SECTION 1

MULE-HIDE PRODUCTS CO., INC.

TPO SYSTEM GUIDELINES

How to Install Mule-Hide TPO Membranes

Equipment Needed to Install Mule-Hide Heat-Weld Membranes

Insulation Guidelines

Fastener Guidelines

PLEASE CONSULT THE MULE-HIDE WEBSITE FOR THE MOST CURRENT INFORMATION

Mule-Hide Products Co., Inc.
How to Install Mule-Hide Reinforced TPO Membranes

BASIC CONSIDERATIONS

The installation of a Mule-Hide roof involves procedures and techniques that have been carefully conceived and engineered to help you provide your customers with the most reliable, lowest maintenance roofing system available.

Successful roof installations do not just happen; they must be carefully planned and implemented. An understanding of the basic properties of the Mule-Hide system can help the contractor exploit its unique strengths and to avoid unnecessary problems. Keep the following in mind as you go through this section: Mule-Hide TPO Heat-Weld Membranes are polyester scrim-reinforced, single-ply roofing systems designed for mechanical, fully adhered, and ballasted attachment with hot-air welded seams. Mule-Hide TPO membrane is formulated with polymers that are highly resistant to sunlight and weather as well as many chemicals.

The remainder of this section covers the proper methods of performing each step of the installation. This material was written to provide the contractor with practical, detailed information that can help ensure the proper performance of each step of the Mule-Hide installation.

THE ADVANTAGE OF HOT-AIR WELDABILITY

The unique hot-air weldability of both the scrim-reinforced TPO field sheet membrane and non-reinforced TPO flashing membrane gives the contractor a special advantage when completing roof details. When used in connection with roofing details, hot-air welding provides the same assurance of watertightness as in field seaming - assurance that comes from permanently fused seams that can be as strong as the Mule-Hide TPO Membrane itself.

GENERAL APPROACH

The general approach to complete common roofing features involves hot-air welding, Mule-Hide Bonding Adhesive, Mule-Hide TPO Cut Edge Sealant, and terminating flashings. Common roofing features include such details as wall flashings, vertical and flat edge terminations, inside corners, outside corners, round shapes, drains, curbs and pitch pockets. Mule-Hide recommends that you rely on pitch pockets only as a last-ditch measure, although from time to time they can provide efficient means of dealing with particular problems concerning irregularly shaped projections.

As a general approach, the Bonding Adhesive is used to adhere, as appropriate, field sheet membrane to features such as curbs, vents, and parapets. Then hot-air welding is used to seam membrane overlaps and Mule-Hide TPO Cut Edge Sealant is applied to cut edges of reinforced membrane.

IMPORTANT: All roofing work must follow Mule-Hide TPO Standard Details. Any failure to complete details to Mule-Hide specifications can stand between you and a favorable inspection - and therefore, a Warranty. If no TPO Standard Detail applies to a particular requirement of your job, sketch the way you think it should be handled and submit the sketch with your Pre-Job Survey for approval. Consult Mule-Hide's Technical Department if you have any questions about the Mule-Hide TPO Standard Details.

NOTE: No deviation from Mule-Hide TPO Standard Details is authorized until: (1) it is submitted by the contractor in writing or sketch form for review and the job file, and (2) is approved by Mule-Hide's Technical Department.

PREPARING THE SUBSTRATE

The substrate under the Mule-Hide TPO Membranes must be properly prepared. The general goal of this preparation is to provide a smooth compatible surface for the insulation (when required) and the membrane.

The contractor should follow good roofing practice when evaluating and preparing the surface. For example, as general practice, especially on reroofing jobs, prepare the entire roof before starting the Mule-Hide installation in order to minimize contamination and ensure the integrity of the seams. By keeping in mind the general properties of the Mule-Hide TPO Membrane you can help evaluate unusual situations when they arise; but if you are in doubt as to the resolution of problems not addressed on the Mule-Hide TPO Standard Details or Specifications, contact the Mule-Hide Technical Service Department for advice.

New Roofing Installations

On new roofing installations, keep the deck and insulation surface free of debris and trash. Note precisely the location of structural members, electrical conduits, and gas and water lines under the deck, as well as general deck characteristics that will affect the placement of mechanical fasteners - such as the direction and spacing of steel deck flutes.

Follow good roofing practice in the loading of the roof with Mule-Hide Heat-Weld Membrane rolls. Stack carefully and store in a cool, clean, dry location.

CAUTION: Keep the packaging protecting the Mule-Hide Heat-Weld Membrane intact until ready to use.

Reroofing Installations

To ensure a successful reroofing job, you must be aware of the conditions that led to the need for the reroof. It may be that leakage has occurred from sources other than the roof. If so, be sure that the Building Owner or Operator is aware of any such sources as early as possible and understands that the application of a new roof may not solve all of the leakage problems. Some useful points to cover in your evaluation follow.

Investigate existing leakage conditions thoroughly. Before the installation begins, be sure that a thorough investigation of existing roof conditions has been performed and that a review of “as-built” plans and specifications for the building, as well as the assessment of current conditions, has determined that the building is structurally sound and otherwise suitable for reroofing.

It is helpful to know such details as the nature, extent, and duration of leaks that may have occurred through the old roofing. Because leaks often occur from sources such as building parapets, walls, and windows, a new roof may not solve all leakage problems. Check the building walls for dampness, spalling brick, large stress cracks, and efflorescence (salty, powdery deterioration) - signs of problems that extend beyond the roof itself. Look for stains inside the building and be sure that all sources of such stains are known.

Evaluate existing roof conditions: The cause(s) of poor drainage conditions should be thoroughly understood and solved as part of the reroofing process. For example, check for signs of ponding, a sure sign of poor drainage. If ponding occurs, determine the extent and duration of ponding. If needed, are overflow scuppers or other means of supplemental drainage present? Determine if a provision should be made for their installation.

Are there noticeable splits in the existing roofing? Splits may indicate a change in substrate or metal deck direction; they could be indications that an expansion joint is required.

Be sure that you know ALL types and conditions of substrate that are present, the spacing of structural members under the deck, the direction and gauge of a steel deck, the thickness of concrete, thickness of insulating fill (if present), drain placement, slope, and the location of expansion joints.

Make a roof drawing: Once on the roof, work up a detailed roof drawing on the Mule-Hide Pre-Job Survey showing all dimensions, drains, mechanical equipment, penetrations, skylights, monitors, parapet walls, and other features. You will have to submit your drawing(s) as part of the Warranty Application.

Removal (tear-off) of existing roofing: Your crews should remove no more roofing and insulation from a given area of the roof than what can be completely covered with new insulation and Mule-Hide TPO membrane that day. On tear-offs, ALL gravel and debris will have to be broomed from the deck.

Reroofing over existing roofing: When reroofing over old roofing, broom ALL gravel and debris from the old roofing surface, cut out blisters and fishmouths, and seal. When reroofing over existing single ply membranes, cut the existing membrane in 10' x 10' grids. Remove and replace wet insulation as required. Tear off all existing flashings or cover with a suitable material (plywood, OSB, metal, etc.).

LAYING INSULATION

If old insulation is present and is to be retained, you should determine if it is wet. The surest diagnostic technique is by taking and evaluating a series of roof cuts. Alternatively, three techniques currently available to make this determination by indirect means are: nuclear moisture detection, infrared thermography, and electrical capacitance.

These techniques provide measurements of factors that can be associated with the presence of moisture. As such, they can help point out certain inconsistencies in the existing roof system but do not necessarily provide valid measures of moisture. Limited direct verification is always advisable.

Whatever your method of investigation, wet insulation must be removed and replaced. The presence of wet insulation must be noted on the Pre-Job Survey. These areas must be designated on the roof diagram.

Insulation must be laid and fastened according to its manufacturer's specifications and at a minimum must follow Factory Mutual's suggested guidelines.

The longest dimension of the insulation should run PARALLEL to the flutes of a steel deck and PERPENDICULAR to the direction in which the Mule-Hide field sheet will be unrolled. Regardless of the approved lay of the insulation board, the membrane field sheet direction must be proper with respect to the deck construction, as explained in "Installing Membrane - Field Sheet Membrane."

Lay no more new insulation than will be covered by the roofing membrane on the same day. Work on any given area of the roof must be made completely watertight at the end of each workday.

Good roofing practice dictates that care should be taken to achieve smooth transitions between insulation boards and roof areas. Always consider proper drainage and adjust thicknesses accordingly to achieve proper drainage. The membrane should never have to bridge an area and transitions should never cause ponding.

INSULATION ATTACHMENT

Mechanically Attached Systems

For a Mechanically Attached System, the roof insulation is attached to the substrate in order to keep the insulation in place. The individual boards are typically attached as follows:

4' x 8' Insulation Boards, less than 2" thick – 6 fasteners/plates per board over entire roof area.

4' x 8' Insulation Boards, 2" or more thick – 5 fasteners/plates per board over entire roof area.
4' x 4' Insulation Boards – 4 insulation fasteners/plates per board over entire roof area, regardless of thickness.

The 3" Galvalume Stress Plate must be used with a minimum #12 Drill Point Fastener to fasten roof insulation. See page 3 of the Fastener Guidelines portion of this manual for basic fastener patterns. Consult the Mule-Hide Technical Department for additional questions.

Fully Adhered Systems

In a Fully Adhered System, the membrane is bonded directly to the insulation or substrate. Therefore, the strength, or wind uplift resistance of a Fully Adhered System is dependent upon the type and thickness of the *top most layer* of insulation and the method/density of insulation attachment (fasteners and/or foam adhesive). This requires increased insulation attachment for a Fully Adhered System over a Mechanically Attached one.

The density of insulation attachment used varies across the roof area. In the center of the roof, called the Field, the uplift pressures are calculated and the appropriate density of insulation attachment is specified to meet the design uplift pressures. Uplift pressures are greater in the Perimeter and Corner areas of the roof, resulting in the need to increase insulation attachment in those areas. It is the Field attachment requirements that set the requirements for the Perimeters and Corners. The Perimeter attachment requirements are generally 50% more than what is required in the Field and the attachment requirements in the Corners are generally 100% more that what is required in the Field.

The 3" Galvalume Stress Plate must be used with a minimum #12 Drill Point Fastener to fasten roof insulation. Basic insulation attachment patterns can be found in the Fastener Guidelines portion of this manual, beginning on page 3. More specific information is available in our Design Summary's located in Section 2 of this manual. Contact Mule-Hide Technical Department for addition information.

Low rise foam adhesives can be used in lieu of mechanical fasteners to attach insulation to the roof deck. Roof decks that are non-conducive to mechanical attachment, such as concrete, gypsum, lightweight concrete, or cementitious wood fiber, are prime candidates for the use of low rise foam adhesives to attach roof insulation. The Mule-Hide Technical Department must be contacted prior to bidding any project where low rise foam adhesives are being considered.

MEMBRANE ATTACHMENT

Mechanically Attached Systems

Perimeter Enhancements

To ensure that your installation meets the Mule-Hide specifications, refer to TPO Standard Details as you read this section.

CAUTION: Keep the protective packaging of the Mule-Hide Heat-Weld Membrane intact until ready to use.

NOTE: Half-sheet dimensions are 50% to 60% of the width of the field sheet. The field sheets must always be installed perpendicular to steel deck flutes, plywood deck joints, or deck plank direction, as appropriate. All field seams shall be shingled with the flow of water. Mule-Hide requires a minimum perimeter enhancement of 1 perimeter half sheet on all TPO Mechanically Attached systems. Consult TPO Tech Bulletin MA02-2006 for TPO half sheet requirements.

There are three methods for perimeter enhancements. Perimeter Enhancements can be formed by using individual 4' to 6' wide sheets, by subdividing 8' or 10' wide field sheets using 10" wide Pressure-Sensitive RUSS strip, or by installing rows of seam fastening plates through the top of the

membrane and patching with appropriate materials.

1. Individual Perimeter Sheets Method

   Position the half-sheets (either 4’ or 6’ wide) along the perimeter of the roof over the acceptable insulation/underlayment. Mechanically attach the half-sheets using Seam Plates and appropriate HD fasteners at the designated spacing dictated by the building height and roof deck type. TPO membrane is always fastened with 2.4” Seam Plates and minimum #14 HDP fasteners.

   a. Over steel roof decks

      All seams and fastener rows must run perpendicular to the ribs of the deck. This requirement will necessitate that perimeter sheets on two sides of the roof (where the seams would be running parallel with the ribs of the deck) be turned so that the seams in the perimeter sheets run perpendicular to the deck ribs. See Details MHT-FM-308B, MHT-FM-310B, or MHT-FM-312B.

2. 10” RUSS Method

   When **field sheets are positioned parallel to a roof perimeter, 10" wide TPO Pressure-Sensitive RUSS** (with 3” wide tape each side) shall be placed approximately down the center of the 8’, 10', or 12' wide TPO field membrane sheets. When a 10” RUSS divides a field sheet in half, two perimeter sheets are created.

   Unroll and position the 10" wide TPO Pressure-Sensitive RUSS over the insulation/substrate where membrane securement is desired. Locate the RUSS with the fastener markings and tape facing upwards.

   Position Mule-Hide Seam Plates at the same spacing as the field sheets and secure with an appropriate fastener. Do not fasten plates over top of the release liner as this will cause the liner to tear when removed. 10” RUSS is always fastened with 2.4” Seam Plates and minimum #14 HDP fasteners.

   Position the field sheet membrane and **thoroughly clean the underside of the TPO membrane using Weathered Membrane Cleaner if necessary.** (The entire membrane surface where the tape is to contact must be clean. The adhesive on the TPO Pressure Sensitive RUSS will not adhere to dusted / dirty surfaces). Apply Tape Primer to the underside of the membrane and let dry until tacky, remove the plastic release liners, and mate the field sheet to the 10” RUSS.

   a. Over steel roof decks

      Position “fingers” of 10” TPO RUSS below the membrane along the center of each field sheet where the field membrane sheets **extend perpendicular to the edge of the roof**. The 10” TPO RUSS should extend a distance equal to the perimeter enhancement dimension required by the specifications. Refer to Details MHT-FM-308A, MHT-FM-310A, or MHT-FM-312A.

      CAUTION: 6" wide TPO RUSS is only available with 3” wide tape on one side and therefore cannot be used for perimeter enhancements.

3. Fastening Plates Method

   In lieu of the 10” TPO RUSS securement method, position a row of seam fastening plates on top of the membrane down the center of the 8’, 10’, or 12’ wide field sheets. Secure

plates with appropriate fastener though the membrane and overlay plates with 6” wide Pressure-Sensitive TPO Cover Strip or 6” Reinforced TPO Cover Strip hot air welded to the field membrane. TPO membrane is always fastened with 2.4” Seam Plates and minimum #14 HDP fasteners.

On projects requesting warranties of 20 years or more, the plates and fasteners must be overlaid with 6” Reinforced TPO Cover Strip and hot air welded to the field membrane. Cut Edge Sealant must be applied to all cut edges of the Reinforced TPO Cover Strip.

a. Over steel roof decks

Position “fingers” of Seam Plates and appropriate fasteners on top of the membrane along the center of each field sheet where the field membrane sheets **extend perpendicular to the edge of the roof**. The rows of Seam Plates and appropriate fasteners should extend a distance equal to the perimeter enhancement dimension required by the specifications. Refer to Details MHT-FM-308A, MHT-FM-310A, or MHT-FM-312A

NOTE: Consult Fastener Guidelines (Section 5) for determination of “perimeter” and fastener spacing.

Buildings with special conditions

Air pressurized buildings, canopies and buildings with large openings where the total wall openings exceed 10% of the total wall area on which the openings are located (such as airport hangars, warehouses and large maintenance facilities) will typically require additional perimeter enhancement. Refer to Details MHT-MA-103A or MHT-MA-103B

Field Sheet Membrane

1. Unroll the first full-width sheet membrane. Roll out the full-width Mule-Hide field sheet membrane so that it laps UNDER the perimeter half sheet by 5-1/2 inches. This will produce a 2 to 2-1/2 inch clear lap area for seam welding. Position the butt end of the membrane so that it will be overlapped 5-1/2 in. by the half-sheet that will be installed perpendicular to the field sheets.

   a. On Steel Roof Decks – run the first full width sheet so that the seam is perpendicular to the ribs of the deck. If perimeter half sheets are used, roll out the first full-width sheet so that it laps under the perimeter sheet by 5-1/2 inches on the roof edge that is perpendicular to the ribs of the deck. Run the full-width sheet all the way to the roof edge on the sides that are parallel to the ribs of the deck.

   NOTE: All field seams shall be shingled with the flow of water.

2. Allow the membrane to relax at least 15 minutes prior to fastening, 30 minutes when the temperature is below 60° F.

3. Fasten the field sheet. TPO membrane is always attached with 2.4” Seam Plates and minimum #14 HDP fasteners. Mechanically fasten both edges and the butt end of the first field sheet (that overlaps a half sheet) into the deck. Take care to avoid making wrinkles. Fasteners must be installed so that the plates are 1/2 in. from the edges and end of field sheet. Space fasteners apart as required for the specific deck type and wind uplift requirements (see Section 4).

4. Install two more field sheets. These and subsequent rolls of field sheet membrane must OVERLAP by 5-1/2 inches (to the scribed lap line) the previous runs of field sheet membrane. Align ends so that they will be overlapped 5-1/2 inches by the perpendicular half-sheet, if used. Mechanically fasten field sheet into the deck along the edge that does not overlap the previous

sheet. Space fasteners apart as indicated for the specific deck type and wind uplift requirements.

5. See Hot Air Welding section on Page 9.

   NOTE: Wherever there is a change in plane greater than 2" per foot, base attachment must be installed. Base attachment can be accomplished by the use of 6" TPO Pressure Sensitive RUSS with Seam Plates and appropriate HD fasteners, Seam Plates and appropriate HD fasteners through the top of the membrane, or A/P Bar and appropriate fasteners. Refer to TPO Standard Details for approved base attachment construction.

   NOTE: Pay special attention to the "T" lap seams formed where the perpendicular half-sheet overlaps the butt ends of the field sheets and at the end laps of the field sheets. To ensure proper seaming of the "T" joints for 45 mil membrane with warranty lengths not exceeding 15 years, the top layer of the Heat-Weld Membrane is creased a minimum of one inch into the lower layer of membrane by using a heat gun with a narrow or pencil tip nozzle and a rubber hand roller. By inserting a heat gun nozzle between the layers of the membrane, the membrane will soften and begin to flow allowing it to crease and seal completely after applying pressure with a hand roller to ensure adequate bonding of the softened material. On all 60 mil and 80 mil membranes and on projects requesting warranties exceeding 15 years, a separate "T" patch constructed of non-reinforced membrane is heat welded d directly over the "T" joint.

Fully Adhered Systems

Perimeter Half Sheets are NOT required in a Fully Adhered System. However, increased insulation fastening densities are required in the perimeters and the corners to compensate for the increased wind forces in these areas. Mule-Hide requires the following additional insulation attachment provisions:

Perimeters – insulation attachment to be increased 50% over the field attachment requirements with a maximum of one (1) fastener every one (1) square feet.

Corners – insulation attachment to be increased 50% over the field attachment requirements with a maximum of one (1) fastener every one (1) square feet.

Mule-Hide defines the perimeter and corner width as a minimum of eight (8) feet. See Details MHT-UN-108A and MHT-UN-108B

To ensure that your installation meets the Mule-Hide specifications, refer to TPO Standard Details as you read this section.

CAUTION: Keep the protective packaging of the Mule-Hide Heat-Weld Membrane intact until ready to use.

Position membrane over substrate with a minimum 3" overlap at lap seams, and positioned so that laps will shed water. Allow the membrane to relax at least 15 minutes prior to adhering, 30 minutes when temperatures are below 60° F. After membrane has relaxed, fold membrane in half lengthwise exposing the underside of the sheet. Pails of adhesive are often used to weight the back edge of the membrane to hold it in position.

Using a medium nap roller, apply a smooth even coat of bonding adhesive to back side of membrane and substrate. Coverage rate should be 120 square feet per gallon per side for an installed coverage rate of 60 square feet per gallon. **Do not apply adhesive in area of seam laps.** Allow adhesive to dry to a 'tacky' state. Test adhesive by placing a knuckle into it and turning your wrist a one-quarter turn. Adhesive is ready to mate when it does not string when knuckle is lifted.

Roll coated membrane onto substrate being careful to not wrinkle the sheet or trap air bubbles. Once the membrane is mated to the substrate, thoroughly broom into place with a stiff bristled push broom

to ensure proper contact and 100% adhesion. Repeat this procedure for remaining sheets.

See Hot Air Welding section on Page 9.

NOTE: Wherever there is a change in plane greater than 2" per foot, base attachment must be installed. Base attachment can be accomplished by the use of 6" TPO Pressure Sensitive RUSS with Seam Plates and appropriate HD fasteners, Seam Plates and appropriate HD fasteners through the top of the membrane, or A/P Bar and appropriate fasteners. Refer to TPO Standard Details for approved base attachment construction.

NOTE: Pay special attention to the "T" lap seams at the butt ends of the field sheets. To ensure proper seaming of the "T" joints for 45 mil membrane with warranty lengths not exceeding 15 years, the top layer of the Heat-Weld Membrane is creased a minimum of one inch into the lower layer of membrane by using a heat gun with a narrow or pencil tip nozzle and a rubber hand roller. By inserting a heat gun nozzle between the layers of the membrane, the membrane will soften and begin to flow allowing it to crease and seal completely after applying pressure with a hand roller to ensure adequate bonding of the softened material. On all 60 mil and 80 mil membranes and on projects requesting warranties exceeding 15 years, a separate "T" patch constructed of non-reinforced membrane is heat welded directly over the "T" joint.

FLASHING DETAILS

While many roofing jobs are likely to have their own special problems, the contractor is just as likely to face certain rooftop features over and over again. This section explains how to accommodate these common roof features quickly and effectively, time after time with the Mule-Hide TPO Membrane Roofing Systems.

In general, when dealing with common roof features (curbs, vents, etc.) complete the pertinent details per Mule-Hide TPO Standard Details. When approaching such features, cut and fit the membrane around each obstacle you encounter. All membrane flashings shall be installed concurrently with the roofing membrane as the job progresses. Install night seals as necessary at the end of each workday. Should any water penetrate the new roofing because of incomplete flashings, the affected areas shall be removed and replaced. In reroofing, maintain the ability of the existing roof to drain - don't block off drains or scuppers.

Base Attachment

Wherever there is a change in plane greater than 2" per foot, base attachment must be installed. Base attachment can be accomplished by the use of 6" TPO Pressure Sensitive RUSS with Seam Plates and appropriate HD fasteners, Seam Plates and appropriate HD fasteners through the top of the membrane, or A/P Bar and appropriate fasteners. 6" RUSS is always fastened with 2.4" Seam Plates a minimum #14 HDP fasteners. Refer to TPO Standard Details for approved base attachment construction.

Standard Details

IMPORTANT: All roofing detail work must follow Mule-Hide TPO Standard Details. Any failure to complete details to Mule-Hide specifications can stand between you and a favorable inspection - and therefore, a Warranty. Consult Mule-Hide Technical Service department if you have any questions about how to solve special roofing problems using the Mule-Hide system, or about the Mule-Hide TPO Standard Details.

Curbs, Vents, and Roof-to-Wall Flashings

Install approved base attachment required around these penetrations. Cut flashing membrane using the Mule-Hide Reinforced TPO Membrane as required. All TPO Membrane flashings shall be fully

adhered using an approved Mule-Hide bonding adhesive. The following conditions must be met:

1. All existing flashing materials must be removed down to the substrate or covered with a suitable material. All surfaces to be fully adhered should be compatible, dry and smooth with no excessive surface roughness.

2. After the proper surface has been prepared, the approved Mule-Hide bonding adhesive shall be applied to both the back of the membrane and the substrate using a minimum 1/2 inch nap paint roller at a rate of approximately 1 gallon per 120 square feet of surface area depending on the type of substrate. Installed coverage rate will be 60 square feet per gallon. Apply adhesive in smooth even coat, avoiding globs, puddles, or other types of irregularities.

   Let adhesive dry sufficiently to produce strings when touched with a dry, clean finger. Mule-Hide TPO Membranes used as flashing shall be cut to a workable length and shall have an even coating of bonding adhesive applied to it at a rate of approximately 1 gallon per 120 square feet. Installed coverage rate will be 60 square feet per gallon. Carefully roll onto the previously coated substrate after the adhesive coating on the membrane has dried sufficiently as indicated above. **Coverage rates will vary depending on substrate and environmental conditions.**

Avoid wrinkling membrane when applying to substrate. The amount of adhesive that can be successfully applied to the membrane will vary depending on ambient temperatures, humidity and manpower. After mating membrane to the substrate, carefully roll the membrane with a 2-inch wide rubber hand roller to promote maximum positive contact between the membrane and the substrate. Overlap all adjacent flashing sheets a minimum of 2 inches. The TPO Membrane Flashings shall extend a minimum of 6 inches onto the field sheet to allow the use of the automatic welder on the flashing seams. There shall be a minimum 2 inches hot-air weld in front of any fastener plates used on top of the membrane.

Areas of the flashings and membrane to be welded are not to have bonding adhesive applied to them.

All flashings shall extend a minimum of 8 inches above roof membrane level unless previously accepted by the Mule-Hide Technical Department. All flashings shall be hot air welded at their connections with the roofing membrane. Apply Cut Edge Sealant at all welded edges of reinforced flashings. All flashings shall be properly terminated according to Mule-Hide's published TPO Standard Details.

Roof Drains

Install roof drains according to the TPO Standard Details. Field seams must not run through drains. If seams are located within 24 inches of a roof drain, a minimum 36" x 36" target patch must be installed. In reroofing, old drains must be "**thoroughly cleaned**" or replaced. Existing sealing materials must be completely removed to avoid contamination and interference with the new membrane seal and with consistent clamping pressure. Insure that drain bolts and clamping ring are in good condition. Replace missing or broken parts as required, including screens. Missing drain bolts will not be allowed.

Metal Work

Install metalwork in a manner that prevents damage from expansion or contraction and from the wind. Seal and waterproof all metalwork in an acceptable manner. Note that metalwork other than Mule-Hide Coated Metal and Mule-Hide Metal Accessories supplied by Mule-Hide are not covered by Mule-Hide Warranty.

HOT AIR WELDING OF SEAMS

To qualify for a labor and material warranty, Mule-Hide requires that all seams be welded using an automatic welder, when it is practical for the automatic welder to be used. Some examples where using an automatic welder is impractical would be:

- Highly sloped surfaces
- Severely congested roof areas where there are limited open runs down the seams
- Small roofing details

The use of an automatic welder provides a consistent 1-½" to 2" wide solid weld at the seams. Take care to avoid wrinkles. Refer to the next section of TPO System Guidelines entitled Equipment Needed to Install Mule-Hide Heat-Weld Membranes for detailed information on heat welding.

Probing Seams

Probe all seams and repair all deficient seams no later than the following workday. **FAULTY SEAMS HAVE BEEN THE SINGLE MOST COMMON DEFICIENCY NOTED BY MULE-HIDE INSPECTORS.** Make it a routine to probe seams each workday, and to repair all seam deficiencies with the hand welder before leaving the work site.

The probing of seams should not be done until the hot-air welds have thoroughly cooled. As a general procedure, seam probing and repair of deficiencies should be done for all seams approximately 8 hours after they are initially welded.

WARNING: Premature probing can open or damage warm seams that would have been perfectly acceptable once they had cooled.

1. Draw probing tool tip along seams. Gripping the probing tool by its handle, draw its tip along the edge of the hot-air welded seam. Apply firm pressure into the seam junction - not into the bottom sheet. The tool should not penetrate into the lap area.

2. Mark deficiencies. Using a water-soluble marker, mark off the beginning and end of voids.

3. Repair deficiencies promptly. Using a hand-held welder, repair all seam deficiencies as quickly as possible. It is required by Mule-Hide that repairs be made the same day that they are discovered.

4. Check repairs. After the repaired seams have cooled completely, probe them again. If the repair is successful, wipe off the water-soluble marker line; if not, do the repair over.

Voids and Wrinkles in Seams - General

Unprobed, defective seams are the most common problem found by Mule-Hide inspectors. If defective seams are found by the Inspector on your job, they are likely to delay the issuance of a Mule-Hide Warranty. Therefore, it is in your best interest and good roofing practice to thoroughly check your seams to ensure they are acceptable to Mule-Hide BEFORE the final inspection occurs.

Probe all seams daily. Be sure to probe ALL new seams approximately 8 hours after completion or at the beginning of the next workday. Mark all voids and other defects for repair with a water-soluble marker. All seam welds must be at least 1-½ to 2" inches wide and free of voids. Seams that do not meet these specifications are not acceptable to Mule-Hide.

Defective seams must be repaired the same day as found. All voids and otherwise defective seams must be repaired by hot-air welding with a Mule-Hide approved hand-held hot-air welder the same day as probed.

NOTE: Seams do not deteriorate over a few days' or weeks' time when properly welded. When an inspector finds voids, the contractor could have found the problem with effective probing during the installation.

Repairing Voids and Wrinkles

Voids. The presence of voids generally indicates that not enough heat is being applied to the membrane, and therefore the movement of the welding machine should be slowed down. It may also be possible that you are trying to weld membrane that is dirty or wet. Follow this procedure to clean dirty TPO:

Clean the surface to be welded. Clean the surfaces of both sheets to be welded thoroughly with Fantastik® or other similar general cleaner. Rinse clear and let dry. Surfaces must be cleaned until they are white. Make a final pass over the cleaned area with a clean rag dampened with Mule-Hide Weathered Membrane Cleaner.

Wrinkles. The presence of wrinkles in seams indicates the possibility of voids and a weak seam. Wrinkles may form if the hot-air welding machine drags the membrane at an angle to the seam. Such dragging can be caused by a machine that is out of alignment, by the welding of seams along, up, or down too great a slope, or by the improper unrolling of the membrane so that it does not lie flat and/or parallel to the seam direction.

Wrinkles and other distortions may also occur in hand welding operations because of inconsistent hand-rolling and welder movement. The operator should strive for smooth, consistent progress. Use a low enough heat setting to permit smooth work, especially with non-reinforced sheet.

Hand welding for field seams may be necessary on steep slopes, although some contractors find that the hot-air welder machine can be "held back" by the operator (possible with a helper) when welding DOWN slopes. This practice increases the difficulty of "staying on course," and is not recommended for the novice operator.

SPECIAL PROBLEMS

Many roofing jobs are likely to have some special problems. This section explains how to accommodate some of these problems quickly and effectively with the Mule-Hide Roofing System.

Repairing Punctures and Holes in Membranes

Occasionally, punctures and holes may occur in the Mule-Hide TPO Membrane. Punctures and holes are frequently the result of other trades working on the roof, which should be kept to a minimum by the building owner/manager or project general contractor.

To repair punctures and holes in the TPO Membrane, follow this procedure for hand welding a patch:

1. Clean the surface to be patched. Clean an area a minimum of 4 inches in all directions around the puncture or hole thoroughly with Fantastik® or other similar general cleaner. Rinse thoroughly. Wipe with clean, damp rags and dry well. Surface must be cleaned until it is white.

2. Wipe the cleaned area of the field sheet membrane with Mule-Hide Weathered Membrane Cleaner, following all directions and precautions on the label. Final cleaning with the Mule-Hide Weathered Membrane Cleaner will help ensure the removal of any remaining dirt or soap film.

3. Cut out patch. Cut a round or rectangular patch with rounded corners from reinforced field sheet membrane. The patch must be 3 inches larger in all directions than the puncture or hole.

   NOTE: All patches must be cut from scrim-reinforced membrane.

4. Position patch over the puncture or hole. Take care to allow for even laps on all sides.

5. Hot-air weld the patch. Using the hand-held hot-air welder and hand roller, hot-air weld the patch over the puncture or hole.

6. Probe the edges of the patch after it has cooled sufficiently.

7. Seal all edges of the patch with Mule-Hide Cut Edge Sealant.

Making a Temporary Tie-In

While the roofing job is underway, it is vital to keep insulation, roofing board, and/or other substrates and the deck dry. Moisture that is present under the Mule-Hide TPO Membrane will have a difficult time escaping once the membrane is hot-air welded.

Therefore, a “night seal,” or temporary waterstop, should be applied whenever storms threaten and at the end of every workday. The time needed to apply a night seal is well invested. The resulting protection can prevent the need for costly and time-consuming tear-off of wet substrate materials!

IMPORTANT! The membrane used to make a night seal must be trimmed back prior to work.

Temporary Sealing of a Penetration

From time to time, at the end of a workday or before a storm breaks, it may be necessary to seal penetrations temporarily. Follow this procedure:

1. DO NOT make finished cuts at this time. A surplus of membrane will ensure that the next steps do not compromise the eventual, final completion of the penetration detail.

2. Turn membrane up on curb or equipment a minimum of 2 inches.

3. Install duct tape. Tape should be a minimum of 4 inches wide. Make sure you have a good bond between the tape and the curb. Tape should always be used in a manner that does not rely strictly on the tape adhesive to stay in place; e.g. ballast, wrap, or tack in place.

4. Before permanent seaming and adhesive bonding, trim membrane that is contaminated with tape adhesive. Remember, adhesive from the duct tape will prevent successful hot-air welding and good bonding with Mule-Hide bonding adhesive.

WARNING: Duct tape is not a suitable means for permanent sealing of seams in the Mule-Hide TPO Membrane System. Only hot-air welding is an acceptable means of seaming.

ROOF WALKWAYS

A walkway must be provided to accommodate regular traffic to service rooftop units. You can use smooth surface paver blocks over a slip sheet, or use our Mule-Hide TPO Walkway Rolls.

End of Section

Mule-Hide Products Co., Inc.
Equipment Needed to Install Mule-Hide Heat-Weld Membranes

Introduction - This section is intended to serve as a general guideline of the equipment that the contractor may need to successfully install a Mule-Hide Heat-Weld Membrane Roofing System.

General - The following list of hand tools should be included for an average crew of 4 to 6 men:

- One automatic welder
- Asphalt-free extension cord (#10/3 wire, 220 volt) with 220/30 amp male-female twist lock plugs for use with the automatic welder, not to exceed 100 feet in length
- 2 or 3 hand welders with nozzles
- Asphalt-free extension cords (#14/3 wire, 110 volts)
- 3 or 4 rubber hand rollers
- 1 pair of scissors per man
- 3 standard screw guns with disengaging clutch (RPM range of 1800-2500 with adjustable nose piece)
- Tape measures and one 100-foot tape
- 2 or 3 cotter pin extractors for probing seams
- Non-permanent ink pens (water soluble)
- Chalk lines with non permanent chalk (blue chalk)
- 4-inch wide paint brushes
- One-half inch nap paint rollers with solvent-resistant cores and handles
- Clean cotton rags
- Caulking guns
- Push Brooms
- Asphalt free waterproof canvas or other type of waterproof tarp for covering Mule-Hide products and equipment

Specialized Equipment - The Mule-Hide Roofing System requires 4 types of specialized equipment:

- Mule-Hide-approved automatic hot air seaming machine
- Mule-Hide-approved hand-held seaming machine
- Generator large enough to provide power to automatic welder and hand gun(s)
- Cotter pin puller or other type of pointed instrument to probe seams

WARNING: Never touch the metal portion of the fan housing, blower tube or blower nozzle of the automatic welder or hand held heat guns. They become extremely hot and can cause severe burns.

The Mule-Hide Heat-Weld Membranes can be permanently fused to itself by the application of super-heated air and pressure. To provide the required heat and pressure, Mule-Hide Heat-Weld Membrane Roofing Systems specifies an automatic welder for making field seams. A hand welder is specified when an automatic welder cannot be used (see next Section).

Automatic Welder

General Description: An automatic welder is an electrically powered, self-propelled device that utilizes electrical resistance heating and fan-forced hot air in combination with its own weight (including additional weight mounted on the exterior housing) to fuse the Mule-Hide Heat-Weld Membranes to themselves.

Technical Specifications

The following specifications are for general information. Consult the manual accompanying the equipment for additional details.

- **Electrical requirements:** 220V, 30A (minimum fused), 7500 W (minimum recommended available power), single-phase current. If using a generator, ensure generator is of sufficient size to power all welding tools (hand gun(s), automatic welder) run from generator.

- **Power cord and extensions:** #10, 3-conductor type may be used for distances up to 100 ft.; for longer lengths, consult an electrical contractor. We suggest the use of the highest quality electrical cords to extend the life of your equipment and improve overall performance.

- **Supplemental weight:** When welding Mule-Hide field membrane, an additional weight is to be fixed on the exterior housing over the wheels of the automatic welder. Most automatic welders have removable external weights.

- **Adjustments:** Tracking alignment, nozzle alignment, forward speed, temperature of heating element and airflow louver (and therefore hot air output).

- **Welding speed:** The speed of the welder must be no faster than necessary to reproduce good hot air weld and will vary according to environmental conditions. As a general rule, 10 to 12 feet per minute (fpm) is a typical speed in warm summer temperatures; 8 fpm or less is typical in cold weather temperatures.

- **Metal track (if required by welder manufacturer):** Several lengths, 8 foot each of 24-26 gauge galvanized metal for use as a track for the automatic welder. The metal tracks may be necessary to minimize wrinkles during welding.

NOTE: Conditions seldom justify running at maximums speed, which usually result in inconsistent seam quality. As ambient temperatures change throughout the day, the operator must rely on his judgment to determine the optimum operating speed and temperature of the automatic welder. It is good roofing practice to conduct test seaming before welding the field seams. See page 4 for test welding instructions.

Procedure - Before Connecting to Power

Use the automatic hot-air welder to make all field seams as general practice; the nozzle can be adjusted to weld near-horizontal seams (typical field seams). .

Be sure to take the following preliminary steps when using an automatic unit.

1. Supplemental weight. Fix the supplemental weight to the exterior housing over the wheels. This weight will ensure that the proper pressure is applied to the seam being welded.

2. Check hot-air nozzle alignment and adjust if required.

3. Welding and non-welding positions. The hot-air nozzle can be locked into an UPWARD non-welding position, or into its DOWNWARD welding positions. The nozzle and blower assembly can be freely raised from the welding position after the release trigger on the blower housing is pulled and the entire assembly is slid OUTWARD from the machine. In this OUTWARD position, the nozzle and blower assembly escapes the detent that locks it into the DOWN position, and can be rotated to the UP position, where it will lock when the trigger is released. Position the hot-air nozzle so that it is in its DOWNWARD welding position and visually check to ensure that the nozzle will not direct the hot air into the silicone drive wheel or belt. Such misdirected super-heated air can quickly ruin the expensive wheel or belt drive. Any misalignment of the nozzle should be corrected at this time. After ensuring that the nozzle is properly aligned, return the hot-air nozzle to its UPWARD, non-welding position.

Be sure that the blower and transmission power switches are OFF and that the blower temperature control and speed control are set to ZERO.

CHECKPOINT: At this point, it is assumed that you are ready to hot-air weld a field seam, and the following requirements have been met:

- A roll of Mule-Hide Heat-Weld Membrane has been attached to the roof deck, and a second roll has been unrolled to provide a 5-1/2-inch overlap for mechanically attached and a 3” overlap for fully adhered over the previously attached edge, per Standard Mule-Hide Specifications.

- The surfaces to be hot-air welded are clean. If these surfaces are dirty, they must be rag-wiped clean with Fantastik® (or similar cleaner), then wiped with a clean rinse rag and thoroughly dried. The seam area should then be wiped with a clean rag dampened with Mule-Hide Membrane Cleaner to ensure removal of any remaining dirt or soap film.

- With the nozzle and blower assembly in the UP position, the automatic welder is positioned so that the silicone pressure wheel or belt is placed at the edge of overlapping sheet and the beveled guide wheel in front is at the edge of the top Mule-Hide sheet.

- Transmission and blower switches are OFF and speed and heat controls are set to ZERO.

WARNING: Never touch the metal portion of the fan housing blower tube, or blower nozzle. They become extremely hot and can cause severe burns.

Procedure - Connecting to Power

With the preliminaries done, you are ready to hot-air weld.

4. Connect the machine to power.

5. Turn the heater/blower power switch ON.

6. Set the temperature switch to the desired setting (1004º F is a good starting point).

7. Allow the machine to warm up (generally around 5 minutes).

NOTE: Test seams should be made at least at the start of work each morning and afternoon or any

other time there is a noticeable change in temperature. Test seams should be made on use scrap material. After scrap material has cooled, attempt to physically tear them apart and examine them for consistent 1-1/2 to 2 inch wide fully laminated seam.

8. Prepare to set the machine in motion.

   - If ambient temperature is higher than 60 degrees F, adjust the transmission speed control switch so that the machine will move at about 12 fpm; further adjustment may be required once you are underway, depending on the quality of the seam produced.

   - If ambient temperature is 40-60 degrees F, adjust the machine to move at about 10 fpm; further adjustment may be required, depending on the quality of the seam produced.

   - If ambient temperature is less that 40 degrees F, adjust the machine to move at less than 8 fpm; the best rate will have to be determined based on the quality of the seam produced. As a general rule, the colder the ambient temperature - and, hence, the membrane - the more slowly the automatic welder will have to proceed in order to produce good seams.

   NOTE: As there are no ideal working conditions and ambient temperatures change throughout the day, the operator must rely solely on his own judgment to determine the operating speed of the automatic welder.

   CAUTION: the operator of the welding equipment should be absolutely sure that the machine is positioned properly to begin welding before proceeding to the next step. Remember that the guide handle points IN THE DIRECTION THAT THE MACHINE WILL MOVE.

9. Separate the overlapping sheets. Place one hand palm-down on the blower housing, and put your index finger on the release trigger. With your other hand, use a seam probe (or similar tool) to separate the two overlapping Mule-Hide Heat-Weld Membranes so that the nozzle can be slid between them.

10. Insert the blower nozzle between the sheets. Pull the trigger, and position the nozzle between the membrane sheets, locking it in its DOWN welding position. Immediately proceed to the next step to prevent burning the membrane!

11. Start the machine moving. Quickly turn the transmission switch ON. NOTE: Some machines start automatically. The machine will start moving and welding the seam. Mark the start of the seam with a water-soluble marker.

12. Stay on course. As the automatic welder proceeds, keep the small guide wheel at the front of the machine at the edge of the top sheet. Steer the machine from the front to minimize zigzagging, which is likely to result from steering from the rear. If you go off-course, simply get back on course quickly. Seam deficiencies will be repaired later, with the hand welder.

    IMPORTANT: Keep plenty of slack in the power cord. Any drag can pull the machine off-course.

13. Adjust to the speed that produces the best weld. The guidelines set in Step 8 provide good starting points. As welding proceeds, some trial-and-error adjustments will be required. Generally, adjusting the speed will be the most effective means of “dialing in” the best seam production. When the ambient temperature is very high, it may be necessary to turn the temperature down.

Rules-of-Thumb for Judging Seam Quality

- The seamed membrane is not discolored: Increase speed if membrane discolors (yellow/brown). If ambient temperature is very high and membrane discolors even when

speed is at maximum, turn down the temperature control.

- Bubbling. If welder setup is marginally too hot, the seam surface may exhibit a slight bubbling appearance.

- Voids and wrinkles. A good seam has no voids or wrinkles and is 2 inches wide with the exposed edge tight. If not, see “Repairing Voids and Wrinkles,” and “Repairing Holes in Membranes.”

- Seam strength may be tested when cool. For best results, testing seams 8 hours after hot-air welding is recommended.

14. Completing a welding run. At the end of a run, lock the nozzle in its UP, non-welding position and turn the transmission switch OFF to stop the machine’s movement. NOTE: some machines stop automatically when the nozzle is taken out of the seam. Mark the end of the seam with a water-soluble marker.

15. Clean the nozzle frequently. The nozzle should be wire-brushed frequently to remove hot particles of the Mule-Hide Heat-Weld compound. (Some applicators wire-brush after each welding run.) If not removed, such particles are likely to be deposited by the nozzle, forming brown streaks at the edge of the lap; more than aesthetics is at stake - the presence of such particles in the seam can affect seam integrity.

16. Cool the welder down. At the completion of a period of welding - for example, at lunchtime or quitting time - with the nozzle locked in its UPWARD position, turn the temperature adjustment dial to its lowest setting. The heating element will shut off, but the blower will continue to operate, cooling the heating element. After about five minutes, turn the power switch OFF. NOTE: some machines will shut down automatically after pushing only one button.

Precautions

As with any high power electrical equipment used outdoors, use accepted practice and common sense to avoid injury. Some suggestions:

- Do not operate any heat welder during storms.

- Use extreme caution to avoid burns. The temperature of the super-heated air in this machine can reach approximately 1200 degrees F (645 degrees C).

- Guard against snagging the power cord.

- If the power cord should become disconnected while the machine is operating, it is desirable to reconnect as quickly as possible, with careful attention to safety, to avoid possible damage from overheating. Switch the machine OFF to avoid arcing when reconnecting to power. Reconnect to power. Turn the power switch ON to resume normal operation.

- Inspect the power cord and connections before each welding session. Repair or replace worn or frayed cords and connectors promptly.

- Although the unit may be a double-insulated design, a ground fault interrupter (G.F.I.) at the power source is still recommended.

NOTICE: This equipment is for industrial use only. These instructions are for general information only. Prior to actual operation of the hot-air welding equipment, refer to the operating instructions that are provided by the manufacturer. Because the handling and use of this equipment is beyond Mule-Hide's control, we will not accept any liability for the results obtained.

All statements herein are expressions of opinion, which by performance and testing are believed to be accurate and reliable, and are presented without any knowledge that such recommended uses may infringe any patent. No warranty of any kind whatsoever, expressed or implied, is made or intended.

Hand Welder

General Description: The hand-held hot-air welder is an electrical powered, hand-held device that utilizes electrical resistance heating and fan-forced super-heated air to heat Mule-Hide Heat-Weld Membranes. A hand-held rubber roller is used in conjunction with the welder to apply the pressure that fuses the heated Mule-Hide Heat-Weld Membrane surfaces to each other.

The hand-Held welder is used as general practice to touch up imperfect seams. It is also used when the self-propelled automatic model is inappropriate, such as in roofing details and on highly sloped surfaces.

Technical Specifications:

- **Electrical requirements:** 115V, 15A (minimum fused), 2,500 W (minimum recommended available power), single-phase current. If using a generator, ensure generator is capable of providing adequate wattage for using the automatic welder and hand gun(s) at the same time.
- **Power cord and extensions:** #12, 3-conductor type may be used for distances up to 100 ft.
- **Adjustments:** Temperature of heating element and air flow louvers (and therefore hot air output).
- **Accessories:** 3/4-in. (20-mm) nozzle (for welding details), 1-1/2-in. (40-mm) nozzle (for straight welding, as when repairing field seams), hand-held silicone rubber roller.
- **Welding speed:** Speed will vary according to ambient weather conditions, element control settings, and user proficiency.

Procedure - Before Connecting to Power

Use the hand-held hot-air welder to repair and/or make all seams that cannot be made by the automatic welders. Be sure to take the following preliminary steps before plugging in the equipment:

1. Fit the appropriate nozzle. In general, the 1-1/2-in. (40 mm) nozzle should be fitted to the welder when making or repairing straight welds; the 3/4-in. (20 mm) nozzle should be fitted when welding flashing details.
2. Be sure the power is OFF and the heat adjustment switch is set to ZERO.

   CHECKPOINT: At this point, it is assumed that you are ready to hot-air weld a seam, and the following requirements have been met:

   - All fasteners are in place and the two surfaces to be welded are in position.
   - The surfaces to be hot-air welded are clean, free of adhesive (a potential problem with flashing details) and other contaminants. If these surfaces are dirty or contaminated, they must be rag-wiped clean with Fantastik® or similar general cleaner, then wiped with a

clean rinse rag and dried thoroughly. The seam area should then be wiped with a clean rag dampened with Mule-Hide Membrane Cleaner to ensure removal of any remaining dirt or soap film.

- During its warm-up period, hot air from the welder should be directed in a safe direction.
- A rubber hand roller is available.

WARNING: Never touch the metal portion of the fan housing, blower tube, or blower nozzle. They become extremely hot and can cause severe burns.

Procedure - Connecting to Power

With the preliminaries done, you are ready to hot-air weld.

1. Connect the machine to power. Ensure that the welder is pointed in a safe, unobstructed direction.
2. Switch the power on. Turn the power switch ON and turn the heat adjustment switch to its highest position.
3. Warm-up the welder for 5 minutes.

NOTE: When first starting out or when welding confined work areas such as corners and pipe penetrations, it is advisable to turn the heat setting down a few notches to avoid applying heat faster than you can work effectively.

4. Insert the nozzle into the lap approximately 2” back from the edge of the membrane to create an air dam. Position the nozzle between the surfaces to be welded and quickly position the hand roller on the outer membrane about 1/8 to 1/4 in. from the end of the nozzle.

NOTE: More heat is needed when beginning a weld than after a weld is underway, because the membrane is cool. In addition, the super-heated air has an easy escape before a seam is formed. As welding proceeds, the membrane warms up and the hot air from the welder is partially trapped by the seam. Be prepared to pick up the pace as you proceed.

5. Roll the seam. When the membrane becomes softened, apply a firm pressure to the roller and roll it across the seam in strokes about 3 in. long.
6. After finishing the first pass down the seam to create the air dam, repeat the process to complete the seam. When making the final pass down the seam, keep a small (1/8”) portion of the tip exposed beyond the edge of the membrane to ensure a complete weld all the way across the seam.
7. Adjust seaming speed to produce the best weld. As the seaming continues, some trial-and-error adjustment of seaming speed will be required. The membrane surfaces must be heated sufficiently to permit the roller pressure to fuse them together, yet the membrane must not be overheated.

Rules-of-Thumb for Judging Seam Quality

- The seamed membrane is not discolored: Increase seaming speed if membrane discolors (yellow-brown).
- Bubbles and thinning: Overheating the membrane causes small bubbles and overstretching to the point of leaving too little sheet thickness, especially when working with unreinforced

material. Another sign of overheating is a darkened “smeared” appearance on the seam.

- Voids and wrinkles. A good seam has no voids or wrinkles. If voids or wrinkles are present, see “Repairing Voids and Wrinkles.”

8. Clean the nozzle frequently. As with the automatic welding machine, the nozzle of the hand welder should be wire-brushed frequently to remove hot particles of the Mule-Hide Heat-Weld compound that may adhere to it. If not removed, such particles are likely to be deposited by the nozzle; the presence of such burned particles in the seam can affect seam integrity.

9. Cool the welder down. When the welder is to be shut down at the completion of a period of welding - turn the temperature adjustment dial to its lowest setting. The heating element will shut off, but the blower will continue to operate, cooling the heating element. Set the welder down so that hot air from the welder is pointed in a safe direction. After about five minutes, turn the power switch OFF.

Precautions

As with any high power electrical equipment used outdoors, use accepted practice and common sense to avoid injury. Some suggestions:

- Do not operate any heat welding equipment during storms.
- Use extreme caution to avoid burns. The temperature of the super-heated air in this machine can reach approximately 800 degrees F (427 degrees C).
- Guard against snagging the power cord.
- If the power cord should become disconnected while the machine is operating, it is desirable to reconnect as quickly as possible, with careful attention to safety, to avoid possible damage from overheating. Switch the machine OFF to avoid arcing when reconnecting to power. Reconnect to power. Turn the power switch ON to resume normal operation.
- Inspect the power cord and connections before each welding session. Repair or replace worn or frayed cords and connectors promptly.
- Use of a ground fault interrupter (G.F.I.) at the power source is recommended.

NOTICE: This equipment is for industrial use only. These instructions are for general information only. Prior to actual operation of the hand-held welding equipment, refer to the operating instructions that are provided by the manufacturer. Because the handling and use of this equipment is beyond Mule-Hide’s control, we will not accept any liability for the results obtained.

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Seam Probing

General Description: the probing of hot-air welded seams is an important step in the application of a Mule-Hide roof, and is your best insurance for successful inspection. **SEAMS WITH VOIDS AND WRINKLES HAVE BEEN THE MOST COMMON DEFECTS CITED BY MULE-HIDE INSPECTORS OVER THE YEARS.**

To ensure consistently high-quality seaming on your job, be sure that ALL seams are probed with an appropriate seam probing tool each work day, and all deficiencies noted/marked with a water-soluble

marker and repaired as promptly as possible with a hand-held hot-air welder. Mule-Hide recommends that you probe seams with a cotter pin puller.

Procedure for Probing the Seams

The probing of seams should not be done until the hot-air welds have thoroughly cooled. As a general procedure, seam probing and repair of deficiencies should be done for all seams approximately 8 hours after they are initially welded.

WARNING: Premature probing can open warm seams that would have been perfectly acceptable once they had cooled.

1. Draw probing tool tip along seams. Gripping the probing tool by its handle, draw its tip along the edge of the hot-air welded seam. Apply firm pressure into the seam junction - not into the bottom sheet. The tool should not penetrate into the lap area.

2. Mark deficiencies. Using a water-soluble marker, mark off the beginning and end of each void.

3. Repair deficiencies promptly. Using a hand-held welder, repair all seam deficiencies as quickly as possible. It is required by Mule-Hide that repairs be made the same day that they are discovered.

4. Check repairs. After the repaired seams have cooled completely, probe them again. If the repair is successful, wipe off the water-soluble marker line; if not, do the repair over.

End of Section

MULE-HIDE PRODUCTS CO., INC.

INSULATION GUIDELINES

TABLE OF CONTENTS

Section		Page
1.0	Insulation Guidelines	1
2.0	Insulation	1
3.0	Minimum Insulation Specifications	2
4.0	Insulation Fastening Patterns	2
5.0	Optional Methods of Insulation Attachment	3
6.0	Insulation Storage	3
7.0	Insulation Application - Recommended Practices	4

Please consult the Mule-Hide website for the most current information at www.mulehide.com

MULE-HIDE PRODUCTS CO., INC.
INSULATION GUIDELINES

1.0 Insulation Guidelines

A. The following is a list of generic insulations acceptable for use with Mule-Hide Roofing Systems. Requests to use other types of insulation boards are to be made to Mule-Hide's Technical Department in writing prior to job bid. Such requests must include the conditions for approval, project name and location of project.

B. Insulation must be no less than 1 inch thick with the exception of high-density wood fiberboard, high density polyisocyanurate, extruded polystyrene and tapered boards. When the insulation is applied directly over a steel deck, in no case shall the minimum allowable thickness be less than that required to span the flutes of a steel deck.

C. Applicable building codes should always be checked prior to proposing the application to Mule-Hide or the building owner.

D. Factory Mutual (FM) and Underwriters Laboratory (UL) assemblies can be found in the Factory Mutual Approval Guide and/or Underwriters Laboratories Building Material Directory and Fire Resistance Directory. Code requirements may dictate the use of specific types and thicknesses of insulation. You can contact the Mule-Hide Technical Department for help in determining which Mule-Hide system may meet your code requirements.

2.0 Insulation

Insulation Type	Used as Overlay Board	Roof Systems		
		Adhered	Ballasted	Mech Attached
Polyisocyanurate - Min 1" thick (top layer) - Min 20 psi	Yes	Yes	Yes	Yes
OSB/Polyisocyanurate Composite - Min 1.5"	Yes	Yes	Yes	Yes
HD Polyisocyanurate Coverboard – Min ½" thick	Yes	Yes	Yes	Yes
HD Fiberboard - Min 1/2" thick [8]	Yes	Yes	Yes	Yes
Dens Deck Prime / Securock - Min 1/4" thick	Yes	Yes	Yes	Yes
OSB - Min 7/16" thick [2]	Yes	Yes	Yes	Yes
Expanded Polystyrene - Min 1" - Type I [3 4 6]	NO	NO [1]	Yes	NO [1]
Expanded Polystyrene w/facer - Min 1" - Type II [3 4 7]	NO	NO [1]	Yes	Yes [5]
Extruded Polystyrene - Min 3/4" thick - Type X [3 4]	NO	NO [1]	Yes	NO [1]
Extruded Polystyrene - Min 1" - Type IV [3 4]	NO	NO [1]	Yes	Yes [5]
Extruded Polystyrene Fan Fold – Min ¼" thick [3 4]	NO	NO [1]	NO	Yes
Protection Mat - Min 6 oz.	NO	NO [1]	Yes	Yes

Notes:
1 - Requires overlay board
2 - OSB must be installed with the rough side up
3 - Not approved over Coal Tar Pitch
4 - Can not be placed in contact with PVC, requires a separation layer
5 - Overlay board recommended
6 - Type I = min 0.90 lb density
7 - Type II = min 1.35 lb density
8 - DO NOT use '6-sided' or asphalt coated board for PVC or water based adhesive

See other requirements listed below.

3.0 Minimum Insulation Specifications

A. Project or Code requirements may dictate use of materials other than those listed below. Contact Mule-Hide Technical Department with questions regarding use insulations in a Mule-Hide Roofing System.

1. Wood fiberboard (High Density)
   Thickness: 1/2" Minimum
   Classification: ASTM C-208, Type 2

2. Polyisocyanurate
   Thickness: 1" Minimum
   Classification: ASTM C 1289,
   Facers: Fiber reinforced facers, both sides

3. High Density Polyisocyanurate
   Thickness: 1/2" Minimum
   Compressive Strength: Min 90 psi at 10% deformation
   Facers: Fiber reinforced facers, both sides

4. Extruded Polystyrene Boards (flat stock)
   Thickness: 3/4" Minimum
   Classification: Type X
   Compressive Strength: Min 15 psi at 10% deformation
   Not for use over Coal Tar Pitch. Applications may require use of higher density material or overlay.

5. Extruded Polystyrene Boards (fan fold)
   Thickness: 1/4" Minimum
   Compressive Strength: Min 15 psi at 10% deformation
   Not for use over Coal Tar Pitch.

6. Expanded Polystyrene Boards
   Thickness: 1" Minimum
   Classification: Type 1
   Compressive Strength: Min 10 psi at 10% deformation
   Not for use over Coal Tar Pitch. Applications may require use of higher density material or overlay.

7. Expanded Polystyrene Boards (fan fold)
   Thickness: 1/2" Minimum
   Classification: Type 1
   Compressive Strength: Min 10 psi at 10% deformation
   Not for use over Coal Tar Pitch. Applications may require use of higher density material or overlay.

8. Perlite is a mineral fiber insulation board that Mule-Hide does not recommend be used in conjunction with the Mule-Hide Roofing Systems. However, should perlite be required to meet building codes, FM, or UL requirements, the perlite **must** be overlaid with an acceptable insulation. **Perlite is not acceptable for use in recover applications.**

9. Fiberglass is not an acceptable insulation for use in Mule-Hide Roofing Systems.

4.0 Insulation Fastening Patterns

A. Insulation that is mechanically attached to the substrate shall use approved Mule-Hide fasteners. Minimum insulation attachment rates shall be as per Mule-Hide's requirements or insulation manufacturer's specifications, whichever is greater. Projects requiring Factory Mutual or other Code approvals may require heavier gauge fasteners or additional fasteners. In no case shall the insulation attachment rate be less than Mule-Hide's requirements.

B. Insulation is always fastened with 3” Galvalume Stress Plates with minimum #12 Drill Point fasteners.

C. Refer to Mule-Hide specifications and details for minimum fastening rates and patterns.

5.0 Other Methods of Insulation Attachment

A. Asphalt - While Mule-Hide may accept (on a job to job basis) attachment of insulation with hot asphalt for use with Mule-Hide systems, asphalt is neither supplied nor manufactured by Mule-Hide; therefore, the attachment of the insulation with asphalt shall not be covered by Mule-Hide's Standard Warranty. However, if a qualified project designer specifies asphalt attachment, the following recommendations are given:

1. Steep asphalt ASTM D312, Type III or IV, shall be specified

2. Asphalt may only be used to attach approved insulations to primed structural concrete decks, properly nailed base sheets or a base layer of mechanically attached, approved insulation. Insulation must be approved by Manufacturer for use with hot asphalt.

3. Maximum insulation board size shall not exceed 4'x 4'. **4'x 8' boards are not permitted.**

4. Expanded or extruded polystyrene insulation shall not be attached with asphalt.

B. Other insulation adhesive products may be an acceptable method of attaching certain insulation boards to approved substrates. As Mule-Hide does not supply or manufacture insulation adhesives, the products must be installed in strict compliance with the requirements published by the manufacturer. Contact the manufacturer for information and recommendations regarding the appropriate use of these products. Mule-Hide must be contacted prior to the use of any such product. The attachment of the insulation is not covered by the Standard Mule-Hide warranty.

C. Mule-Hide Premium warranties require that Mule-Hide give approval of the insulation adhesive prior to bidding. A copy of the Insulation Adhesive Manufacturer's letter of acceptance for the project must be forwarded to Mule-Hide for review and acceptance by Mule-Hide prior to bidding the project.

6.0 Insulation Storage

A. Insulation boards stored or stocked on the job site or roof must be stacked on pallets (or other supports) above the deck or ground.

B. Insulation shall be covered with waterproof tarps to protect insulation from sun and inclement weather. Wet or damaged insulation must not be used in Mule-Hide roofing systems.

C. Insulation should not be stored on the job site for more than thirty (30) days if at all possible.

7.0 Insulation Application - Recommended Practices

A. For mechanically attached systems, install field sheets perpendicular to long dimension of the top layer of insulation. Where possible, boards should run parallel to the direction of the flutes of the deck.

B. Install insulation boards in parallel courses with tightly fitted and staggered joints. Cut all boards accurately to fit neatly around all projections and at all edges. Gaps greater than 1/4" shall be filled. End joints should be staggered a minimum of 6 inches or as approved by insulation manufacturer.

C. Do not use wet or damaged insulation boards. Install no more insulation than can be covered with seamed membrane and watertight details before any precipitation occurs.

D. On steel decks, the ends of the insulation boards shall rest on the top of the flutes and not in suspension over the valleys.

E. When two layers of insulation are used, the second layer must have the joints staggered to the first layer a minimum of 6 inches or as approved by insulation manufacturer. One set of fasteners may be used to secure both layers of insulation unless otherwise required by the insulation board manufacturer or the design professional.

F. In accordance with Mule-Hide specifications, provide proper water cutoffs to completely seal the insulation on a daily basis.

Caution: Do not install over wet, damp or uneven substrates.

Caution: Keep all insulations away from fire, flame and ignition sources during storage and installation.

End Of Section