall be a minimum of 2" (50 mm) wide. Use silicone hand rollers to assure proper compression of the heated surfaces as hand welding proceeds.
3. On vertical surface welds, or where an automatic welder is not practical, hand welders shall be used.

E. T-Joint and Membrane Transition Patches

Install T-Joint patches at reinforced membrane seam intersections when membrane thicker than 0.045" (1.14 mm) is used. Membrane to receive T-joint cover shall have the edge chamfered by heating and rolling to minimize any step-down. Also install T-Joint patches wherever reinforced membrane seams extend through angle changes of 2:12 or greater. Refer to Lap Splice and T-Joint Detail Section of Firestone's Technical Manual.

D. Seam Inspection

Probe all completed welds with a dull cotter pin puller type tool to verify seam integrity, paying special attention to hand welded areas (i.e. corners, t-joints, angle changes, robot welder starts and stops, etc.). Do not probe welds until they have cooled. Any welds found to be insufficiently fused need to be repaired daily. Avoid damaging membrane when checking welds.

F. Cut Edge Sealant

All membrane lap edges with exposed scrim (cut edges) shall be sealed with Firestone UltraPly TPO Cut Edge Sealant or UltraPly TPO General Purpose Sealant.

1.11 ADDITIONAL MEMBRANE SECUREMENT AND BASE TIE-IN FLASHING

A. Provide membrane securement

Secure the membrane at all locations where the membrane undergoes an angle change greater than 1" in 12" (25 mm in 305 mm). This typically occurs at roof edges, curbs, wall intersections, parapets, etc. Firestone offers several options for base tie-in on InvisiWeld systems. Where InvisiWeld or InvisiWeld-S plates are used as a base tie-in, the InvisiWeld or InvisiWeld-S plate outside edge must be 1" (25 mm) away from the transition and spaced 12" (305 mm) o.c. Refer to Firestone UltraPly TPO Base Tie-In details and Technical Information Sheets for additional information. Note: QuickSeam RPF is not acceptable for 25 and 30 year warranties on TPO InvisiWeld installations.

1.12 FLASHING-PENETRATIONS

A. General

1. Remove all loose existing flashing (i.e., lead flashings, bituminous materials, mastics, etc.).
2. Flash all penetrations that pass through the UltraPly TPO membrane in accordance with Firestone standard TPO details as indicated in the Technical Information Manual.
3. The flashing seal must be made directly to the penetration.

B. Pipes, Round Supports, Structural Steel Tubing, etc.

1. Flash pipes with Firestone UltraPly TPO Pre-molded Pipe Flashing wherever possible. Do not split TPO pre-molded pipe flashings to assist in their installation.
2. Refer to the Firestone Technical Information Sheet for minimum and maximum pipe diameters

that can be successfully flashed with Firestone UltraPly TPO Pre-Molded Pipe Flashings.

3. Firestone manufacturers custom pipe flashings in round, square and conical shape, with or without a split. Contact your Firestone Sales Representative for additional information.
- C. Roof Drains (cast iron only)
1. Remove all existing flashing (including lead flashing), roofing materials and cement from the existing drain in preparation for UltraPly TPO membrane and Firestone Water Block Seal.
 2. Provide a clean, even finish on the mating surfaces between the clamping ring and the drain bowl.
 3. Install tapered insulation with acceptable bonding surfaces around the drain to provide a smooth transition from the roof surface to the drain. Slope into drain shall not exceed 1" in 12" (25 mm in 305 mm).
 4. Position the UltraPly TPO membrane, then cut a hole for the roof drain to allow a ½" (13 mm) minimum and ¾" (19 mm) maximum overhang inside the clamping ring.
 5. Using a punch or other suitable device, make round holes (sized to receive clamping bolts) in the membrane to align with clamping bolts. Do not cut the membrane back to the bolt holes.
 6. Install Firestone Water Block Seal on the clamping ring seat flange below the membrane. Use a minimum of one half of a 10-ounce (295 CC) tube for a 10" (250 mm) drain.
 7. Install the roof drain clamping ring and clamping bolts. Tighten the clamping bolts to achieve constant compression of the Water Block Seal.
 8. Firestone Insert Drains are an option for installation when existing drains are not suited for reuse or for re-roofing situations where existing drain sumps exceed Firestone minimum requirements.
- D. Pipe Clusters and Unusual Shaped Penetrations
1. Fabricate Firestone UltraPly TPO Coated metal penetration pockets to allow a minimum clearance of 1" (25 mm) between the penetrations and all sides of the pocket.
 2. Secure Firestone QuickSeam or weldable penetration pockets, and flash per current Firestone details.
 3. Fill penetration pockets with Firestone Pourable Sealer to shed water from penetrations. Firestone Pourable Sealer shall be poured to a depth of 2" (50 mm) minimum.
 4. Firestone UltraPly TPO unsupported flashing may also be used for some details.
- E. Hot Pipes
1. Protect UltraPly TPO components from direct contact with steam or heat sources that exceed the in-service temperature of 160 °F (71 °C).
 2. Roof penetrations exceeding 160 °F (71 °C) shall be flashed to an intermediate, or separator sleeve per Firestone details to protect UltraPly TPO components from direct heat sources.
- F. Flexible Penetrations
- Flexible roof penetrations shall be flashed by means of a watertight gooseneck set in Water Block Seal, secured to the deck and flashed in accordance with Firestone Details.
- G. Scuppers
1. Remove any existing scuppers and install a new scupper sleeve fabricated from Firestone UltraPly TPO coated metal, or customized prefabricated scupper.
 2. Secure new scupper to the structure.
 3. Flash new scupper in accordance with Firestone Details.
- H. Expansion Joints
1. Install expansion joints in accordance with Firestone details where specified by project designer.
 2. Flash expansion joints in accordance with Firestone details.

1.13 FLASHING: WALLS, PARAPETS, MECHANICAL EQUIPMENT CURBS, ETC.

A. General

Using the largest piece(s) of continuous Firestone UltraPly TPO membrane, UltraPly TPO Flex Adhered, TPO Custom Curb Flashing or 18" TPO Curb Flashing practical, flash all walls, parapets,

curbs, etc., to the height of 8" (203 mm) minimum or as specified by the project designer.

- B. Evaluate bonding substrate. Add acceptable bonding substrate as required.
The following substrates require the installation of $\frac{5}{8}$ " (16 mm) exterior grade or "Wolmanized" plywood, anchored in accordance with project designer's requirements: interior gypsum board, stucco, cobblestone, textured masonry, exterior gypsum panels, corrugated metal panels, and all other uneven or loose substrates.
- C. Install additional membrane securement as described in section 1.11 of this guide.
- D. Provide membrane termination in accordance with Firestone specifications and details.
- E. Provide intermediate flashing attachment at 36" (914 mm) intervals in accordance with Firestone details unless:
 - 1. The wall surface is smooth, without noticeable high spots or depressions (i.e. plywood, poured or precast concrete, hollow core block or masonry walls where joints are flush with masonry surface).
 - 2. The termination is either a Termination Bar or the flashing membrane extends beneath a metal coping and over the outside edge of the wall. flashing in accordance with Firestone details.

1.14 FLASHING: GRAVEL STOPS OR ROOF EDGE METALS

- A. Use Firestone prefabricated Coping, AnchorGard, EdgeGard or other product as indicated and installed in accordance with Firestone details.
- B. Use Firestone UltraPly TPO Coated Metal per Firestone details.
- C. Use other metals formed as needed for edge condition and flash according to Firestone specifications and details using TPO or EcoWhite QuickSeam Flashing. Maximum warranty length for QuickSeam edge flashing details is 20 years. Refer to the Firestone TPO Application Guide for additional installation information.
- D. Use Firestone Drain Bar.

1.15 MEMBRANE REPAIR

- A. Repair punctures/cuts/damage to UltraPly TPO membrane with like materials.
The repair material shall be heat welded UltraPly TPO membrane with 2" (50.8 mm) minimum extended past the damaged area in all directions. Round all corners of the repair piece. For example: a pinhole will require a minimum 4" x 4" (102 mm x 102 mm) patch.
- B. Inspect the plates.
At each InvisiWeld or InvisiWeld-S bonded plate location, the condition of the plate bonded or attached membrane should be inspected for membrane abrasion at the plate peripheral edges, and for any debris, or holes in the membrane over the plate. If any abrasion or membrane damage is found, the entire area must be patched with a minimum 4" x 4" (102 mm x 102 mm) patch that covers the plate area completely. An UltraPly TPO T-joint cover may also be used to repair a pinhole over InvisiWeld plate.



NOTE: For inspection purposes, Firestone recommends the use of a bathroom plunger to inspect the individual InvisiWeld or InvisiWeld-S plate welds. By applying the rubber end of a plunger to the membrane adjacent to the welded InvisiWeld plate and pulling upwards, the condition of the weld can be assessed. This is an effective method to ensure that no InvisiWeld or InvisiWeld-S plate welds were missed during installation.

- C. Clean the membrane
When repairing "in-service" Firestone UltraPly TPO Membrane it is necessary to remove accumulated field dirt. The membrane is properly prepared by scrubbing with a scrub brush and warm soapy water, rinsing with clear water, drying with clean cloths, then wiping with a clean cotton cloth dipped in Firestone SW-100 Splice Wash.
- D. Install repair per membrane hot air welding procedures.
- E. Multiple Repairs
If the membrane is damaged in more than six (6) locations in a 100 ft² area, new membrane extending 6" (152.4 mm) beyond the border of the damaged area must be installed over existing membrane in accordance with published Firestone specifications. Secure the replacement membrane in the same

manner as the existing membrane. Contact your Firestone Field Technical Representative with questions on how to address comprehensive damage.

1.16 TEMPORARY CLOSURE

- A. Temporary closures to ensure that moisture does not damage any completed section of the new roofing system are the responsibility of the roofing contractor and not covered under any Firestone warranty.
- B. Flashings, terminations, and temporary closures should be completed as required to provide a watertight condition at the end of each workday.
- C. Any material contaminated by temporary closure shall be removed and discarded before resumption of installation.

1.17 ROOF WALKWAYS

- A. Install Firestone approved walkway material in locations as required by Firestone specifications and as specified by the project designer in accordance with Firestone requirements.

1.18 SHEET METAL WORK

- A. For specific installation instructions for Firestone prefabricated metal edge treatments: Firestone Coping, AnchorGard, EdgeGard or UltraPly TPO Coated Metal, refer to the respective Technical Information Sheets.
- B. For all other sheet metal work not supplied by Firestone, refer to fabrication and installation requirements established by the project designer.

1.19 CLEAN UP

If required by the specifier to ensure the aesthetics of the Firestone UltraPly membrane, (i.e., hand prints, footprints, general traffic grime, industrial pollutants and environmental dirt), the membrane may be cleaned by scrubbing with non-abrasive soapy water and rinsing the area completely with clean water. Firestone SW-100 Splice Wash can be used sparingly to clean small areas of membrane.

1.20 FIRESTONE ULTRAPLY TPO INVISIWELD SYSTEM – METAL BUILDING RECOVER

- A. Prepare Substrate
 - 1. A dry, clean and smooth substrate shall be prepared to receive the Firestone UltraPly TPO InvisiWeld system.
 - 2. The applicator shall inspect the substrate for defects, such as excessive surface roughness, contamination, structural inadequacy, or any other condition that may adversely affect the quality of work.
 - 3. The substrate shall be clean, smooth, dry, and free of flaws, sharp edges, loose and foreign material, oil and grease. Roofing shall not start until all defects have been corrected.
 - 4. All roof surfaces shall be free of water, ice and snow.
 - 5. Compressible fill material or spray, expanding urethane foam shall be used to minimize air infiltration under wood nailers for corrugated metal roof panels.
 - 6. The Firestone UltraPly TPO InvisiWeld system shall be applied over compatible or acceptable substrates only.
- B. Install Insulation
 - 1. Approved Insulation fill material, with a minimum compressive strength of 20 psi (140 kPa) must be inserted in the existing metal standing seam roof panel to provide a level substrate for installation of the approved cover board or insulation boards, as shown in Detail UT-IW-2. The fill layer must be cut to fit inside the metal panel seam and secured in place to fit flush with the top of the standing seam.

NOTE: For Factory Mutual insured buildings, polystyrene insulation may not be applied directly to steel deck.

- 2. Insulation shall be installed according to insulation manufacturer's instructions.

3. Top layer of insulation shall be the membrane underlayment or substrate, cover board or any other approved Firestone insulation product. Edges shall be butted together with no gaps greater than ¼" (6 mm).
4. Insulation shall be neatly cut to fit around penetrations and projections with gaps not exceeding ¼" (6 mm).
5. Install tapered insulation around drains as necessary to promote positive drainage.
6. Do not install more insulation board than can be covered with Firestone TPO membrane by the end of each work day or before the onset of inclement weather.
7. Use at least 2 layers of insulation when the total insulation thickness for the overlayment (not including flute fill layer) exceeds 2.5" (64 mm). Stagger joints at least 12" (305 mm) between layers.

C. Attach Insulation

1. Insulation shall be mechanically fastened to purlins with Firestone Purlin fasteners or to the structural deck with approved Firestone fasteners and InvisiWeld or InvisiWeld-S plates.
2. Attachment rate shall be according to Firestone Building Products and FM (if insured by FM) recommendations for fastening rates and patterns for the InvisiWeld system into metal purlins, but not less than 1 fastener per 6.4 ft² (0.6 m²) or 5 fasteners per 4' x 8' (1.2 m x 2.4 m) board. Refer to the Firestone Attachment Guide for additional information.
3. The quantity and locations of the fasteners and plates shall also cause the insulation boards to rest evenly on the roof deck/substrate. Each insulation board shall be installed tightly against the adjacent boards on all sides.
4. Along with the purlin attached InvisiWeld Plates, use standard Firestone AP or HD fasteners and Firestone 3" Insulation plates to ensure each 4' x 8' (1.2 m x 2.4 m) board of insulation has at least 5 fasteners and plates, one in each corner and one at the board mid center point.
5. Install fasteners in accordance with Firestone specifications, with a minimum penetration of 1" (25 mm) through the structural deck.
3. Firestone suggests fastening tools with a depth locator and torque-limiting attachment to assist in proper securement.

D. Attachment to Purlins

1. Fasten the insulation so the InvisiWeld or InvisiWeld-S plate and Firestone Purlin fastener will be centered over the structural purlin at a density according to Firestone's and the wind design requirements. Fasteners must be tight enough that the InvisiWeld or InvisiWeld-S plate does not turn, but not so tight as to deform the InvisiWeld plate.



NOTE: The minimum fastening requirement for the InvisiWeld metal roof recover system is at a purlin spacing of 10' (3 m) at a fastener spacing of 12" o.c. (305 mm) in the field of the roof. The minimum fastening for the perimeter and corner areas is at a purlin spacing of 5' (1.5 m) at a fastener spacing of 6" o.c. (150 mm).

2. Perimeter and Corner Areas

- a) Perimeter and corner area are determined by building height, width and other conditions according to ASCE 7 guidelines, Firestone's Technical or FM LPDS 1-29 (if insured by Factory Mutual).
- b) To meet the perimeter and corner uplift requirements, increase the fastening density by decreasing the spacing between fasteners along each fastener row in the perimeter and corner areas. Firestone Purlin fastener spacing shall be a maximum of 60 percent of the field spacing for the perimeter and 40 percent of the field spacing for the corner, but never closer than 3" (76 mm).
- c) See Detail UT-IW-4 for more details.

NOTE: Perimeter area is defined as the outer boundary of the roof. If the roof is broken into different levels, each roof area shall be treated as an individual roof with its outer boundary considered a perimeter. The ridge is defined as the high point of the roof area formed by two intersecting planes. Each side of the ridge is considered a perimeter area. Typically, internal expansion joints and firewalls are not considered to be full perimeters. Refer to Factory Mutuals Data Sheet 1-28 for more information.

E. Membrane Securement

1. Fastener pullout tests shall be conducted on the metal roofing deck with approved fasteners by the manufacturer of the fasteners, or the specifier/designer for the project. A minimum of 15 pullouts for up to 50,000 ft² (4,650 m²) of which 8 are to be in perimeter and corner zones; and, seven additional pullouts for each additional 50,000 ft² (4,650 m²) or portion thereof.
2. Fasten the insulation so that the InvisiWeld or InvisiWeld-S plate and Firestone purlin fastener (depending on pullout value) are installed directly into the purlin through the insulation according to Firestone's specifications and any other wind design requirements. Fasteners must be tight enough that the InvisiWeld plate does not turn, but not so tight as to deform the plate.
3. InvisiWeld re-cover system over metal roof – typical ridge detail – See Detail UT-IW-5.
4. InvisiWeld re-cover system over metal roof – typical eave detail – See Detail UT-IW-6
5. For additional wind requirement information for the InvisiWeld Roofing System over a metal building, please direct all questions to a Firestone Technical Services Advisor.

1.21 WARRANTY COVERAGE

A. Acceptable Fasteners

The following fasteners are acceptable for use and eligible for warranty with the Firestone UltraPly TPO InvisiWeld and InvisiWeld-S system:

- All Purpose Fasteners (max 20-year, new construction)
- Heavy Duty Fasteners
- Heavy Duty Plus Fasteners
- Purlin Fasteners

B. Acceptable Roof Deck Types

The following roof deck types are acceptable for use and eligible for warranty with the Firestone UltraPly TPO InvisiWeld System:

- Steel Decks
- Wood Decks
- Structural Concrete Decks

C. Acceptable Roof Insulation / Cover Boards

The following roof insulation types are acceptable for use as substrates and eligible for warranty with the Firestone UltraPly TPO InvisiWeld System:

- Firestone Polyisocyanurate insulation (ISO 95+™ GL / ISOGARD GL, RESISTA™ / ISOGARD CG)
- Firestone ISOGARD HD Cover Board
- Structodek® HD Fiberboard
- DensDeck® / DensDeck Prime
- Securock®
- DexCell®



NOTE: Induction welding should not be used to attach membrane (with plate and induction welding tool) directly over extruded polystyrene (XPS), expanded polystyrene (EPS) or foil faced insulation boards.

1.22 AVAILABLE ROOF WARRANTIES

- A. The following table shows the roof warranties, warranty duration, and system components available for the Firestone UltraPly TPO InvisiWeld system for new construction or re-cover applications.
- B. For additional warranty information on the application of the Firestone UltraPly TPO InvisiWeld system, please contact your Firestone Technical Services Advisor.

Table 1.22-1

FIRESTONE ULTRAPLY TPO INVISIWELD and INVISIWELD-S SYSTEM MINIMUM ATTACHMENT REQUIREMENTS FOR WARRANTY

RED SHIELD™ WARRANTY	FIRESTONE FASTENER	Membrane / Insulation Attachment per 4' x 8' (1.2 m x 2.4 m) board			Additional Insulation Attachment When Vapor Barrier is Used		
		F	P	C	F	P	C
5-20 Year, New Construction	All-Purpose (AP)	6	10	12	See Table 1.08-1 Varies by Insulation Top Layer Thickness		
15+ Years, Re-cover	Heavy Duty (HD)	6	10	12			
20+ Years, (See NOTE #2)	Heavy Duty (HD)	6	10	12			
72 mph Wind Speed Coverage	Heavy Duty (HD)	6	10	15			
80 mph Wind Speed Coverage	Heavy Duty (HD)	8	12	16			
90-100 mph Wind Speed Coverage	Heavy Duty (HD)	8	14	20			
110-120 mph Wind Speed Coverage	Heavy Duty (HD)	12	20	30			
For all Wind Speed Warranties above 80 mph, contact your Firestone Technical Services Advisor at 1-800-428-4511							
FM Global		F	P	C	F	P	C
FM 1-90	Heavy Duty (HD)	6	10	15	Contact your Firestone Technical Services Advisor		
FM 1-120	Heavy Duty (HD)	8	14	20			
FM 1-150	Heavy Duty (HD)	12	20	30			
Metal Building Re-cover		F	P	C	F	P	C
10, 15, or 20 Years	Membrane Attachment– Purlin Fastener spacing	12" o.c. (305 mm)	6" o.c. (152 mm)	6" o.c. (152 mm)	N/A		
	Insulation Attachment– Heavy Duty (HD)	5	5	5	Contact your Firestone Technical Services Advisor		
NOTE: For Metal Building Recover, membrane must be attached to InvisiWeld plates that are installed directly into purlins with Firestone purlin fasteners, in rows a maximum of 10' o.c. in the field and 5' o.c. for perimeter and corners.							
NOTE:							
1. Fastening rates for perimeter and corner are based on contributory area.							
2. 45 or 60 mil membrane acceptable for 20-year InvisiWeld warranty. For 25 or 30-year InvisiWeld warranties or increased wind speeds, 80 mil membrane is required.							
3. F=Field; P=Perimeter; C-Corner							
4. Cover board selection may alter these attachment rates. Consult your Technical Services Advisor.							

END OF SECTION