WELDING GUIDE
FOR
HENSLEY ADAPTERS

OCTOBER 2009
The Hensley "Welding Guide" is intended to assist customers with welding Hensley GET products. It is a general welding guide and is not all inclusive. Your specific application may require different welding practices. This welding guide is not intended to be used for joint design of buckets or other attachments. Hensley accepts no responsibility for the misuse or misinterpretation of this information.
Preparation of the Plate Steel and the Steel Castings

The surfaces to be welded must be free from scale, grease, paint, water, etc. The basis here is to provide a good surface for welding. This is a very good practice and is mentioned in all welding codes including AWS 14.3, the "Specification for Welding Earthmoving and Construction Equipment". The surfaces must be sufficiently clean so that there is nothing that might contain hydrocarbons, which break down in the heat of the arc producing hydrogen, which can be absorbed in the weld and cause cracks. Preparation of the weld surfaces may be achieved by sand blasting, shot blasting, grinding, sanding, air carbon arc gouging, or a combination of any these process.

In a new fabrication, rebuild, or a conversion, there can be gaps between the adapters and the plate lip. Gaps that are no greater than 3/32" / 2.4mm require no additional work, just good sound welding techniques. Gaps that are greater than 3/32" / 2.4mm, should be dealt with in the following manner:

1. Preheat adapter leg to 300°F / 150°C
2. Deposit stringer bead(s) on the landing of the adapter to reduce the gap condition
3. Grind weld so that there is a smooth transition in the weld groove area of the adapter
4. Check fit adapter on lip – grind or weld as required to eliminate gap condition

If the throat opening of the adapter is too narrow to fit the lip, grinding of the land at the bottom of the weld groove is permissible. If more than 1/8" / 3.2mm is removed from the land, the weld groove needs to be widened to achieve the original weld groove size.

Welding Processes

Welding may be done by any of the following processes:

- Shielded Metal Arc Welding (SMAW)
- Gas Metal Arc Welding (GMAW)
- Flux-cored Arc Welding (FCAW)

A combination of SMAW and GMAW or FCAW can be employed.

<table>
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<tr>
<th>Process</th>
<th>AWS</th>
<th>JIS</th>
<th>NF</th>
<th>DIN</th>
<th>BS</th>
<th>Shielding Gas</th>
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<td>JIS Z3212</td>
<td>E515B12029(H)</td>
<td>E51B10120</td>
<td>E515B12029(H)</td>
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<td>NF A 81 309</td>
<td>DIN 8556</td>
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<td>JIS Z3312</td>
<td>GS 2</td>
<td>SG2</td>
<td>A18</td>
<td>100 CO2</td>
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<td>NF A 81-311</td>
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<td>BS2901-1</td>
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<td>GMAW</td>
<td>E70C-6M</td>
<td>JIS Z3313</td>
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<td>SG2</td>
<td>GBH</td>
<td>92%Ar/8%CO2</td>
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<tr>
<td></td>
<td>AWS A5.18</td>
<td>YFW-A50DM</td>
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<td></td>
<td>90%Ar/10%CO2</td>
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<td>FCAW</td>
<td>E70T-5</td>
<td>JIS Z3313</td>
<td>TGS 51 3.3</td>
<td>GB1</td>
<td>T530</td>
<td>100% CO2</td>
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<td>AWS A5.20</td>
<td>YFW-C50DM</td>
<td>BH NF A 81-350</td>
<td>CY4254 DIN 8559</td>
<td>GBH BS7084</td>
<td>75%Ar/25%CO2</td>
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<tr>
<td>FCAW</td>
<td>E71T-1</td>
<td>JIS Z3312</td>
<td>TGS 51 3.3</td>
<td>GB1</td>
<td>T530</td>
<td>100% CO2</td>
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<td>YFW-C50DR</td>
<td>BH NF A 81-350</td>
<td>CY4254 DIN 8559</td>
<td>GBH BS7084</td>
<td>75%Ar/25%CO2</td>
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Electrical Characteristics

A. Polarity

All welding shall be done using direct current electrode positive (DCEP)

B. Current and Voltage Ranges

<table>
<thead>
<tr>
<th>Electrode Diameter</th>
<th>SMAW Amperes</th>
<th>GMAW and FCAW Amperes</th>
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</thead>
<tbody>
<tr>
<td>2.4mm / 3/32 in.</td>
<td>65 to 120</td>
<td></td>
</tr>
<tr>
<td>3.2mm / 1/8 in.</td>
<td>80 to 160</td>
<td></td>
</tr>
<tr>
<td>4.0mm / 5/32 in.</td>
<td>115 to 220</td>
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</tr>
<tr>
<td>4.8mm / 3/16 in.</td>
<td>140 to 300</td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>Electrode Diameter</th>
<th>Voltage</th>
<th>Amperes</th>
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</thead>
<tbody>
<tr>
<td>1.2mm / 0.045 in</td>
<td>22 to 30</td>
<td>220 to 320</td>
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<tr>
<td>1.4 mm / 0.052</td>
<td>25 to 30</td>
<td>250 to 325</td>
</tr>
<tr>
<td>1.6mm / 1/16 in.</td>
<td>25 to 35</td>
<td>250 to 360</td>
</tr>
<tr>
<td>2.4mm / 3/32 in</td>
<td>28 to 35</td>
<td>350 to 450</td>
</tr>
</tbody>
</table>

Welding Symbols

Weld symbols are used as a type of shorthand to indicate the type of weld, its size and other processing and finishing information. The following section will introduce you to the most common symbols you may encounter, while using our product, and their meaning. The complete set of symbols is given in a standard published by American National Standards Institute (ANSI) and the American Welding Society (AWS): ANSI/AWS A2.4, Symbols for Welding and Nondestructive Testing.

Welding Symbol Structure

The horizontal line, called the reference line, is the anchor to which all the other welding symbols are tied. The instructions for making the weld are strung along the reference line. An arrow connects the reference line to the joint that is to be welded. The example above has the arrow growing out of the right end of the reference line and heading down to the right, but other combinations may be encountered.
Quite often, there are two sides of the joint to which the arrow points, and therefore two potential places for a weld. For example, when two steel plates are joined together into a "T" shape, welding may be done on either side of the stem of the "T".

![Diagram of a "T" joint with arrow and other side labels]

The weld symbol distinguishes between the two sides of a joint by using the arrow and the spaces above and below the reference line. The side of the joint to which the arrow points is known as the **arrow side**, and its weld is made according to the instructions given below the reference line. The other side of the joint is known as the **other side**, and its weld is made according to the instructions given above the reference line. The below=arrow and above=other rules apply regardless of the arrow's direction.

The flag (**field weld symbol**) growing out of the junction of the reference line and the arrow is present if the weld is to be made in the field during erection of the structure. A weld symbol without a flag indicates the weld is to be made in the shop.

The unfilled circle (**weld-all-around symbol**) at the junction of the reference line and the arrow indicates the joint is to be welded all the way around.

![Diagram of a weld symbol with unfilled circle and additional information]

The tail of the weld symbol is the place for supplementary information on the weld. It may contain a reference to the welding process, the electrode, a detail drawing or any information that aids in the making of the weld that does no have its own special place on the symbol. If there is no additional information needed, the tail may be omitted.

**SMAW**

In this example, the tail contains information indicating the welding process that is to be used which in this case is Shielded Metal Arc Welding (stick welding).

see ref. drawing # A6647

This example indicates that there is a drawing that needs to be referenced for additional information.
Types of Welds and Their Symbols

Each type of weld has its own basic symbol, which is typically placed near the center of the reference line (and above or below it, depending on which side of the joint it’s on). The symbol is a small drawing that can usually be interpreted as a simplified cross-section of the weld. The examples below show the most common types of welds that may be utilized on our products. They are shown in both **arrow-side** and **other-side** position and how they would appear in a complete weld symbol. This is not meant to be an all-inclusive list of weld symbols. The complete set of symbols is given in a standard published by [American National Standards Institute (ANSI)](http://www.ansi.org) and the [American Welding Society (AWS)](http://www.aws.org): *ANSI/AWS A2.4, Symbols for Welding and Nondestructive Testing.*

- **Fillet weld**
- **Square groove weld**
- **"J" groove weld**
- **"V" groove weld**
- **Bevel groove weld**
- **Plug welds and slot welds**

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**Complete Weld Symbol Example**

A = welding process  B = weld type  C = weld size

The above symbol is read as: deposit a 3/4" fillet weld on the arrow-side of the joint utilizing the Gas Metal Arc Welding Process (Mig).
All welding should be done in the flat or horizontal position. Deviation from the flat or horizontal position is permissible following the figure shown below which is adapted from AWS D1.1, Structural Welding Code – Steel, figure 4.2 "Positions of fillet welds".

The longitudinal axis of the weld may be inclined no more than 15° with respect to the horizontal plane. The center of the weld face © must lie within the rotational limits of 80° to 280° as shown.
Preheat and Interpass Temperatures

Preheat is the application of heat to the work piece prior to welding, cutting, or gouging. All cutting and welding processes use a high temperature heat source. These high temperatures exceed the melting point of the base metal. This creates the problem of a traveling high temperature, localized heat source, and the effect that it has on the surrounding base metal.

A large temperature differential causes thermal expansion and contraction, high stresses, hardened areas, and a very small area for hydrogen gases to escape from the steel. Preheating will reduce the danger of weld cracking, reduce maximum hardness of the heat affected zone, minimize shrinkage stresses, lessen distortion, and create a larger area for hydrogen gases to escape from the metal.

Prior to any cutting, gouging, tacking, or welding operation, the following preheat temperatures must be achieved and maintained.

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness</th>
<th>Minimum Preheat Temperature</th>
<th>Maximum Interpass Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hensley Castings</td>
<td>N/A</td>
<td>300°F / 150°C</td>
<td>450°F / 230°C</td>
</tr>
<tr>
<td>ASTM A514 (T1) Bisalloy 80</td>
<td>Thru 1-1/2&quot; / 38mm</td>
<td>125°F / 50°C</td>
<td>450°F / 230°C</td>
</tr>
<tr>
<td>Weldox 100</td>
<td>1-1/2&quot; / 38mm thru 2-1/2&quot; / 63mm</td>
<td>175°F / 80°C</td>
<td>450°F / 230°C</td>
</tr>
<tr>
<td></td>
<td>Over 2-1/2&quot; / 63mm</td>
<td>250°F / 120°C</td>
<td>450°F / 230°C</td>
</tr>
<tr>
<td>400 BHN Abrasion Resistant Steel-Hardox 400</td>
<td>All thicknesses between 1&quot; / 25mm and 5&quot; / 127mm</td>
<td>300°F / 150°C</td>
<td>450°F / 230°C</td>
</tr>
</tbody>
</table>

The chart shown above lists common materials used on buckets and attachments that utilize Hensley Ground Engaging Tools (GET). It is not an all inclusive list of materials. To determine the pre-heat and interpass temperatures for materials not listed here:

1) Consult the material manufacturer or supplier.
2) Use the Carbon Equivalency Formula (CE).

**Carbon Equivalency Formula**

$$\text{CE} = C + \frac{(Mn + Si)}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15} = \text{ (percent)}$$

The elemental values (e.g. Mn, Si etc.) can be obtained from the material's *mill cert* (mill certification) from the manufacturer or supplier.

The result of the CE formula is then compared to charts that may be provided by the steel manufacturer or listed in *American Welding Society publication D14.3*. The charts will indicate the amount of preheat that is required for that particular steel's composition and thickness.
Welding Technique

Stringer beads are recommended for higher strength and to minimize distortion. The use of weave or wash beads should not be used, however weaving is permitted to the extent that bead widths are no greater than 1/2" / 12mm.

Craters: When a weld pass is terminated within the finished product, the crater shall be filled to at least 85% of the full cross section of the weld. This will help eliminate the possibility of crater cracks. When welding with the SMAW process, the easiest way to achieve this is to stop the travel of the electrode and pause briefly before breaking the arc. When welding with the GMAW or FCAW processes, stop the travel and extinguish the arc, initiate the arc briefly, then extinguish.

Porosity: Porosity is a cavity-type discontinuity or defect that is formed by gas entrapment during solidification. Porosity reduces the strength of a weld and should be removed and replaced if the sum of the visual or surface porosity, including piping porosity, is greater than 1/4" / 6mm in any 4" / 100mm length of weld. A single void shall not exceed 1/16" / 1.6mm.

Overlap and Undercut: Weld overlap shall not exceed 1/16" / 1.6mm beyond the fusion line of the weld. Undercut shall not exceed 1/16" / 1.6mm in any joint or 10% of the base metal whichever is less. In addition, the accumulative length is not to exceed 1-1/2" / 38mm over a 24" / 610mm continuous section of weld.

Arc Strikes: A discontinuity resulting from a arc, consisting of any localized re-melted metal. Arc strikes should be avoided. Arc strikes that occur inside or outside the weld zone should be ground out.

Each weld shall merge smoothly into adjoining bead or base metal surface. Remove all unacceptable defects (crater cracks, porosity, overlap, undercut, etc.) on the weld surface or groove sidewalls before proceeding with the next weld pass. Removal may be accomplished by grinding with abrasive wheels, stones, or carbide burrs. Air carbon arc gouging may also be used, followed by grinding to remove all carbon slag.

Clean each pass of deposited weld metal before depositing the next weld pass. Using manual slag hammers, pneumatic needle gun, wire brushes or any combination of these tools may accomplish cleaning.

Notes: If the ambient humidity is high and or the temperature is below 40°F / 4°C, the tabulated value should be increased by 80°F / 27°C. At no time should any material type or thickness be welded when the temperature of the steel is at or below 40°F / 4°C.

Preheating with burners or torches is much more effective when the heat is applied from the bottom side of the work piece with insulating blankets on the topside. The blankets help to disperse the heat evenly as well as retain the heat that has been input. Measure the temperature with a temperature indicating crayon or an infrared thermometer from the topside. This will insure that the preheat is not just on the surface of the material, but a complete preheat through the thickness of the materials to be welded. All material within 4" / 100mm of the weld zone must be within the specified temperature.

Cool slowly. Do not allow drafts or cool ambient temperatures to cool the parts or assembly. Cool down rate should not exceed 130°F / 55°C, per hour. If the ambient temperature is at or below 40°F / 5°C, the part should be covered in a thermal blanket to insure the cool down rate listed above is achieved, or the entire part can be post-heated to 300°-400°F / 149°-204°C for four hours and then air cooled.
BE SURE TO READ ALL INSTRUCTIONS PRIOR TO STARTING ANY WELDING!

Preheating

Preheat area to be welded to appropriate temperature (see Preheat and Interpass Temperatures) based on type of base metal being welded.

Welding Sequences

Hensley Construction Size 2 leg Center Adapter

Place adapter on lip plate per desired location from side to side. The top leg of the adapter should be in full contact with the bevel area and the top surface of the lip. Any gap condition should be pushed to the bottom leg of the adapter. Insure that the fit conditions comply with the requirements mentioned in this publication. Preheat in accordance with the preheat chart. Deposit one 1" / 25mm long tack at the root of the weld groove on each side of the adapter.

Welding begins on the bottom side. The bottom leg of the adapter is shorter than the top leg, thus requiring less welding. Starting the welding sequence on the bottom side will help to insure that the lip plate remains flat. Begin welding at the front of the weld groove on the bottom leg and travel towards the back or heel of the adapter. Do not start the weld any closer to the leading edge of the lip than the weld groove in the adapter. Deposit weld on the opposite side of the adapter joining the first bead at the back or heel of the adapter. Repeat this process for the second and third weld passes. Vary the lengths of the weld beads so that the stops (craters) are not in the same location. Turn Lip Over.

Welding Sequence on Bottom Surface of Lip

Deposit root pass on the top leg of the adapter starting 1" / 25mm on the leading edge side of the back of the adapter. Terminate this weld 1" / 25mm beyond the end of the radius on the opposite side of the adapter. (See figure below) Deposit weld at the front of the weld groove and travel towards the first weld pass. Do not weld within 1" / 25mm of the leading edge of the lip. Deposit a similar bead on the opposite side of the adapter. Repeat this process for the second and the third weld passes. Vary the lengths of the weld beads so that the stops (craters) are not in the same location. Turn Lip Over.

Welding Sequence on Top Surface of Lip

Deposit root pass on the top leg of the adapter starting 1" / 25mm on the leading edge side of the back of the adapter. Terminate this weld 1" / 25mm beyond the end of the radius on the opposite side of the adapter. (See figure below) Deposit weld at the front of the weld groove and travel towards the first weld pass. Do not weld within 1" / 25mm of the leading edge of the lip. Deposit a similar bead on the opposite side of the adapter. Repeat this process for the second and the third weld passes. Vary the lengths of the weld beads so that the stops (craters) are not in the same location. Turn Lip Over.
To achieve final fillet weld size, follow bottom leg to top leg weld sequence. (See figure below) It is also recommended to alternate the weld from adapter to adapter following the sequence shown below.

**Example of bottom leg to top leg weld sequence**

![Bottom leg to top leg weld sequence diagram](image)

**Example of adapter to adapter weld sequence**

![Adapter to adapter weld sequence diagram](image)

*Typical 5-tooth layout*
The fillet weld leg size should be a minimum of 1/16" / 1.6mm above the edge of the cast weld groove in the adapter. This final fillet weld should be an equal legged fillet weld. For many of the mining product sized adapters, a 2 to 1 weld ratio is required. In this case, the fillet weld leg length on the lip is twice the length of the height to the edge of the cast weld groove on the adapter.

When welding construction sized adapters, considerable grinding effort can be saved by carefully staggering the starting points of the weld beads near the leading edge of the lip. By starting each weld layer 1/16" / 1.6mm behind the preceding layer, the final fillet weld will have a tapered start. Vary the lengths of the weld beads so that the stops (craters) are not in the same location.

**Example of staggered starts and stops on construction size adapters**

![Construction Size Adapter](image)

**Mining Adapters**
*(for machine classes over 200 tons)*

The use of starter/run-out tabs on mining size adapters is recommended. The starter/run-off tabs should be constructed of 1/4" (6mm) minimum thickness mild steel, (ASTM A36 or equivalent) and must extend at least 2" (50mm) beyond the start of the weld prep on the adapter. Tabs should be positioned 1/4" (6mm) away from the start of the weld bevel on the adapter. Upon completion of the fillet weld, remove the starter/run-off tabs using air carbon arc gouging process. Follow the weld finishing information of mining adapters.
The following instructions are for welding Hensley straddle-leg adapters where the adapter contacts the lip. Take note of weld / no weld areas (see drawings below). Instructions continue on page XX.

Locate straddle-leg adapter on lip plate/cheek plate. Insure that the fit conditions comply with the requirements mentioned in this publication. Preheat in accordance with the preheat chart. Deposit one 1" / 25mm long tack at the root of the weld groove on each side of the adapter.

Welding begins on the bottom side. The bottom leg of the adapter is shorter than the top leg, thus requiring less welding. Starting the welding sequence on the bottom side will help to insure that the lip plate remains flat and that the stresses will equal out from the topside to the bottom side. Begin welding at the front of the weld groove on the bottom leg and travel towards the back or heel of the adapter. Do not start the weld any closer to the leading edge of the lip than the weld groove in the adapter. Deposit weld on the opposite side of the adapter joining the first bead at the back or heel of the adapter. Repeat this process for the second and third weld passes. Vary the lengths of the weld beads so that the stops (craters) are not in the same location. Turn Lip Over.
Begin welding the top leg at the center of the inside top leg and weld the root pass to the end of the weld groove at the back of the leg. The second bead is deposited at the center of the outside top leg and extends to the end of the weld groove at the back of the leg. On the inside leg, begin the root pass at the front of the weld groove and proceed to the starting point of the first bead. Do not weld with in 1” / 25mm of the leading edge of the lip. Deposit a similar root pass on the opposite side of the top leg. Repeat this process for the second and third weld passes. Vary the lengths of the weld beads slightly so that the start/stop positions are not at the same location.

This size adapter requires additional weld layers. Turn lip over and follow the top to bottom weld sequence and the adapter-to-adapter weld sequence mentioned earlier in the publication. Continue in this manner until the desired fillet weld size has been achieved.

The fillet weld leg size should be a minimum of 1/16” / 1.6mm above the edge of the cast weld groove in the adapter. This final fillet weld should be an equal legged fillet weld. For many of the mining product sized adapters, a 2 to 1 weld ratio is required. In this case, the fillet weld leg length on the lip is twice the length of the height to the edge of the cast weld groove on the adapter.

**Hensley Cast Corner Adapter**

Hensley cast corner adapters are offered in a variety of sizes and shapes. Some have weld preps cast into the lip (cutting edge) and cheek plate portions of the corner castings and some do not. Modifying the cast corner adapter is not required and is not recommended. The cutting edge and cheek plates should be beveled to create a 100% penetration weld joint. In full penetration welds it is absolutely necessary that the welder has sufficient room and accessibility to deposit the weld at the root of the joint.

There are three major factors that must be considered when designing the cutting edge to the cast corner adapter weld joint and the cheek plate to cast corner adapter weld joint. These factors are:

1. **Included Angle** - The included angle can vary based on the material thickness, type of weld prep on the cast corner adapter and the welding process that will be used. As the material thickness increases and the joint becomes deeper, a wider joint is required for GMAW wire welding due to the nozzle diameter and access to the root of the joint. The root of a narrow joint can be accessed with SMAW due to the small diameter of the stick electrode.

2. **Root Face** - The root face should be kept to a minimum. This will permit better penetration and less material to be removed in the back-gouging process.

3. **Root Opening** – Too tight of a root opening can prevent full penetration and require more material to be removed in the back-gouging process. Too wide of a root opening can make it difficult for the welder to properly join the materials and is more likely to create welding defects.
Both the double bevel groove and the double “V” groove are pre-qualified and acceptable weld grooves. However, both of these grooves must be constructed to allow access to the root of the joint for the welding process being used.
Hensley Cast Corner Adapter

Remove lifting eye, if applicable. Grind clean all weld joint surfaces of the cast corner adapter to provide a clean surface for welding. All paint should be removed. Position the cast corner adapter at the desired location, in most cases, the top and bottom of the cast corner should be flush with the top and bottom surfaces of the lip plate. **Note: Integral cast corners shall be located so that the nose angle of the cast corner is the same as the nose angle of the adjacent center adapters on the lip.** Insure that the fit conditions comply with the requirements mentioned in this publication. Preheat in accordance with the preheat chart. Tack weld the corners in place using two 1" / 25mm long beads at the root of the groove weld. Install groove extensions.

**Example of how Groove Extensions can be used on cast corner adapters.**
Tack weld starter/run-off tabs or groove extensions at each end of the joint. The starter/run-off tabs should be constructed of ¼" / 6mm minimum thickness mild steel, (ASTM A36 or equivalent) and must extend at least 2" / 50mm beyond the ends of the weld grooves.

**NOTE**
Not all Hensley cast corner adapters will have beveled weld prep areas (see page 17).

Deposit a continuous root bead on one side of the joint, starting on the starter tab and stopping on the run-off tab. Deposit a second layer of weld on the same side of the joint. Turn assembly over and back gouge the root of the joint to sound base metal. Deposit root pass and second pass on this side.

The first few weld passes on the cast corner are very important. These weld passes can cause the cast corner to pull out of square to the lip plane. Continually checking the cast corner for square, and depositing weld accordingly can maintain square. Continue building up the groove in weld layers, turning the lip after each layer.

The cheek plate to cast corner adapter joint is filled the same as the cutting edge joint. Deposit root pass and second layer of weld on the inside of the bucket. Back gouge cheek plate joint on outside of bucket for 100% penetration and clean gouged area. Alternate each layer of weld from inside of bucket to outside of the bucket.

Remove the starter/run-off tabs using the air carbon arc gouging process. Grind the gouged surfaces to form a smooth transition between the lip and the cast corner.
Weld Finishing

Grinding

The surfaces of the adapter to lip welds shall be ground smooth. All welds on the top and bottom sides should be ground.

Grinding should produce a smooth surface free of roughness and unevenness associated with the weld beads. The toes of the welds shall transition into the lip and the adapter smoothly. The transition should have a minimum radius of 1/8" / 3mm.

Proper grinding directions
Temper or Annealing Weld Beads

Temper or annealing weld beads are additional beads placed on top or the bottom of the finished fillet weld. The application of a tempering or annealing weld bead is designed to reduce the risk of hydrogen assisted cracking. The heat from these beads, tempers, anneals, or softens the final weld pass against the casting/lip and the "Heat Affected Zone", (HAZ), within the casting/lip caused by the weld pass adjacent to the casting/lip.

The tempering or annealing weld beads should be placed so that the toe of the bead is 1/8" to 3/16" / 3.2mm to 4.8mm away from the top or bottom toe of the final weld of the fabrication.

**Temper beads should be ground smooth.**

<table>
<thead>
<tr>
<th>Process</th>
<th>Electrode Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAW</td>
<td>5/32&quot; / 4.0mm</td>
</tr>
<tr>
<td>GMAW</td>
<td>1/16&quot; / 1.6mm</td>
</tr>
<tr>
<td>FCAW</td>
<td>1/16&quot; / 1.6mm</td>
</tr>
</tbody>
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Welding Terms and Definitions

• Air Carbon Arc Gouging – A carbon arc process that removes molten metal with a jet of air.

• American Weld Society (AWS) – A nonprofit technical society organized and founded for the purpose of advancing the art and science of welding. The AWS publishes codes and standards concerning all phases of welding.

• British Standards Institute (BSI) – A nonprofit concern. The principal object is to coordinate the efforts of producers and users for the improvement, standardization, and simplification of engineering and industrial material.

• Crater – A depression in the weld face at the termination of a weld bead.

• Defect – A discontinuity or discontinuities that by nature or accumulated effect (for example, accumulative length of undercut not to exceed 1.5" / 38mm over a 24" / 609mm section of weld) render a part or product unable to meet minimum applicable acceptance standards.

• Deutsches Institute fuer Normung (DIN) – German Standard

• Direct Current Electrode Positive (DCEP) – The arrangement of direct current arc welding leads in which the electrode is the positive pole and the workpiece is the negative pole of the welding arc.

• Discontinuity – An interruption of the typical structure of a material, such as lack of homogeneity in its mechanical, metallurgical, or physical characteristics.

• Electrode – A component of the electrical circuit that terminates at the arc, molten conductive slag, or base metal.

• Filler Material – The material to be added in making a welded joint.

• Fillet Weld – A weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, T-joint, or corner joint.

• Flux Cored Arc Welding (FCAW) – An arc welding process that uses an arc between a continuous filler metal electrode and the weld pool. The process is used with shielding gas from a flux contained within the tubular wire electrode, with or without additional shielding from an externally supplied gas and without the application of pressure.

• Francaise de Normalisation (NF) – French Standard

• Gas Metal Arc Welding (GMAW) – An arc welding process that uses an arc between a continuous filler metal electrode and the weld pool. The process is used with shielding from an externally supplied gas and without the application of pressure.

• Japanese Industrial Standards (JIS) – The Japanese Standards Association publishes standards, including metals, welding filler materials, etc.

• Layer – A stratum of weld metal consisting of one or more weld beads.
Welding Terms and Definitions

• Overlap – The protrusion of weld metal beyond the weld toe or weld root.

• Porosity – A cavity-type discontinuity or defect formed by gas entrapment during solidification.

• Preheat – The application of heat to the work piece prior to welding cutting or gouging.

• Root – The point, shown in cross section, at which the weld metal extends furthest into a joint and intersects the base metal.

• Run-off Weld Tab – Additional material that extends beyond the end of the joint, on which the weld is terminated.

• Shielded Metal Arc Welding (SMAW) - An arc welding process with an arc between a covered electrode and the weld pool. The process is used with shielding from the decomposition of the electrode covering, without the application of pressure, and with filler metal from the electrode.

• Shielding Gas – Protective gas used to prevent or reduce atmospheric contamination of a weld, especially by oxygen and nitrogen.

• Starter Weld Tab – Additional material that extends beyond the beginning of the joint, on which the weld is started.

• Stringer Bead – A type of bead made without appreciable weaving motion.

• Tack Weld – A weld made to hold the parts of a weldment in proper alignment until the final welds are made.

• Undercut – A groove melted into the base metal adjacent to the weld toe or root and left unfilled by weld metal.

• Weld Groove – A channel in the surface of a work piece or an opening between two joint members that provides space to contain weld.

• Weld Toe – The junction of the weld face and the base metal.

• Welding Sequence – The order of making welds in a weldment.
SAFETY FIRST: Hensley recommends that you use a soft-faced hammer and ANSI-approved (Z87.1) eye protection while using our products.