

# TPO WELDING GUIDE

## Membrane Fullness

When dealing with installation of membrane with fullness, tighten the sheet between fasteners as follows:

1. Unroll sheets and position.
2. Place a fastener and plate in one end of the sheet on the appropriate fastener mark. Go to the opposite end of the sheet, pull it tight and place a fastener and plate at the appropriate mark. Place the remaining fasteners into the sheet.
3. Proceed to weld the sheet in place and continue across the roof.

## Windy Conditions

Outlined below is a method to prevent membrane distortion during windy conditions:

1. Unroll sheet approximately 5 feet (1.5 m) and position edge of membrane with overlap line on adjacent sheet.
2. Install fasteners along the 5 foot exposed edge.
3. While the 5 feet of exposed membrane is being fastened, begin welding the overlapped edge using the Automatic Hot Air Welder.
4. As sheet is being welded and fastened concurrently, unroll membrane. Unroll only enough membrane to stay a few feet ahead of the welding and fastening process. This reduces the amount of unsecured membrane to be distorted by the wind.
5. Continue this process for each adjoining sheet.

## Membrane Creeping or Moving

What to do when the membrane is creeping or moving causing wrinkles throughout the membrane surface:

1. The operator of the robot must apply foot pressure to the membrane, kicking and sliding the membrane under the robot to keep the membrane tight.

Always have the operator stand on the unfastened sheet of membrane to prevent sheet movement.

Do not release foot pressure from the membrane until the pressure wheel rolls over the membrane in front of the foot that is holding the membrane in place.

## 2. Use of welding tracks:

Set lengthways along the splice, close to the robot air dam wheels to reduce the effect of the membrane movement caused by the robot welding process.

The operator must continue to apply foot pressure to the welding tracks to help hold the membrane splice in place.

Welding tracks are moved as welder progresses along seam.

### Welding tracks can be:

- a. Sheet metal, 22 gauge – 12 inches (31 cm) wide by 10 feet (3 m) long.
- b. Aluminum or steel plates – ¼” by 3” (6 mm by 8 cm), 4 to 6 feet (1.2 to 1.8 m) long.
- c. Lay flat tubing filled with sand - 4’ to 6’ long.
- d. Wood planks – 2” by 12” (5 cm by 31 cm) by 4’ to 6’ long.
- e. Heavy plywood – ¾” by 24” (19 mm by 61 cm) by 8’ (2.4 m) long

**Note:** Always round corners of metal welding tracks to prevent accidental puncturing of membrane.

## Repair Procedure for Aged WeatherBond PRO TPO Membrane

Surface oxidation of WeatherBond PRO TPO membrane will occur upon exposure to heat and sunlight. After approximately 7 days exposure to the elements, membrane must be cleaned with Weathered Membrane Cleaner prior to hot air welding.

The following procedure should be used when standard cleaning with the Weathered Membrane Cleaner and a rag is not sufficient to produce an effective weld.

The membrane may be repaired up to 6 months to a year with the standard cleaning method, however, each project will vary due to the differences in exposure to UV and accumulated dirt.

1. Scrub the area to be welded with a Primer Pad and Weathered Membrane Cleaner. The cleaner will become discolored with dissolved membrane during this procedure.
2. Clean all residue from the area to be welded with a clean rag. If natural fiber rags are used, they must be white to prevent fabric dye from discoloring the membrane.
3. Weld the membrane to the cleaned area using standard welding procedures.

## **Heat Welding Equipment**

### **1. Automatic Hot Air Welding Machine**

- a. **Welding speed:** A recommended initial speed of 12.5 feet per minute is an optimum speed setting. The speed of the welding machine must be no faster than necessary to produce a good hot air weld, and will vary according to environmental conditions.
- c. **Temperature recommendations:** Operating temperature is approximately 1000° F (#8 temperature setting). WeatherBond PRO TPO Membrane will not “bleed out” (membrane begins to flow out from edge).

Typically, the colder the ambient temperature (and likewise the membrane temperature) the slower the Automatic Hot Air Welding Machine speed control must be adjusted to produce proper seams. See the following pages for additional welding speed and temperature information.

2. **Hot Air Hand Welder**

Used to hot air weld WeatherBond PRO TPO membrane and flashing. A hand-held **silicone** rubber roller is used in conjunction with the welder to apply the pressure that fuses the heated membrane surfaces together.

The hand-held welder is typically used to repair seams, or when the use of the automatic hot air welding machine is inappropriate (such as flashing penetrations and on high sloped surfaces). Initial temperature settings are typically “#8” for reinforced membrane and “#5-6” for non-reinforced flashing.

3. **Electrical Cords:** For generator requirements and maximum length of electrical cords, refer to Generator/Electrical Requirements as follows.

4. **Seam Prober:** WeatherBond recommends the use of a cotter pin puller to probe all hot air welded seams. All seams must be probed (**after the seam has thoroughly cooled**) with the seam prober. All deficiencies must be repaired accordingly with a hand held hot air welder no later than the end of each work day.

5. **Silicone Rubber Roller:** A 2 inch (5 cm) wide rubber roller used for rolling hot air welded splices.

6. **Generator/Electrical Requirements**

Building power supplies do not typically provide the proper amount of power necessary for consistent hot air welding. The use of a portable generator conforming to the following guidelines is strongly advised.

a. A **minimum 6500 watt generator** with a minimum output of 210 volts is required **for one Automatic Hot Air Welding Machine, however, a 7500 watt generator is recommended.**

Reduced power availability will result if additional equipment is connected to the generator and may result in faulty hot air welded seams. GFI (Ground Fault Interrupter) protection is recommended.

Additional generators will be required for operating other power tools and hand held hot air welders.

**Electrical cords** (3 conductor) of the maximum length indicated must be used with the corresponding wire as listed:

Maximum Length	Wire Size
50 foot (15 m)	#12
100 foot (30 m)	#10
300 foot (90 m)	#8

- b. **A minimum 3,000 watt generator** may be used to power a maximum of **two hand held welders** as long as no other equipment is connected. This generator should service a minimum of 110 volts and be GFI (Ground Fault Interrupter) protected.

**Electrical cords** (3 conductor) of the maximum length indicated must be used with the corresponding wire as listed:

Maximum Length	Wire Size
50 foot	#14
100 foot	#12

For extension cords longer than 100 feet, consult an electrician or electrical contractor to ensure proper size of generator and wire.

## 1. Hot Air Welding Precautions

- a. Check the welding machine set-up to ensure proper alignment of the heating nozzle, weight plate (air dam), pressure wheels, or moving parts to see they move properly or are free-spinning.

Test run the welding machine to ensure it moves forward following a straight line. If the alignment is off, make necessary adjustments.

- b. Make sure the air intake is open. Clean out the air intake for the blower unit at each start up.
- c. Check the machine for worn or broken parts that need to be replaced. Exercise care to protect the pressure wheel from notches or cuts to prevent incomplete sealing of the welded seam.
- d. Before the machine is connected to the power source, make sure it is switched off to prevent a power surge that could damage the unit.

Turn the unit on and allow the blower/heater unit to warm up for approximately 5 to 10 minutes to reach operating temperature.

- e. Clean the heat nozzle with a wire brush to remove any build-up of membrane, as needed.
- f. To extend the life of the heating element of the Hot Air Welding Equipment, always turn the temperature adjustment down so the welder can cool prior to switching the machine off.
- g. Follow all care and maintenance instructions recommended by the respective manufacturer.
- h. It is recommended that two Automatic Hot Air Welding Machines and two generators be available at the project site in the event of mechanical failure.

## Hot Air Welding Procedures

Hot air weld the WeatherBond PRO TPO membrane sheets using the Automatic Hot Air Welding Machine or Hot Air Hand Welder and silicone roller.

When roof slope exceeds 5 inches per horizontal foot (13 cm/m), use of the Automatic Hot Air Welding Machine may become more difficult; use of the Hand Held Hot Air Welder is recommended.

**Check the surfaces** of the WeatherBond PRO TPO membrane to be hot air welded to ensure they are properly prepared as outlined below:

- a. **Membrane Cleaning** - The surfaces to be hot air welded must be clean. Membrane overlaps that become contaminated with field dirt must be wiped with a clean natural fiber rag containing Weathered Membrane Cleaner. No residual dirt or contaminants should be evident. When natural fiber rags are used, they must be white to prevent fabric dye from discoloring the membrane. Weathered Membrane Cleaner will achieve approximately 600 linear feet (one surface) of coverage per gallon for a standard hot air welded splice area.
- b. **Exposed Membrane Seam Preparation** - Surface oxidation of WeatherBond PRO TPO membrane will occur upon exposure to heat and sunlight. **After a period of 7 days or more exposure** to the elements, membrane must be cleaned with **Weathered Membrane Cleaner** or a complete fusion weld cannot be achieved. If the dirt is not easily removed, **a Primer Pad application will be necessary prior to hot air welding:**
  - 1) Scrub the area to be welded with a Primer pad and Weathered Membrane Cleaner. The cleaner will become discolored with dissolved membrane during this procedure.

- 2) Clean all residue from the area to be welded with a clean rag. No residual dirt or contaminants should be evident. If natural fiber rags are used, they must be white to prevent fabric dye from discoloring the membrane.
- 3) Weld the membrane to the cleaned area using standard welding procedures.

## Temperature Settings

When making a WeatherBond PRO TPO splice, no one temperature setting or speed can be used to describe the temperature setting or speed to set the robot. The splice must be tested to determine the quality of the splice.

Consult the respective heat welding machine manufacturer for recommendations concerning proper temperature setting and speed control of their equipment.

Typically, the colder the ambient temperature (and likewise the membrane temperature) the slower the Automatic Hot Air Welding Machine speed control must be adjusted to produce proper seams.

**As a general guide, WeatherBond PRO TPO membrane will weld at a lower temperature (1000° F) and faster speed (10 feet to 15 feet per minute) than most other heat welded membrane materials.**

With the Leister Varimat Automatic Welder, the suggested heat setting is 1000° F at 10 to 13 feet (3 to 4 m) per minute. With any other brand of robot welder, the temperature should be set at the manufacturer's recommended temperature to obtain the correct splice results.

The following is a list of items to be checked to determine the temperature setting and the speed at which a splice should be completed:

1. Early morning welder speed settings should be set slower than midday heat welder speeds due to typically colder temperatures in the morning.
2. As the membrane surface temperature increases, the welder speed may also be increased.
3. When the membrane is in direct sunlight, the temperature or robot speed may have to be adjusted when moving into a shaded area, check the splice results.

Remember the membrane surface in a shaded area will be cooler than a membrane surface that is in sunlight.

4. Dampness on the membrane from dew, a passing rain shower or misting condition will reduce heat from the splice due to evaporating moisture from the membrane surface.

The heat welding temperature (increased) or the robot speed (slower) will have to be adjusted to produce a good splice.

Water must be wiped from the welding surface prior to welding the splice.

5. Wind has a cooling affect as it blows over the surface. It will also affect the air flow in the splice reducing the effectiveness of the hot air gun. This will require the operator to increase heat from the hot air gun or reduce the welder speed.
6. Substrates make a big difference in the amount of heat required to produce a proper heat welded splice. The robot will have to be adjusted accordingly:
  - a. Plywood and Concrete act as heat sinks and will take a higher temperature or slower speed setting than insulation.
  - b. Cool damp substrates will take a higher temperature or slower speed setting than dry substrates.

7. Membrane “bleed-out” from between sheets will not occur with WeatherBond PRO TPO membrane if properly welded.

If bleed-out is occurring (the dark underside of the membrane begins to melt and flow), the welder speed should be increased to reduce welding temperature.

## **Equipment Set-Up**

Equipment set up is the responsibility of the Applicator. When poor welding is occurring check the following:

1. If the membrane is overheated on one side or the other, check the nozzle to be sure it is distributing the heat evenly between the two sheets.
2. If the heat is bypassing the edge of the sheet producing a cold weld along the edge of the splice, be sure the nozzle is completely under the sheet and the air dam is in place and functional.
3. If the probed splice is tight at the edge but a cold weld is present in the center of the splice (the heat is melting the edges but does not melt the center of the splice), check to be sure the robot is not running too fast.
4. Ensure the silicone pressure wheel is intact with no voids in the silicone. If voids are present, incomplete welding will result.
5. Be sure all wheels on the air dam are not binding. Binding wheels will cause sheet movement and distortion during the welding process.
6. The Automatic Heat Welder nozzle should be adjusted as close to the pressure wheel as possible.

If the nozzle is too far away from the pressure wheel, distortion of the membrane may occur due to heat expansion.

**NOTE:** Adjust welder nozzle so the curved portion (heel) extending outside the seam area does not contact or drag on the exposed surface of the membrane. This portion of the nozzle should be 1/16" – 1/8" above membrane surface.

7. Overheating the membrane will cause poor welds. It is recommended that the automatic welder be run not less than 10 feet (3 m) a minute on average temperature days.

Only on very cold days would the welder be run below this speed. The temperature and welder speeds must be determined based on test welds prior to actual sheet welding.

8. Clean screen of dirt and debris on air inlet of heat gun every day. Accumulation of contaminants on screen will reduce air flow and heat output of welder.

## **Membrane Welding**

1. Prepare the Automatic Hot Air Welding Machine and allow to warm for approximately 5 to 10 minutes to reach operating temperature.
2. Position the Automatic Hot Air Welding Machine properly prior to seaming with the guide handle pointing in the same direction the machine will move along the seam.
3. Lift the overlapping membrane sheet and insert the blower nozzle of the Automatic Hot Air Welding Machine between the overlap.

Immediately begin moving the machine along the seam to prevent burning the membrane.

4. Proceed along the seam ensuring that the small guide wheel in front of the machine aligns with the edge of the top membrane sheet. Guide the machine from the front only.

**CAUTION:** Ensure the power cord has plenty of slack to prevent dragging the machine off course (which could result from a tightly stretched cord).

5. At all splice intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam (the membrane should be creased into any membrane step-off with the edge of the silicone roller).

A false weld may result due to surface irregularities created by multiple thicknesses of WeatherBond PRO TPO membrane sheets.

**NOTE:** When using .060 inch (1.5 mm) thick or heavier WeatherBond PRO TPO Membrane, a TPO T-Joint Cover or a surface splice of Non-Reinforced Flashing must be applied over all "T"joint splice intersections, refer to Detail WBPMA-2.4.

6. To remove the Automatic Hot Air Welding Machine from the finished splice, stop the movement of the machine and immediately remove the nozzle from the seam area.
7. Mark the end of the hot air welded seam with a water-soluble marker for easy identification. A Hand Held Welder will be necessary to complete the weld in the area between where the Automatic Hot Air Welding Machine is stopped and restarted.
8. **Perform a test cut** at least at the start of work each morning and afternoon. Test cuts should be taken if any changes in substrate or weather conditions occur.

## Test Cuts

WeatherBond recommends that the test weld sample be made from a piece of scrap TPO to eliminate the need to remove a section from a completed seam.

Only when necessary should a test cut be taken from the installed roofing system.

1. The test cut should be approximately 1 inch (2,5 cm) wide and longer than the width of the seam (cut across the hot air welded seam).
2. Peel the test sample apart after it has thoroughly cooled (approximately 30 minutes) and examine for a consistent 1-1/2 inch (4 cm) wide minimum weld.

Delamination of the membrane from the scrim-reinforcement is an indication of a properly welded seam.

3. Repair the test seam area by using an overlay of WeatherBond PRO TPO reinforced membrane (with rounded corners) and hand weld around the entire repair area.

Identify the following seam problems to assure seam quality:

**Discolored or melted membrane** – Increase speed or decrease temperature setting if membrane discolors or exhibits melting (membrane begins to flow).

**VOIDS and wrinkles** - A proper hot air welded seam has no voids or wrinkles and must be at least 1-1/2 inches (4 cm) wide. Refer to Seam Probing procedures outlined below for proper inspection of seam deficiencies.

## Hand Held Welder Settings

1. Temperature setting for hand held welders when used for flashing should be approximately “6” (on a scale from 1 to 10).
2. Temperature settings for hand held welders when used for membrane should be approximately “8” (on a scale from 1 to 10).
3. Exact settings will vary based on ambient temperatures, substrate and type of welder.

4. The Silicone roller should always be placed flat against membrane to be welded. **Do not turn roller on edge to weld membrane or flashings.**

## Seam Probing

A WeatherBond Seam Probe is recommended for use to probe all hot air welded seams.

Probing seams must be done once hot air welds have thoroughly cooled. Hot air welded seams must be probed throughout the day to check seam quality and to make proper adjustments to hot air welding equipment. **The repair of deficiencies must be done routinely throughout the day but no later than the end of each workday.**

1. Allow hot air welded seams to cool thoroughly for approximately 30 minutes. Premature probing can damage warm seams.
2. Draw the probing tool tip along the edge of the hot air welded seam. Apply firm pressure to probe the seam junction, but not into the bottom membrane sheet. The tool will not penetrate into the lap area of a properly welded seam.
3. If the seam probing tool penetrates into the lap area, mark the seam using a water-soluble marker at the beginning and the end of voids or wrinkles in the seam edge.
4. Repair seam deficiencies as soon as possible using the hand held welder. WeatherBond recommends that repairs be made the same day they are discovered.
5. Probe **repaired seams** after they have cooled completely. If the repair is acceptable, wipe off the water soluble marker lines; if not acceptable, repair the seam using the procedures for repair of hot air welded seams as outlined in Repair Procedures for Aged WeatherBond PRO TPO Membrane.

**Probing Notes:**

- All laps must be probed each day soon after it has cooled to verify the welder set-up is effective.
  - Particular attention must be given to all membrane intersections and hot air welded seams at insulation joints.
  - In addition, there should be periodic checks (including at the start of each day) to verify good peel strength.
6. **Apply TPO Cut-Edge Sealant** on all cut edges of the reinforced membrane (where the scrim reinforcement is exposed) **after seam probing** is completed. TPO Cut-Edge Sealant is not required on vertical splices.

When a 1/8 inch (3 mm) diameter bead of TPO Cut-Edge Sealant is applied, approximately 225 - 275 linear feet of coverage per squeeze bottle can be achieved.

## **Additional Membrane Securement**

Securement must be provided at the perimeter of each roof level, roof section, expansion joint, curb, skylight, interior wall, penthouse, etc., at any inside angle change where slope exceeds 2 inches to one horizontal foot, and at all penetrations as identified on the WeatherBond PRO details.

As an option, 6" wide TPO Pressure-Sensitive RUSS may be installed in conjunction with WeatherBond Fasteners and HPWX plates spaced a maximum of 12" on center below the membrane. The securement strip shall be installed horizontally at the base of walls or penetrations.

The underside of the deck membrane must be primed with Multipurpose Primer. Membrane is spliced to the RUSS and continued as wall flashing resulting in continuous membrane flashing without penetration of the deck membrane.