

WELDING PROCEDURE FOR HALF ARROW PRODUCTS

SHARK™ GROUND ENGAGING TOOLS

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1.0 SCOPE:

This procedure/specification is intended to provide background information and supplementary instructions to subcontractors/welders who are assembling and welding the following SANDVIK Half Arrow blade products and components including straight / no-spade lip, semi-spade lip, and full-spade lip configurations

- Half Arrow Light Duty
- Half Arrow Heavy Duty
- Half Arrow Extreme Duty

2.0 WELDING SAFETY:

Refer to PWP0001 for details.

3.0 WELD PROCEDURE SPECIFICATION:

Refer to WPS SS-011 - for HA 50 & 32 mm SS2000 & SS2300 material

4.0 WELDING PROCESS:

Refer to PWP0001 for details.

5.0 ELECTRICAL PARAMETERS:

Refer to PWP0001 for details.

6.0 WELDING POSITION

Welding operations shall be performed in the 1G, 1F, 2G, 2F (PA, PB, PC) welding positions. 3GVU (PF) position welded vertical up may be applied where approved by Sandvik representatives. Vertical down progression for any weld pass is strictly prohibited. SMAW / MMAW may weld 3GVU (PF) without approval.

7.0 WELDING CONSUMABLES:

Refer to PWP0001 for details. Recommended consumables are as in Table 2 of PWP0001.

8.0 WELDING PREPARATION:

Refer to PWP001 for details.

9.0 PREHEAT/ INTER-PASS/ POST-WELD COOLING:

Material	Target Pre-heat Temperature °C	Max Inter-pass temperature °C	Post weld Heat Treatment
Sandvik Half Arrow G.E.T. products.	160-190	225	Stabilize for 2Hrs & Max Cooling rate 50°C/hr
Lip plates (ASTM A514 Steels)	As per the manufacturer's recommendation	As per the manufacturer's recommendation	As per the manufacturer's recommendation

Table 1 Preheat, Inter-pass temperature

Refer to Weld procedure PWP0001 & WPS SS-011 for more details.

10.0 AVOIDING HACC & STRESS CRACKING:

The welding of SANDVIK Half Arrow G.E.T products and components demands specific welding precautions to reduce the risk of Hydrogen Assisted Cold Cracking (HACC) and stress cracking. Do not overweld joints. Refer to Sandvik Instructions WPS: SS-011 for G.E.T products for weld profile requirements. This is important to avoid stress cracking.

Grind weld toes during multi pass welding. Completed welds will benefit with weld toe grinding to remove stress concentrations where cracks may initiate.

Refer to PWP0001 & WPS SS-011 for further details.

11.0 WELDING FABRICATION INSTRUCTION:

11.1. PREPARATION, PROFILING & TRIM OF HALF ARROW SHROUDS:

- 11.1.1. Mark the workpieces that require trimming with a trim or cut line (see Figure 1) to suit part placement as indicated by either the lip layout drawing or measured from the bucket lip assembly.

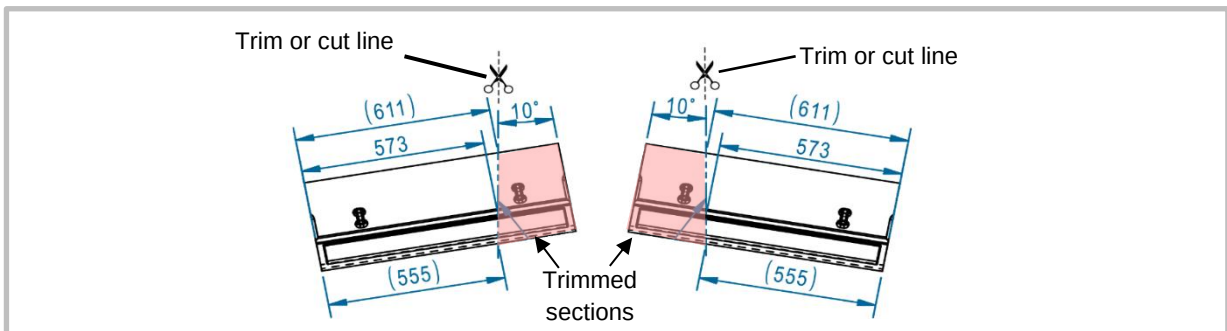


Figure 1 Example of the trim length of Half Arrow products as specified in a lip layout drawing example SL1065.

- 11.1.2. Secure the workpieces for safe trimming.
- 11.1.3. Apply preheat (see section 9.0) if using a thermal cutting process.
- 11.1.4. Cut/trim the workpiece to the desired length.
- 11.1.5. Grind a beveled weld prep edge (use Profile W below) into the trimmed surface of the workpiece (see Figure 2) to the appropriate A length.

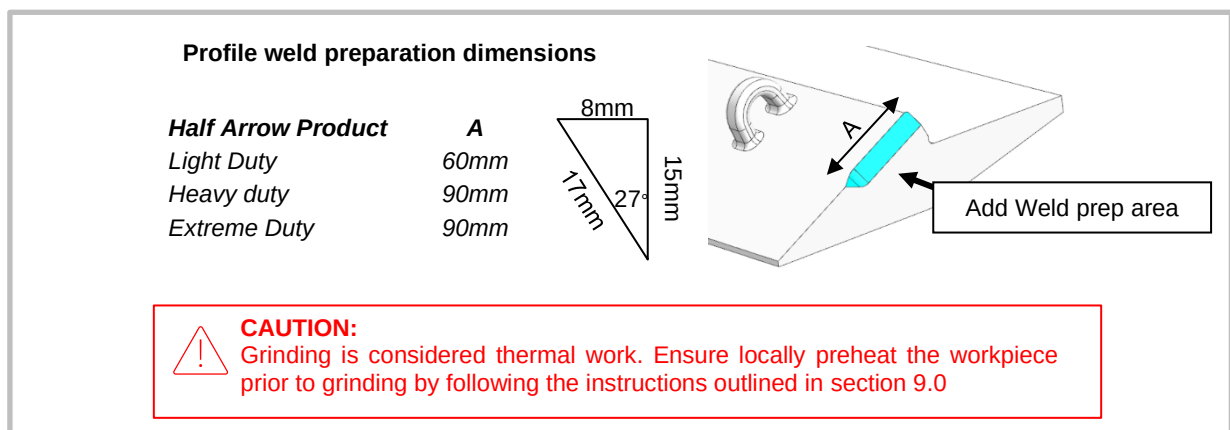


Figure 2 Weld prep size and location.

- 11.1.6. Ensure all workpiece weld areas are free from corrosion, paint, contaminants, and other impurities.

11.2. PREPARATION AND PROFILING OF BUCKET LIP PLATE:

- 11.2.1. Bevel the top and bottom leading edges of the bucket lip plate as per the lip assembly drawing.
- 11.2.2. Ensure the lip plate weld areas are free from corrosion, paint, or other impurities and contaminants.

12.0 WELDING SEQUENCE/ PROCEDURE:

Refer to PWP0001 for details.

13.0 PREHEAT APPLICATION:

All thermal work such as welding, grinding, gouging and arc welder cutting requires the workpiece to be heated to and maintain the temperatures specified in section 9.0

Apply preheat – using large diameter heating nozzles – to the workpiece from the opposite side of the workpiece that is being welded. Refer Figure 3.

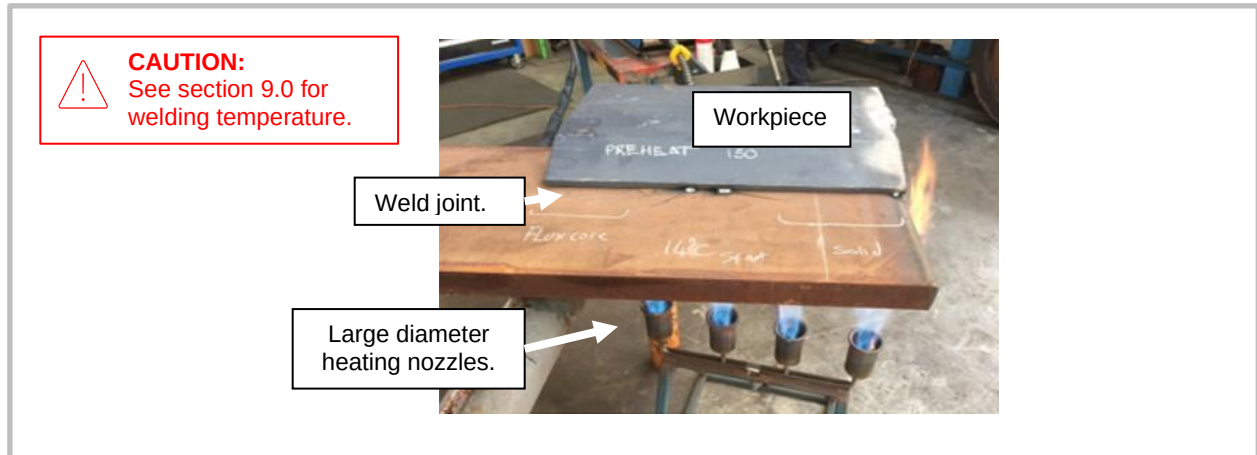


Figure 3 Preheat application

Heat the workpiece to the preheat temperature specified in section 9.0 measured on the opposite side of the preheat at least 75mm / 3" away from and on either side of the weld joint. Inter-pass temperature must be maintained throughout the welding process.

It is good practice to use thermal blankets to maintain welding temperatures.

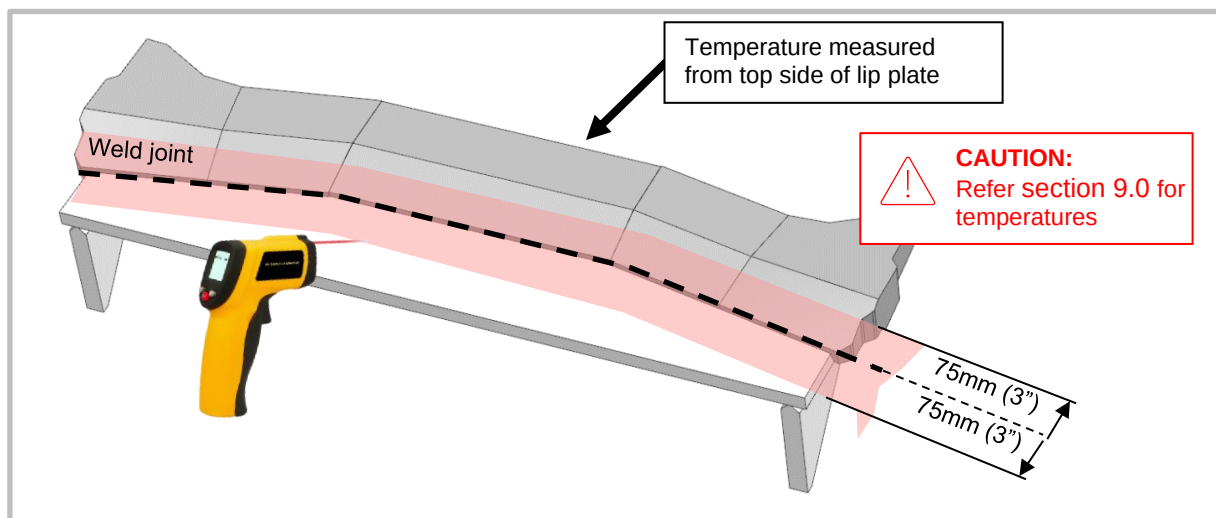


Figure 4 How to measure preheat and inter pass temperatures

14.0 INSTALLING SHROUDS ON LIP PLATES:

It is important to preheat the workpiece components prior to commencing welding (Refer section 9.0) and to maintain the components within the acceptable inter-pass temperature range during welding.

Step 1 : Position Half Arrow segments on the lip plate such that the base of the lip is flat against the Half Arrow lip face and the leading edge is butt against the Half Arrow lip step as shown in Figure 5.

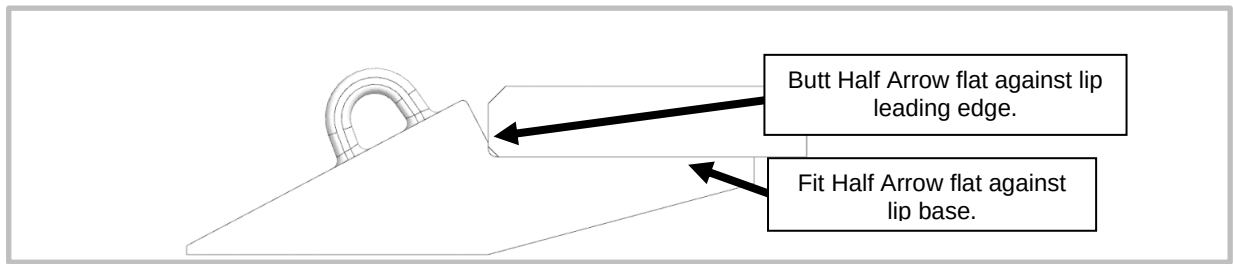


Figure 5 Half Arrow segment placement against lip plate

Step 2 :Place Half Arrow center segment on the lip first and secure it with the help of clamps and tack weld them into place as shown in Figure 6. If the lip has no center segment, move to the next step.

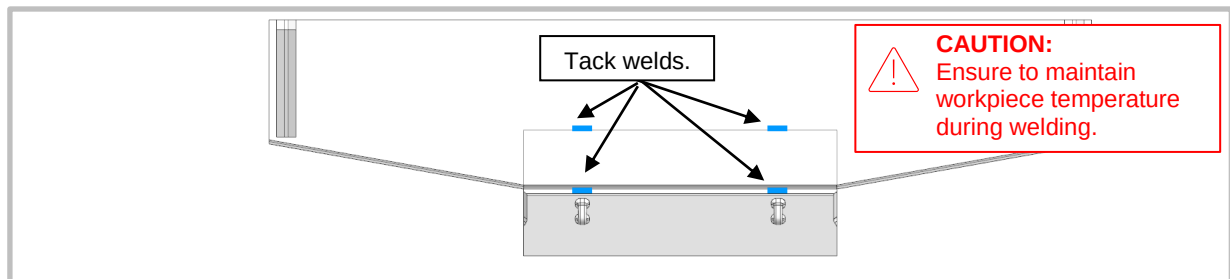


Figure 6 Center segment placement (image is for reference purposes only).

Step 3 :Place Half Arrow corner segments on the lip and tack in place as shown in Figure 7.

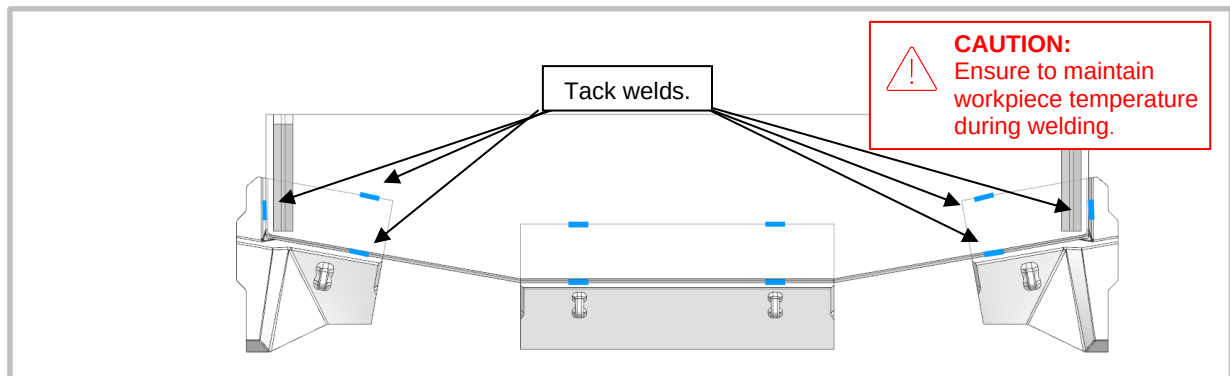


Figure 7 Corner segment placement (image is for reference purposes only)

Step 4 :Trim all Half Arrow side segments (if necessary) to suit the lip layout (see section 11.1). Place Half Arrow side segments on to lip and tack in place as shown in Figure 8.

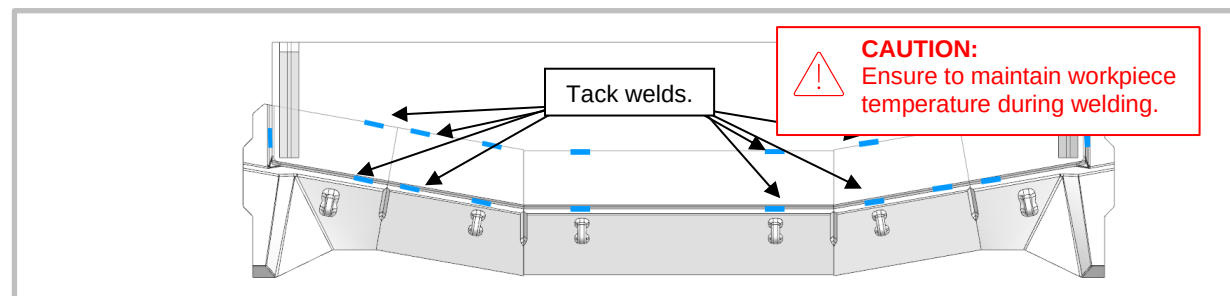


Figure 8 Side segment placement (image is for reference purposes only).

Note: It is acceptable for parts to misalign as shown in Figure 9. Do not attempt to align the tips of the Half Arrow segments as doing so will stress the components and may cause cracking.

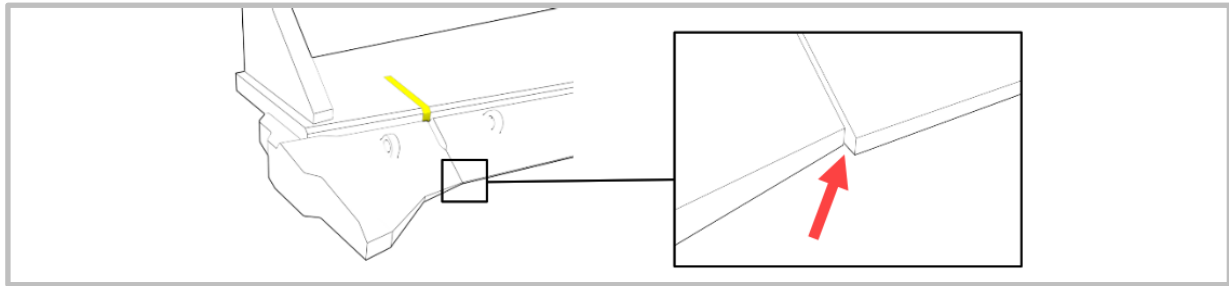


Figure 9 Example of misaligned parts (image is for reference purposes only).

Step 5 :Complete a full root run and one capping pass along the length of the bottom side of the lip.

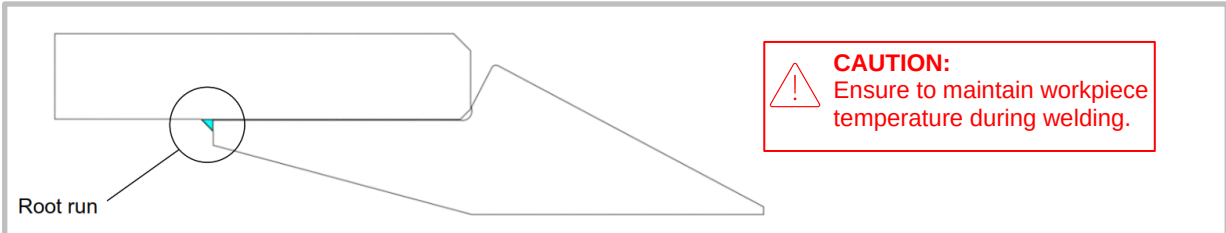


Figure 10 Root run – bottom side of the lip (image is for reference purposes only).

Step 6 :Progressively lap fillet welds on the bottom face of the lip until the correct weld size indicated by the lip assembly drawing is achieved (Figure 11). If the drawing doesn't specify a weld size, refer to the weld size in table below.

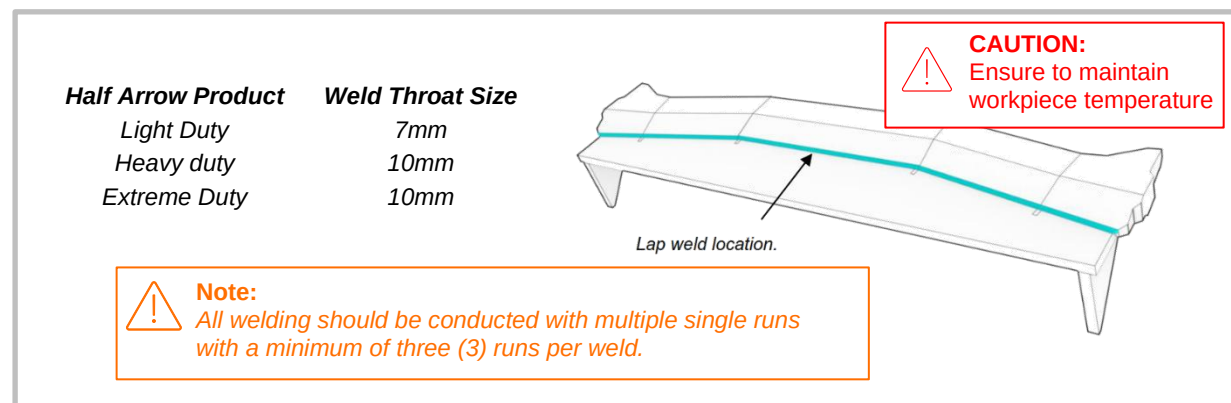


Figure 11 Bottom lip face lap weld (image is for reference purposes only).

Step 7 :Complete a full root run and one capping pass in the top weld gap along the length of the lip.

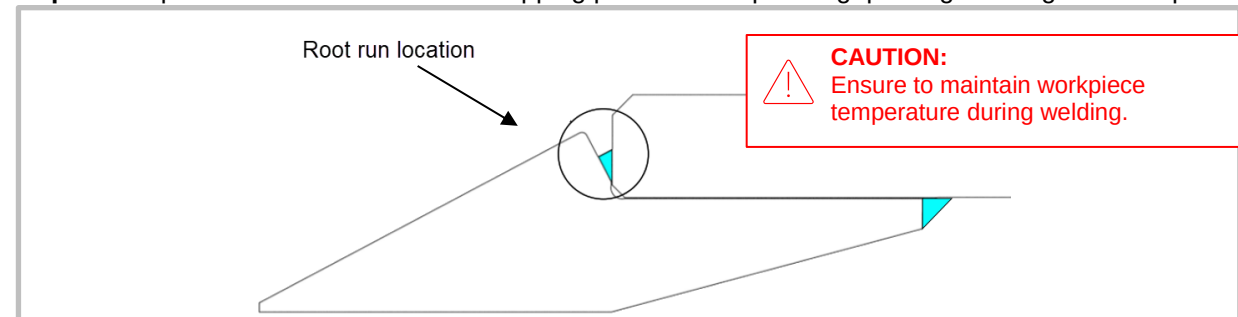
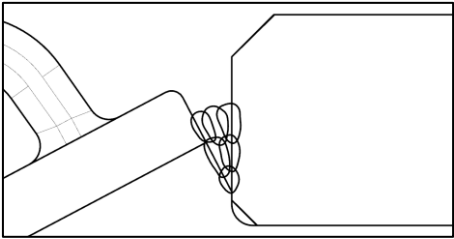


Figure 12 Root run – top side of the lip (image is for reference purposes only)

Step 8 :Progressively lap bevel welds on top lip face and corner side face welds until the correct weld size – as indicated by the lip assembly drawing – is achieved. If the drawing doesn't specify a weld size, refer to the weld size in the table below (Figure 13)

Front Lip Face Weld		Welding sequence
Half Arrow Product	Minimum Bevel Weld Size	
Light Duty	10mm	
Heavy duty	20mm	
Extreme Duty	20mm	
Corner side face		
Half Arrow Product	Minimum Bevel Weld Size	
Light Duty	10mm	
Heavy duty	14mm	
Extreme Duty	14mm	

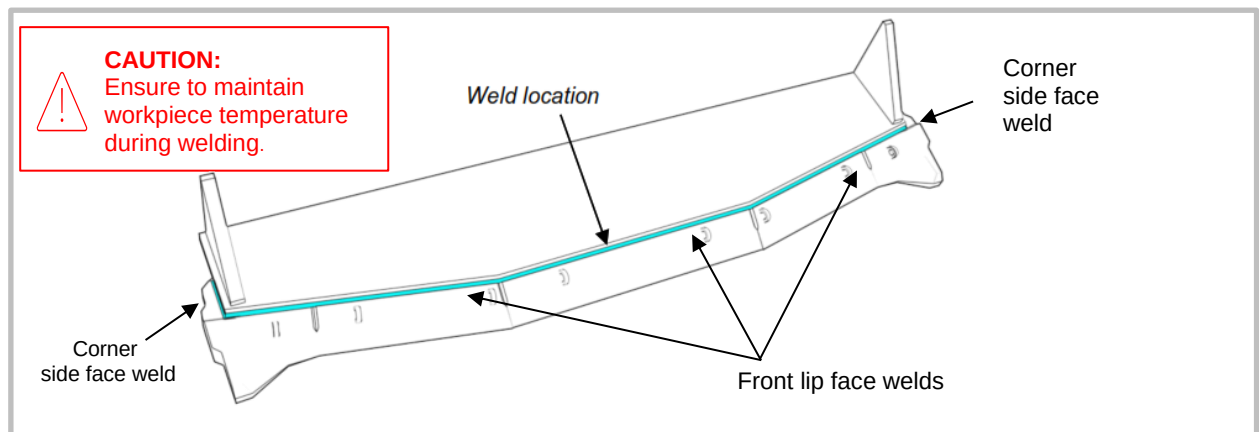


Figure 13 Bevel weld – top side of the lip (image is for reference purposes only).

Step 9: Check the amount of bevel weld using a ruler or a straight edge as shown in Figure 14 to ensure the weld size has reached as specified in the lip layout drawing and WPS: SS-011.

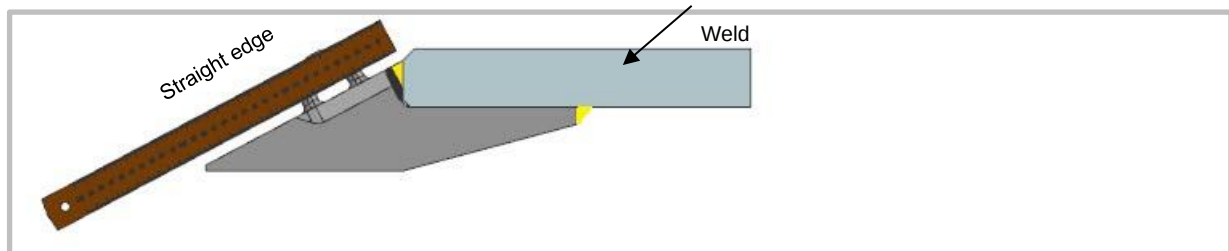


Figure 14 Checking the weld size to avoid over welding

Step 10 :Progressively v-weld down each beveled edge between Half Arrow segments filling the weld prep areas as indicated by the lip assembly drawing.

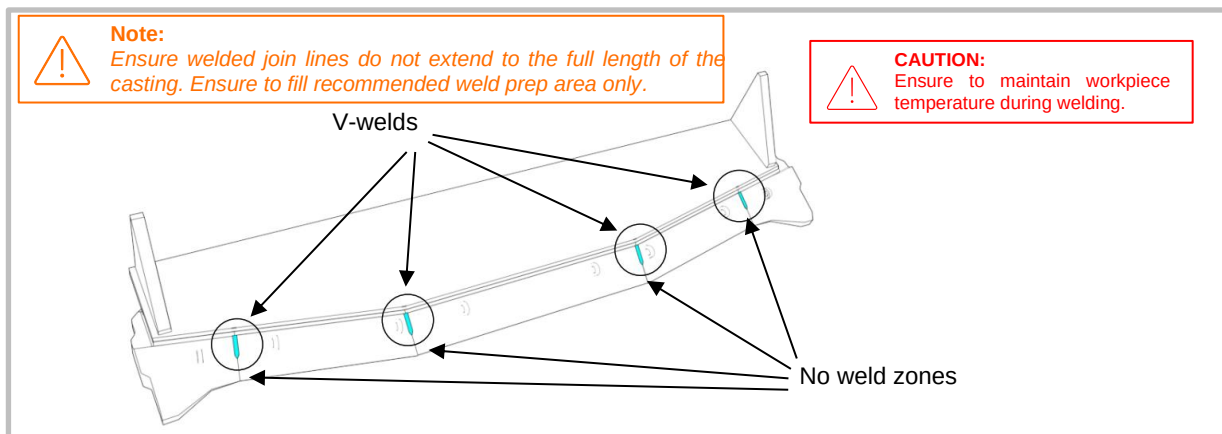


Figure 15 Weld locations example (image is for reference purposes only)

15.0 WELD FINISHING & TESTING (VISUAL & CRACK TESTING):

Refer to PWP0001 for further instructions.

Hydrogen assisted cold cracking appears as delayed cracking and hence it is recommended that crack testing is carried out after 48 to 72 Hrs.

If cracking is found, remove the crack by grinding and re-weld it.

Where Non-Destructive Examination (NDE) methods in addition to visual inspection are applied, the acceptance criteria for welds shall satisfy AS/NZS: 1554 Part 4 – SP criteria of AWS D1.1 cyclically loaded connections

16.0 REWORK/ REPAIR OF CRACKS:

Cracks on the material may occur due to hydrogen cracking, fatigue, mechanical stresses and environmental causes. Hydrogen cracking occurs most often immediately on weldment at temperatures near normal ambient caused by the diffusion of hydrogen to the highly stressed, hardened part of the weldment and sometime due to no preheating taken before welding process.

It is important to apply localized preheating to the rework component areas prior to commencing rework. Refer section#9.0 and maintain the rework area within the acceptable inter pass temperature range throughout the rework process.

- Excavate cracked material until the whole crack is removed and expose the sound base metal.
- Visually inspect the excavated area for any cracks
- If the crack is still present continue excavating till the crack is completely removed.
- Fill the excavated crater with weld material
- Perform quality inspection following the instructions outlined in Section 15.0

17.0 REMOVAL INSTRUCTION

It is important to preheat lip assembly components prior to removing components from the bucket lip (see Section 9 for preheat instructions) and to maintain the lip components within the acceptable inter-pass temperature range throughout the removal process.

Step 1 : Identify Half Arrow parts that require removal.

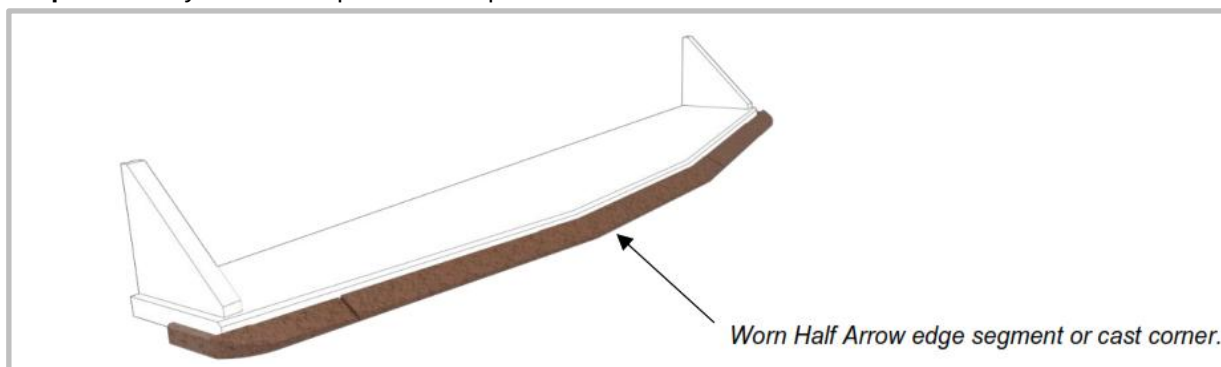


Figure 16 Worn Half Arrow parts

Step 2 :Gouge parts off the bucket.

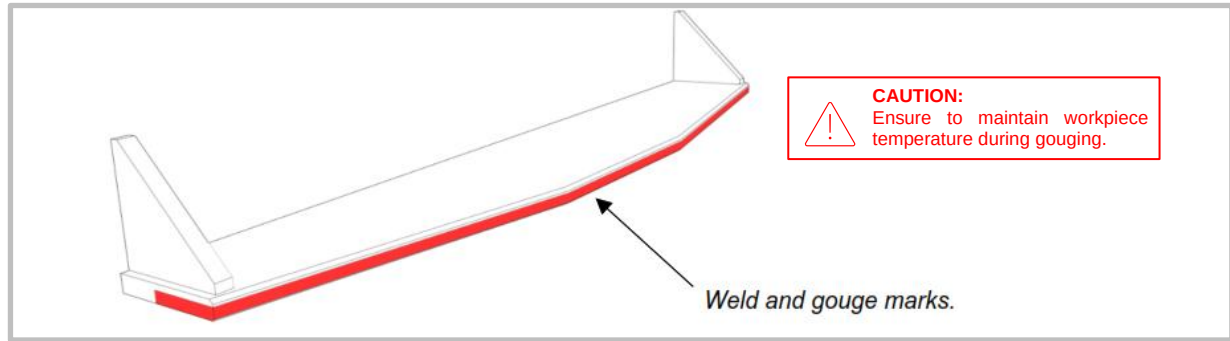


Figure 17 Gouge-worn Half Arrow parts from the primary lip.

Step 3 :Use a grinder to remove leftover welds and clean the carbon-infused area on the bucket lip.

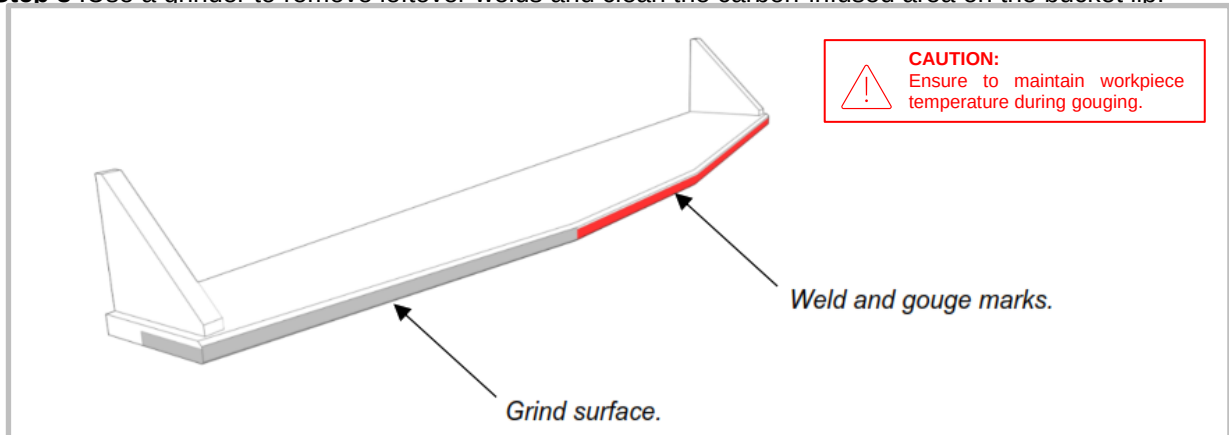


Figure 18 Remove leftover welds and clean the area.

Step 4 :Follow quality inspection instructions as outlined in Section 15. If material cracking is found follow rework instructions as outlined in Section 16.

The lip is considered ready for the next set of shrouds if a visual, dimensional and quality checks pass.

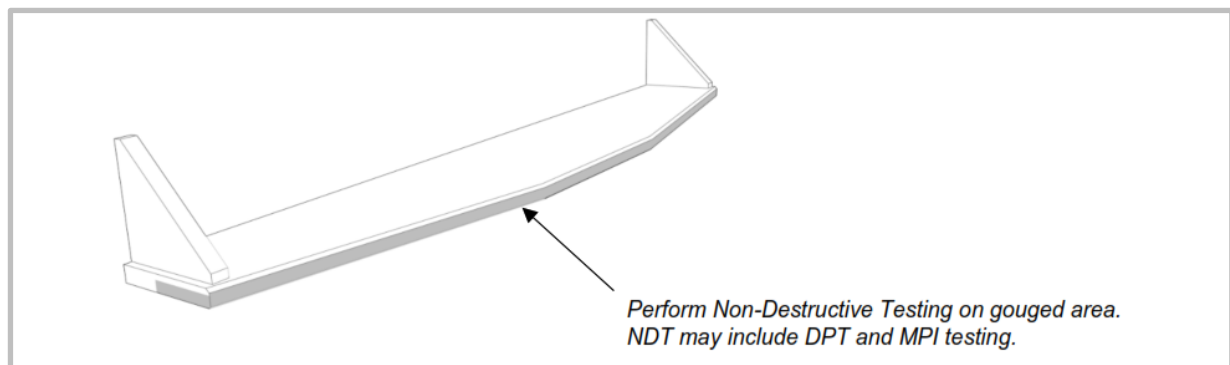


Figure 19 Inspect primary lip.

18.0 APPENDIX 1: WELDING CHECKLIST

Date:		Tick one	
Item	Description	Yes	No
1.0	Site Prestart Checklist		
1.1	Are all welding operators trained/certified?		
1.2	Are all welding instructions clear and understood by operators?		
1.3	Are all welding operators familiar with the welding machine?		
1.4	Do the welding operators have the appropriate equipment to complete this job?		
1.5	Has the equipment been inspected by a competent person and confirmed safe for use?		
1.6	Are all welding operators aware of all site-specific safety and emergency protocols?		
2.0	Welding Prestart Checklist	Yes	No
2.1	Are all welding operators familiar with the General Welding Procedure for Shark™ Ground Engaging Tools (PWP0001)?		
2.2	Are all welding operators familiar with the Shark™/SANDVIK Half Arrow Welding Procedure?		
2.3	Have all welding operators read and understood the welding safety requirements of this document? (If the answer is 'No', read Section 2 of this document)		
2.4	Are all welding operators familiar with the pre-heat and inter-pass temperature requirements for this product? (If the answer is 'No', read Section 8 of this document)		
2.5	Are all welding operators familiar with the welding instructions for this product, including pre and post-welding instructions? (If the answer is 'No', read Section 8 of this document)		
2.6	Are all welding operators using the correct welding consumables for this job? (Refer to PWP0001 - General Welding Procedure)		
2.7	Do you have the correct gauges to aid installation?		
3.0	Post weld Checklist	Yes	No
3.1	Are the welds the correct size? (If the answer is 'No', read Section 13 Step 8 of this document)		
3.2	Are the welding operators controlling the rate of cooling? For example, with a thermal or insulating blanket?		
	Has the correct post-welding procedure been followed? (If the answer is 'No', read Section 14 of this document)		
3.3	Has the weld inspection procedure been followed? (If the answer is 'No', read Section 14 of this document)		
3.4	If rework is required, has the rework procedure been followed? (If the answer is 'No', read Section 15 of this document)		

Welding Record- SANDVIK Half Arrow Blades

1) Pre- Weld Inspection of Castings:

Follow NDT /crack detection test on half arrow castings prior to welding to ensure castings are sound and free from any discontinuities.

Findings:

2) Post Weld Inspection:

Follow NDT test on finished weld. Ensure the welds are free from cracks and other defects. Crack testing is preferred after 72 Hrs of completing the weld, as hydrogen related cracking can appear later.

Findings

3) Record the Weld:

Record all details of Weld including the date, Name of welder, Welding consumables, Pre-heat, Inter-pass and Post weld temperatures

4) Welding records:

Company Name: Date:

Machine Number: Bucket Number:

Machine Operating Hours :

5) Welding work done:

Describe the welding work completed. **Include photograph that clearly show location and extend of welding.** Include a ruler or tape measure in the photo to show the size of the weld or repair.

.....

6) Welding Wire or Electrodes:

Manufacturer, type and product number or code

Carbon Arc gouging rods-make and size

Preheating method

Pre-heat temperature measuring method

Sandvik recommends welding wires or electrodes that are understrength, high ductility with toughness at least 40J @ -40C

Name of the Welder Signature

Inspected bySignature



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20.0 REVISION HISTORY:

REV#	NOTES	PREPARED BY	CHECKED BY	APPROVED BY	DATE
1-6	Previous release	-	-	-	-
7	This draft not released. Procedures are now unified and updated. This document supersedes: PWP0003, PWP0013, PWP0015, PWP0022, PWP0024,	R.L	J.J	M.J	15/08/2022
8	Rev 7 draft reviewed by weld consultant and revised contents in conjunction with PWP001 Rev 6& WPS:SS-011 Rev 1. Gauge BU00031483 replaced with straight edge	J.J	Weld Consultant	M. J	18/04/2023
9	Added applicable HA parts to section#1 The following documents archived as PWP0016 supersedes those documents. 1. PWP0003-SS2000 range center section components. 2. PWP0013- SS2000 range wear edge components. 3. PWP0015- SS2000 range full spade lip 4. PWP0022- SS2300 welding recommendations 5. PWP0024- SS2300 range semi spade lip	J.J	-	M.J	18/05/2023
10	Added Preheat temperature Table to Section 9.0	R.L	J.J	M.J	23/11/2023
11	Updated max inter pass temps	R.L	-	M.J	19/12/2024