

MAKO™ 50 mm LIP FABRICATION AND INSPECTION PROCEDURE

SHARK™ GROUND ENGAGING TOOLS

1.0. INTRODUCTION

The purpose of this procedure is to detail the fabrication steps involved in manufacturing a MAKO™ Lip Assembly. In conjunction with this document, the following documents should be used as referenced.

- PGP0051 - Gauging procedure
- BU00037748 - Weld information drawing
- PWP0001 - Welding procedures for Sandvik G.E.T.
- PWP0021 – Welding procedure for Mako & Blue Pointer products

Each Lip Assembly must be manufactured to the dimensions specified in our Layout drawing (SL0XXX) which is provided when the MAKO™ Lip is ordered.

Follow Sandvik recommended Safe Working Procedure (SWP0004) during lip fabrication process.

2.0. PROCEDURE

2.1. PREPARATION AND PROFILING

2.1.1. Profile cut lip plate from Hardox 400 or 450 Q/T or equivalent Steel to the dimensions specified in layout drawing. Refer Figure 1.

2.1.2. Before cut, ensure pre-heating the cut zone to a temperature of minimum 150 degree Celsius with a maximum of no greater than 250 degree Celsius. The heat should encompass a minimum of 75mm on either side of the cut, as specified in welding procedure PWP0001.

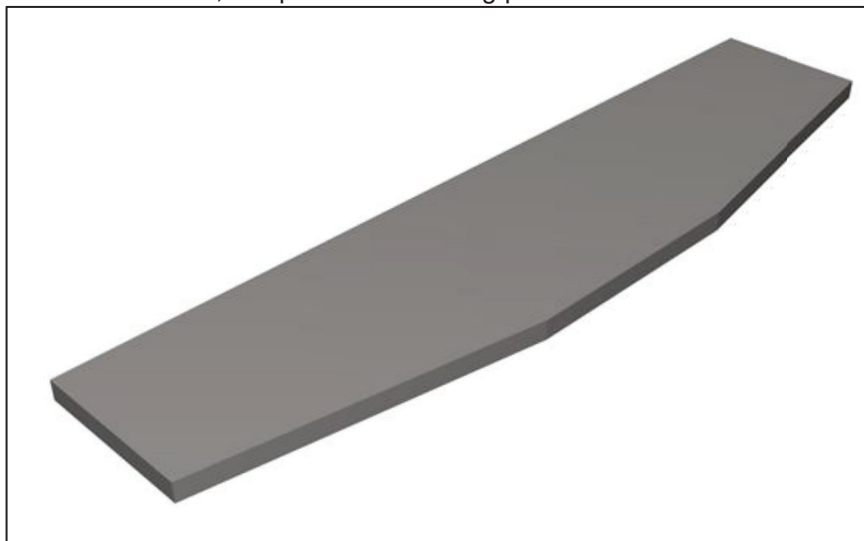


Figure 1 Spade profiled Lip Plate

2.1.3. Inspect the profile cut Hardox plate and measure and record the dimensions as shown in Figure 2. Dimensional values must be as per the lip layout drawing.

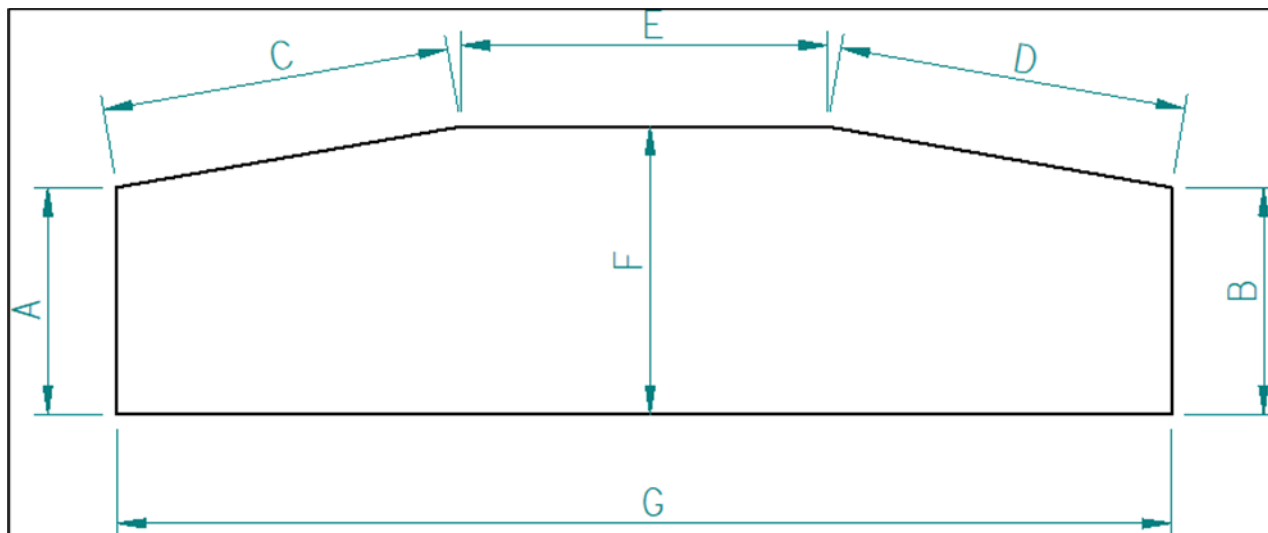


Figure 2 cut plate dimensions

2.2. BEVEL PROFILING AND INSPECTION

2.2.1. Bevel lip plate as detailed in drawing BU00037748. Refer Figure 4.

2.2.2. Once again, before the cut, pre-heat the cut zone as mentioned in step 2.1.2. Refer Figure 3.



Figure 3 Preheating Hardox plate

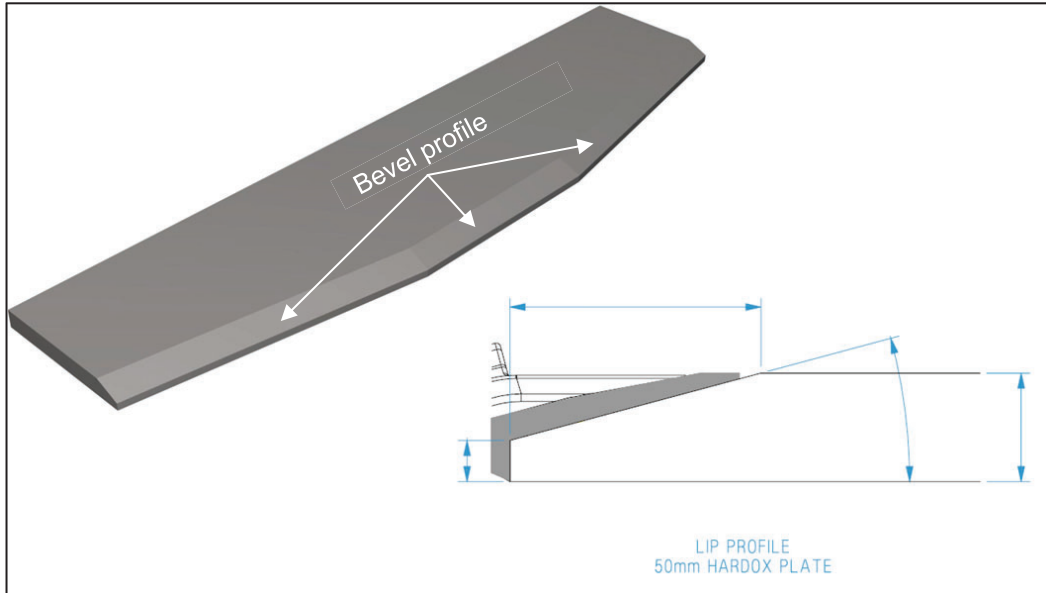


Figure 4 Bevel Profile as per BU00037748 excerpt

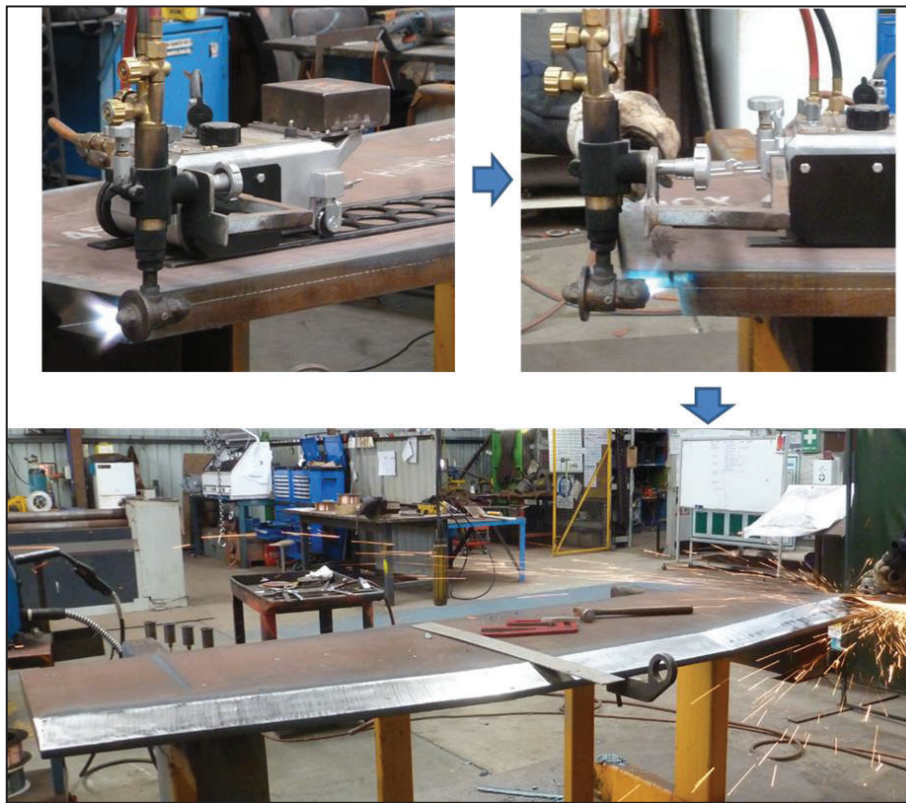


Figure 5 Lip Bevel Profiling

2.2.3. After bevel cut is completed, clean the profile and inspect the Lip using Gauge SGM50-LP as per the procedure PGP0051. Refer Figure 6. Perform inspection at various locations along leading edge. Re-work the Lip in areas of interference.

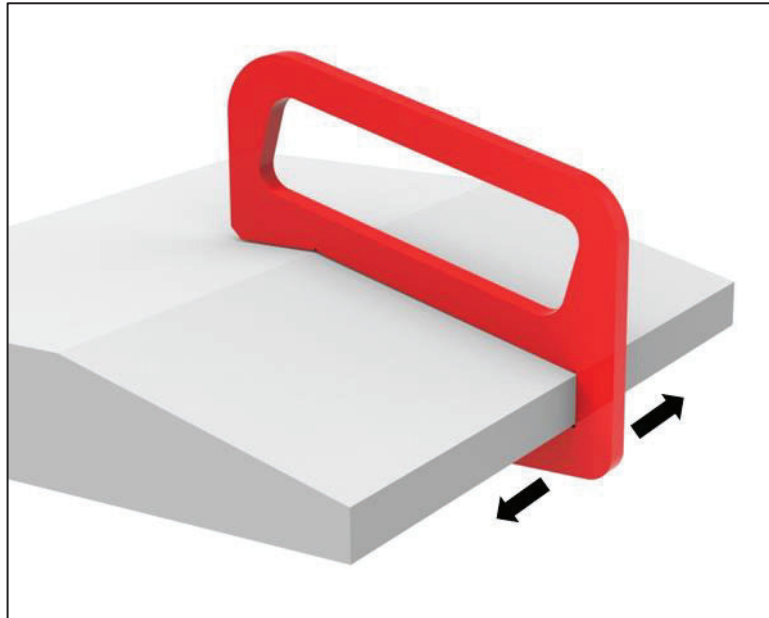


Figure 6 Excerpt from PGP0051

2.3. ATTACH POSITIONING PLATES

2.3.1. Pre-heat the lip plate as detailed in section 2.1.2 and attach the positioning and run on plates as shown in Figure 7.

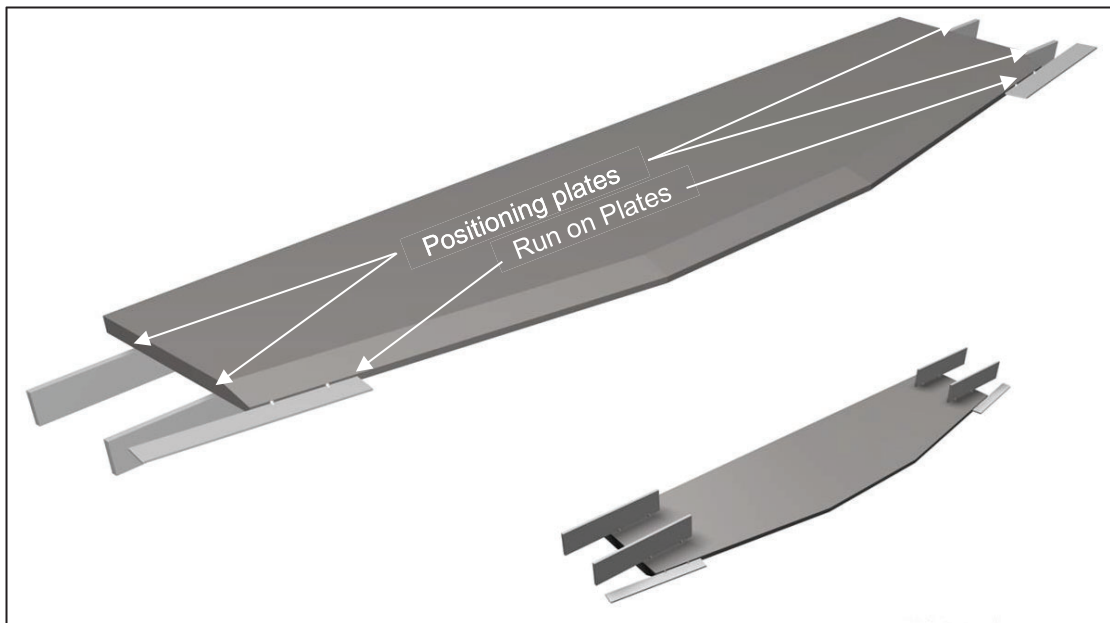


Figure 7 Positioning plates and run on plates



Figure 8 Plates attached

2.4. CAST CORNER POSITIONING

2.4.1. Lightly grind off any paint from the weld joint surfaces of the Cast Corner.

2.4.2. Using a Mechanical lifting device, position the left and right Cast Corners on the positioning plates. Ensure to allow 5mm root gap and appropriate flatness as specified in the layout drawing. Refer Figure 9.

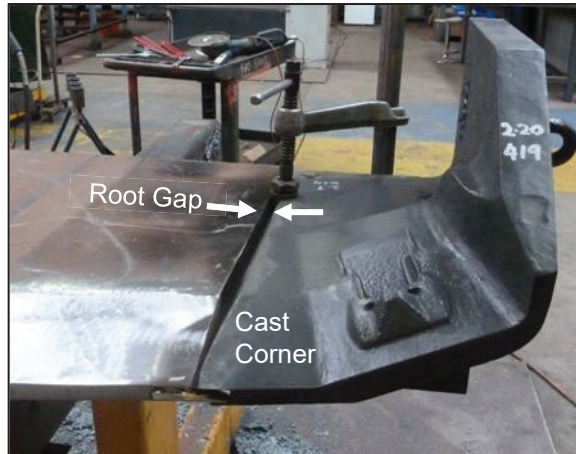


Figure 9 Cast Corner placement

2.4.3. Inspect the center to center (Wing Center -W) of the lip as shown in Figure 10. The distance must be as per the lip layout drawing.

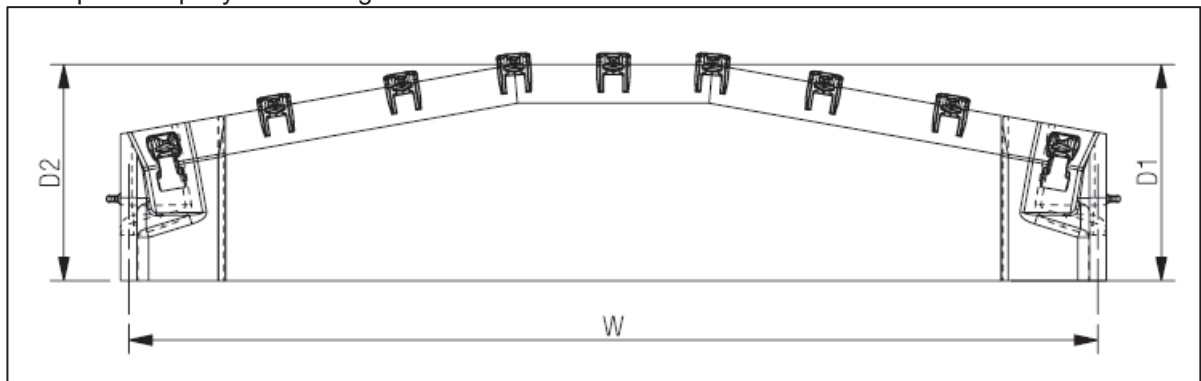


Figure 10 Wing Center inspection

2.4.4. Preheat the Cast corner as mentioned in step 2.1.2.

2.4.5. Tack weld cast corner in position to the Lip plate and positioning plates.

2.4.6. Cross check the Cast corner depths D1 & D2 against lip layout drawing. If required, cut cast corner trailing edge as per the Layout drawing.

2.4.7. If cast corner requires cutting, mark the back of the casting to the desired length to be flush with the rear of the lip.

2.4.8. Before cutting the Cast Corner, ensure pre-heating is conducted as mentioned in step 2.1.2.

2.5. ADD RUN-OFF TAG AND BRACE PLATES

2.5.1. Attach run-off tag and 30 degree brace connecting the rear of the plate and the cast corner at appropriate pre-heat conditions. Brace plate is added to prevent the Cast Corner movement. Refer Figure 11.

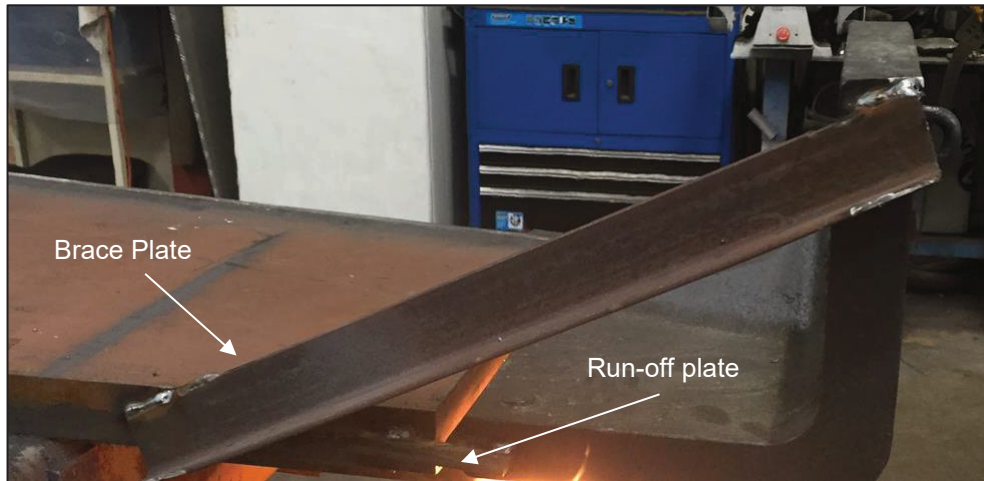


Figure 11 Run-off and Brace plates

2.6. CAST CORNER ROOT RUN

2.6.1. Weld root run once the weld joints reached the required pre-heat temperature as mentioned in the step 2.1.2. Refer Figure 12.



Figure 12 Root run on top

2.6.2. Back grind root run to ensure no scale, cracks or foreign matter is present.

2.6.3. Perform Dye penetrant or MPI test after completion of back grinding of root run. Ensure weld is at ambient temperature prior to doing MPI/Dye penetrant test.

2.7. CAST CORNER PASS WELD

2.7.1. Weld 1st pass to reinforce the root run.

2.8. REMOVE POSITIONING PLATES

2.8.1. Turn lip over using approved lifting devices and remove positioning plates from the base at appropriate pre-heat conditions as mentioned in Weld procedures PWP001 & PWP0021. Refer Figure 13 & Figure 14.



Figure 13 Turning Lip

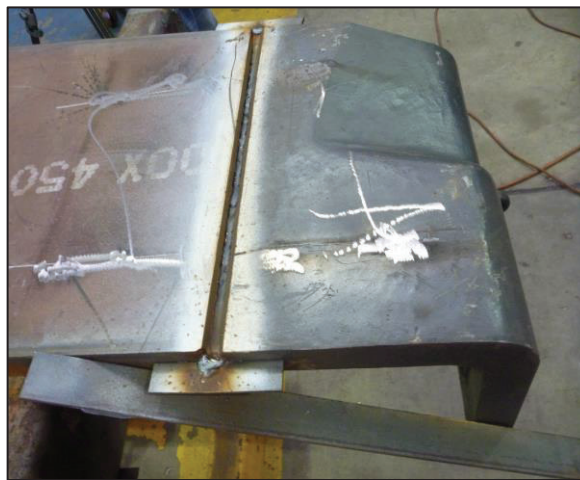


Figure 14 Positioning plates removed

2.8.2. Back grind the root run at appropriate pre-heat condition to ensure no scale, cracks or foreign matter is present. Refer Figure 15.



Figure 15 Back Grind weld

2.8.3. Perform Dye penetrant or MPI test after completion of back grinding of root run. Ensure weld is at ambient temperature prior to doing MPI/Dye penetrant test.

2.8.4. Weld the 1st pass to re-inforce the root run.

2.9. CAST CORNER UNDERSIDE WELD

2.9.1. Complete fill pass welds at the base weld joint.

2.9.2. Ensure back grinding is conducted after each weld until all of the weldment area is filled. Refer Figure 16.



Figure 16 Underside weld

2.9.3. Between pass welds and during back grinding, apply and maintain an effective preheat / minimum inter-run condition as per Weld Procedure PWP0001. Use balanced welding techniques to reduce residual stress throughout all welding activities.

2.10. CAST CORNER TOP SIDE WELD

2.10.1. Turn lip over to the top side of the lip using approved lifting devices.

2.10.2. Complete fill passes and cap pass welds on top side of the lip weld joint ensuring that back grinding is conducted after each weld. As mentioned in 2.9.3, maintain inter run temperature and balanced welding techniques throughout all welding activities.

2.10.3. Continue welding until all of the weld area is filled.

2.11. CLEANING WELD

2.11.1. Once welding has been completed, remove brace, run-on and run-off plates at appropriate inter run temperature conditions.

2.11.2. Clean welds by following procedure PWP0001. Ensure no excess weld is present at top, bottom and at leading edge of the cast corner. Refer Figure 17.

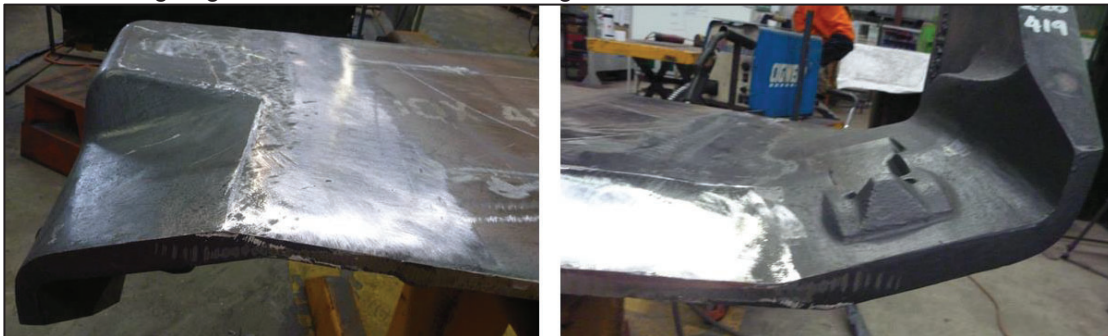


Figure 17 Weld clean up

2.11.3. Cast Corner welding is now complete.

2.11.4. Perform final Dye penetrant or MPI test once Cast Corner welding is completed at top and bottom sides. The weld joint area must be dressed properly prior to commencement of Test. Perform the test to both top and bottom sides of the cast corner welds. Ensure weld is at ambient temperature prior to doing MPI/Dye penetrant test. Grind off the weld cracks if any and re-do the inspection to confirm no cracks are present.

2.12. MARKING BOSS PARTS POSITIONS

2.12.1. Clean the Lip beveled profile and the leading edge to clear all debris.

2.12.2. Locate Spade Corner point using dimension A from Lip layout drawing SL0XXX.

2.12.3. Mark 5 degree center line at the spade corner point as shown in Figure 18.

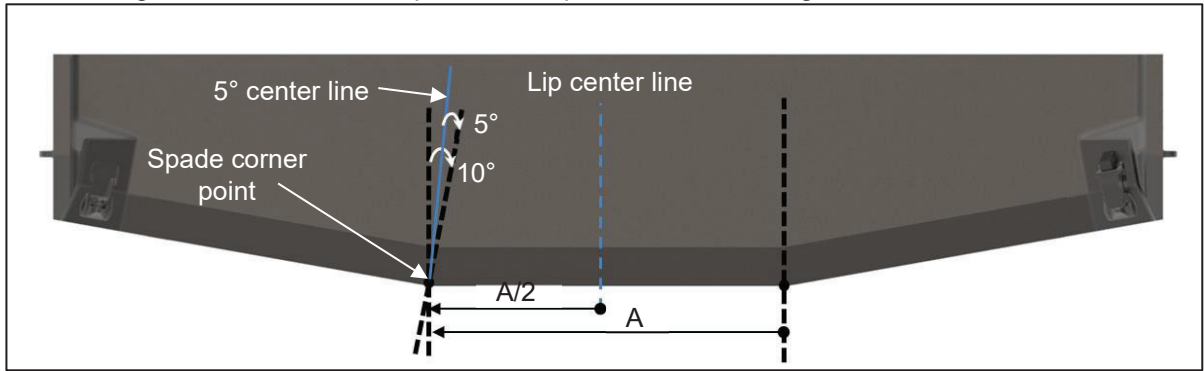


Figure 18 Transition boss mark up

2.12.4. Repeat the above steps on the other spade corner point.

2.12.5. Mark 29mm parallel lines to the center line as shown in Figure 19. These secondary parallel lines are a guide to position the inside faces of the boss feature.

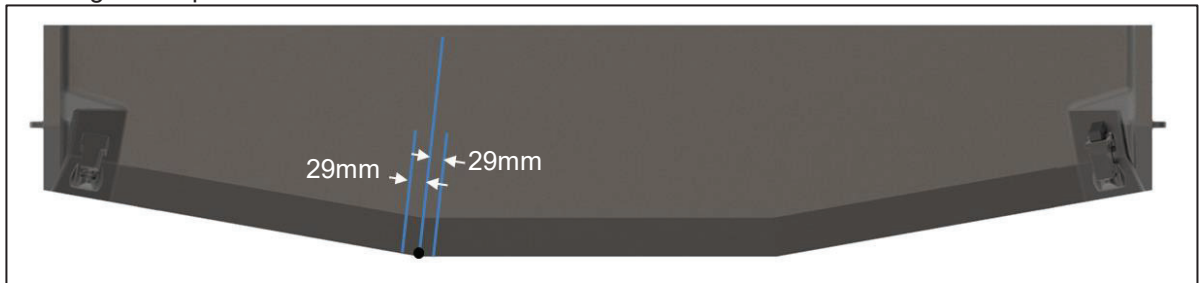


Figure 19 Parallel Lines

2.12.6. Repeat the above step to the other spade corner point.

2.12.7. Continue to mark remaining Boss part center locations as per the Lip Layout drawing SL0XXX.

2.12.8. Mark 29 mm parallel lines to the center line similar to sketch as mentioned in step 2.12.5. Refer Figure 20.

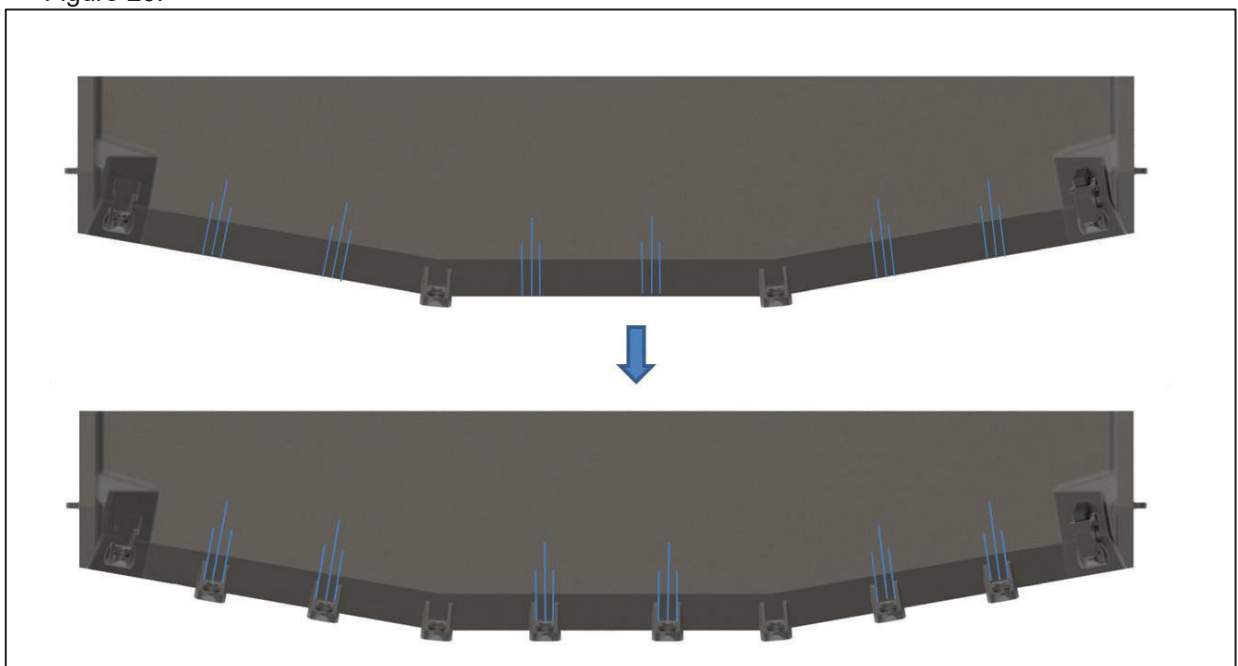


Figure 20 Boss location mark-up

2.13. BOSS POSITIONING

2.13.1. Locate Transition Boss at the spade corner at the pre-marked parallel line locations mentioned in step 2.12. Refer Figure 21. The bottom design feature of the boss will locate the transition point of the lip at the leading edge.

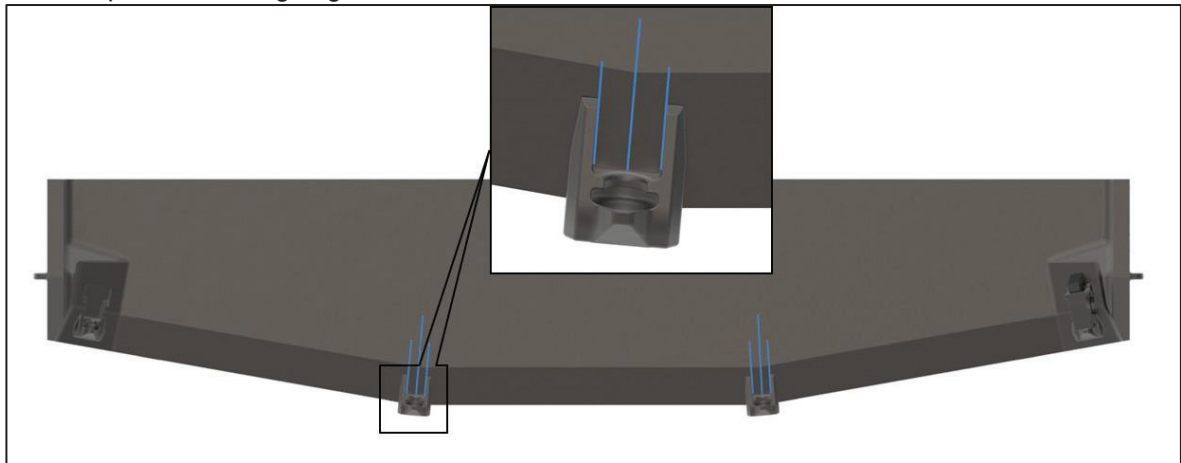


Figure 21 Boss positioning

2.13.2. To keep the Boss part in position, tack the Boss at the outer side of the legs onto the lip at the appropriate pre-heat conditions. Refer Figure 22.

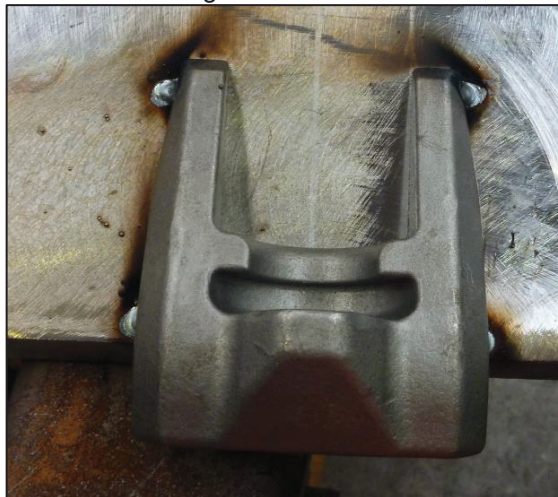


Figure 22 Boss Tack weld locations

2.13.3. Tack all Boss parts onto the lip at marked locations. Refer Figure 23.



Figure 23 Boss part locations

2.14. BOSS POSITION INSPECTION

2.14.1. Visually check the positions of the Boss parts to check if all boss parts are seated properly on the Lip. Ensure the red highlighted surfaces are in contact. Refer Figure 24.

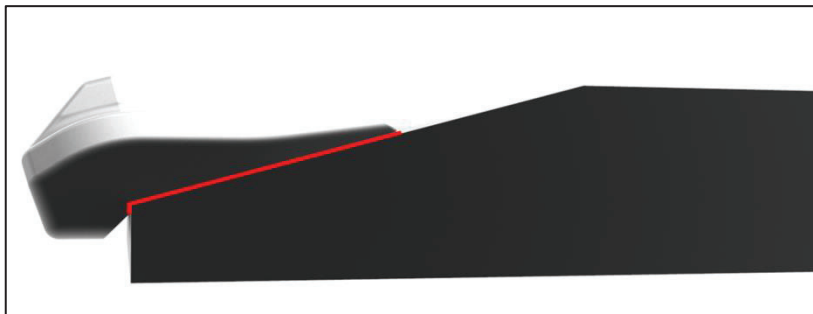


Figure 24 Boss seating

2.14.2. Using a mechanical lifting aid temporarily fit all Shrouds to the lip. Check the positioning and gaps between the shrouds to ensure they are laid out as per the lip layout drawing. Refer Figure 25.

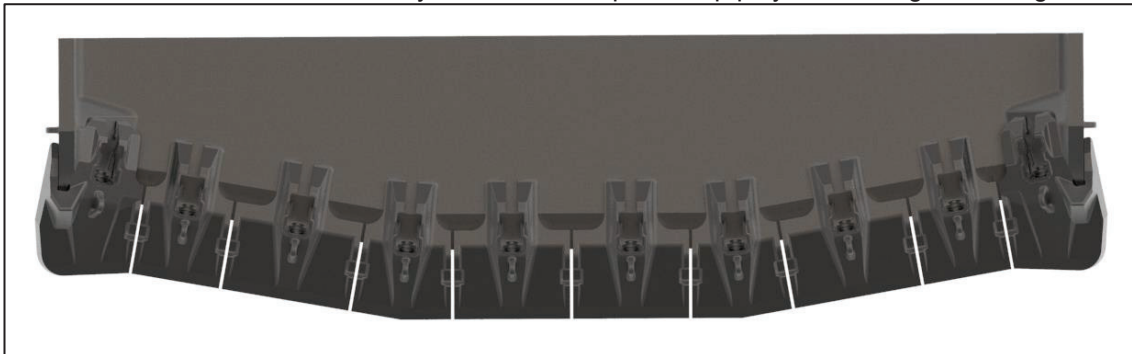


Figure 25 Temporary Shroud Positioning - Example

2.14.3. Remove the shrouds after position inspection.

2.14.4. If the gaps between the shrouds are not matching to the Lip layout drawing (SL0XXX), revisit steps 2.12 & 2.13 and correct all boss positions.

2.15. BOSS FILLET WELD AND INSPECTION

- 2.15.1. Using a mechanical aid, orient the lip so that the weld will be in the 2F position. Secure the lip by placing supports at the base. Refer Figure 26.
- 2.15.2. Pre-heat the Boss parts and the Lip plate. Refer Figure 26. Ensure the weld zone is heated to a temperature of minimum 150 degrees Celsius with a maximum of no greater than 250 degrees Celsius as specified in welding procedure PWP0001.



Figure 26 Boss Preheating

- 2.15.3. Mark all weld points as per Weld Information drawing BU00037748 & Doc# WPS SS-012. Refer Figure 27.

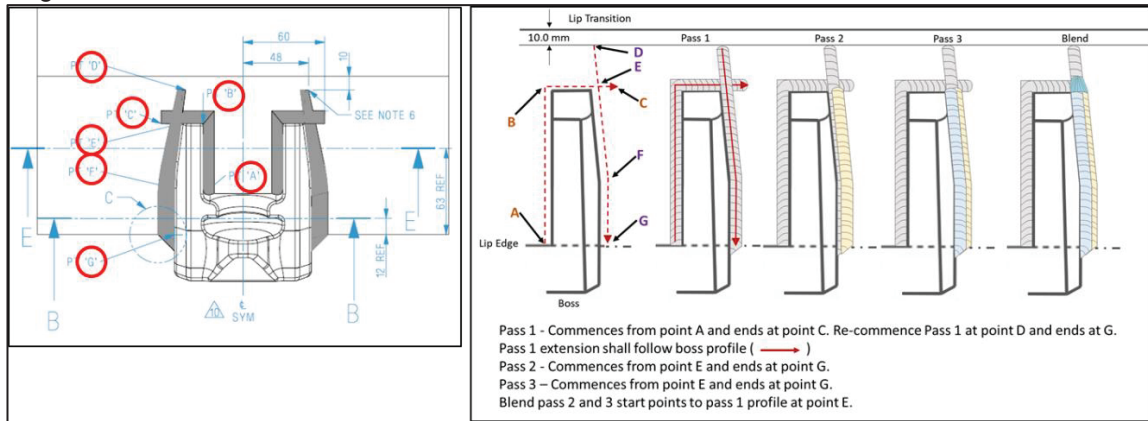


Figure 27 Excerpts from BU00037748 & WPS SS-012

- 2.15.4. Carry out the Fillet welds of Bosses as per the Weld Specification Drawing BU00037748, Doc # WPS SS-012 & Weld procedure PWP0001. Commence the 1st weld pass at point 'A' and end at 'C' following the Boss profile. Re-commence 1st pass at point 'D' and end at 'G'. Two subsequent fillet passes shall commence at point 'E' and end at 'G'. Blend a smooth transition between first fillet passes and subsequent passes at point 'E'. Refer Figure 28.

Complete fillet weld of all bosses at 2F position.

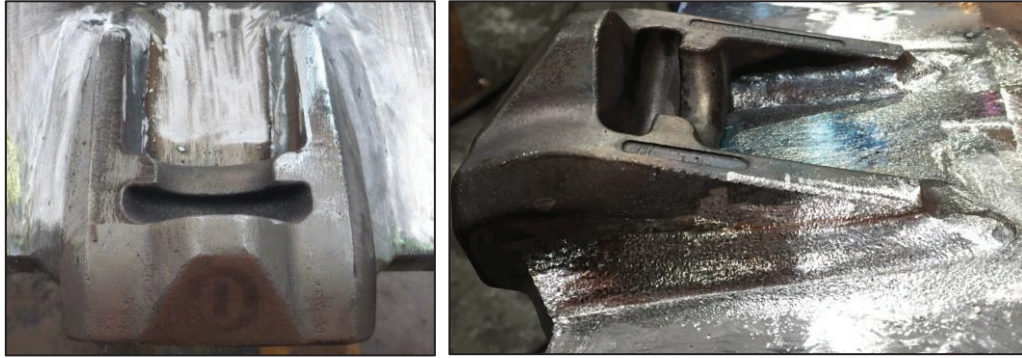


Figure 28 Fillet Welds

2.15.5. After all fillet welds have been completed, clean welds by following weld procedure PWP0001. Grind back any excess weld and smooth transitions between the weld passes. Grind off the extension weld top to Lip Top surface as shown in Weld information drawing BU00037748. Refer Figure 29.

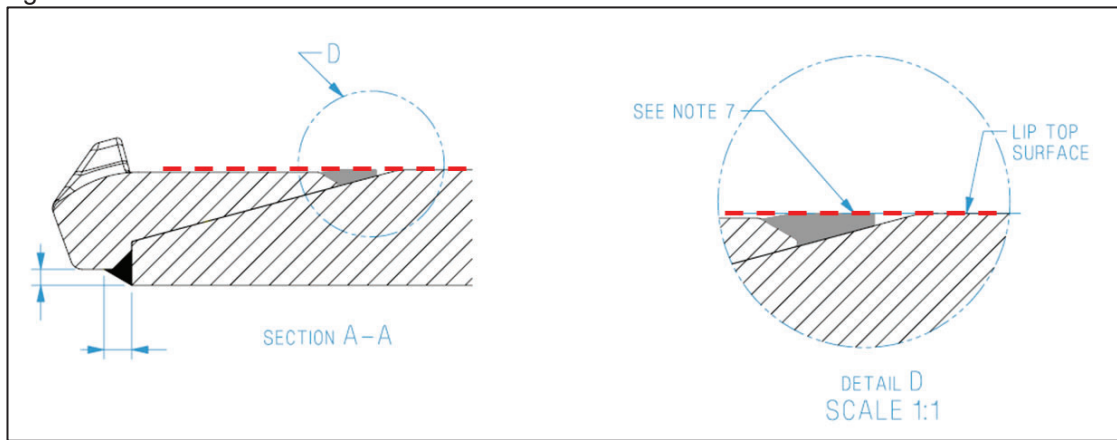


Figure 29 Excerpts from BU00037748 Page 2

2.15.6. Inspect all boss fillet welds by following Gauging Procedure PGP0051. Rectify all over or under welds and smooth transitions between weld passes. Refer Figure 30.

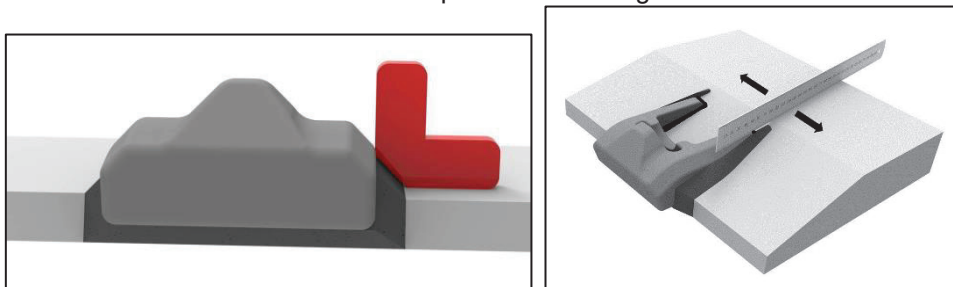


Figure 30 Excerpts from PGP0051

2.16. BOSS PARTIAL PENETRATION BUTT WELDS AND CORNER FILLET WELDS

2.16.1. Using a mechanical aid, orient the lip so that the weld will be in the 1G position. Refer Figure 31.



Figure 31 Pre-heating at 1G position

2.16.2. Pre-heat boss parts and Lip as mentioned in step 2.15.2. Refer Figure 31.

2.16.3. Carry out the Partial Penetration Butt welds of the Bosses at the Lip leading edge as per the Weld Specification Drawing BU00037748 & Weld procedure PWP0001. Refer Figure 32.

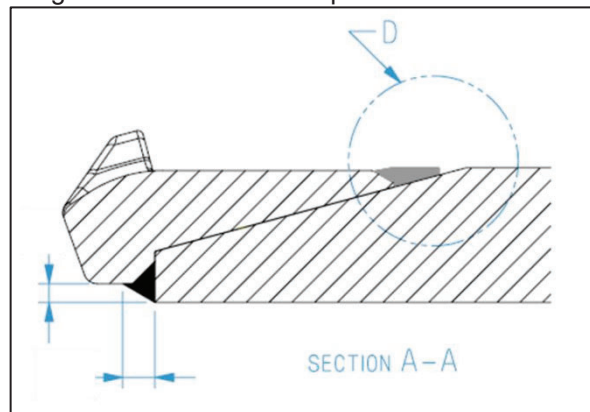


Figure 32 Excerpt – Excerpt from Weld Information drawing BU00037748

2.16.4. Add fillet welds to the Boss corners to connect partial penetration butt weld and fillet welds which were completed during step 2.15. Smooth transition between all welds. Refer Figure 33.

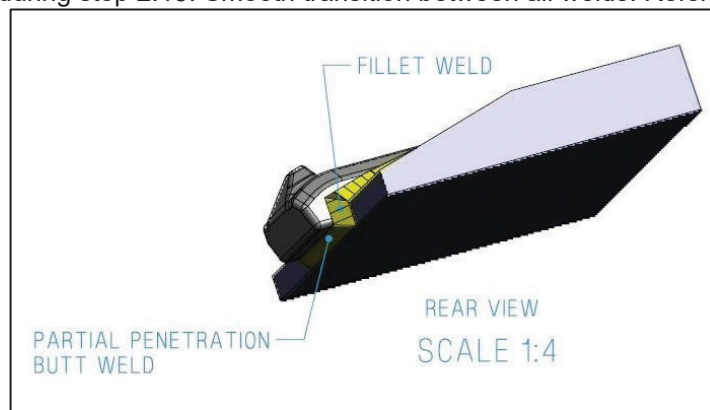


Figure 33 Excerpt from Weld Information drawing BU00037748

2.16.5. Complete Partial Penetration Butt & Fillet welds of all the bosses at 1G position.

2.17. INSPECTION OF PARTIAL PENETRATION BUTT WELD AND CORNER FILLET WELD

2.17.1. As mentioned in step 2.15.5, clean up the welds.

2.17.2. Inspect all boss corner fillet welds using Gauge SGM50-BW by following Gauging Procedure PGP0051. Rectify all over or under welds and smooth transitions between the welds. Refer Figure 34.



Figure 34 Inspection of Boss corner fillet weld

- 2.17.3. Visually inspect all Boss Partial penetration Butt Welds. Grind back any excess welds after inspection.
- 2.17.4. Perform Magnetic Particle Inspection (MPI) tests at all Boss welds during inspection. Refer Figure 35. Rectify any cracks in the welds if observed during the MPI process. Delay MPI until welds have cooled to ambient conditions.



Figure 35 Boss MPI

2.18. PAINTING THE LIP

- 2.18.1. Ensure surfaces to be coated are appropriately cleaned to prepare for painting.
- 2.18.2. Prime and paint the lip as per the customer requirements. For Sandvik LHD lips, use Sandvik Orange color RGB 233, 80, 14. Refer Figure 36.



Figure 36 Painted Lip - Example

MAKO™ Lip fabrication steps are now completed.

3.0. FINAL LIP INSPECTIONS

3.1. INTRODUCTION

The following quality inspections to be performed after completion of lip fabrication to ensure that the lip is manufactured to the dimensions specified in Sandvik Shark Lip layout drawing and all aspects of quality requirements are met. If the lip is failed to meet any of the quality inspections mentioned in the subsequent steps, part must be reworked or otherwise lip must be rejected.

Perform inspection steps# 3.2 – 3.6 before painting the lip.

Preform inspection step# 3.7 after painting the lip.

3.2. LIP PLATE MEASUREMENTS

3.2.1. Inspect the fabricated lip key dimensions shown in Figure 37. Dimensional values must be as per the lip layout drawing. Tolerance as per standard AS1100-1992 applies for all measured dimensions. Refer Figure 38 for details.

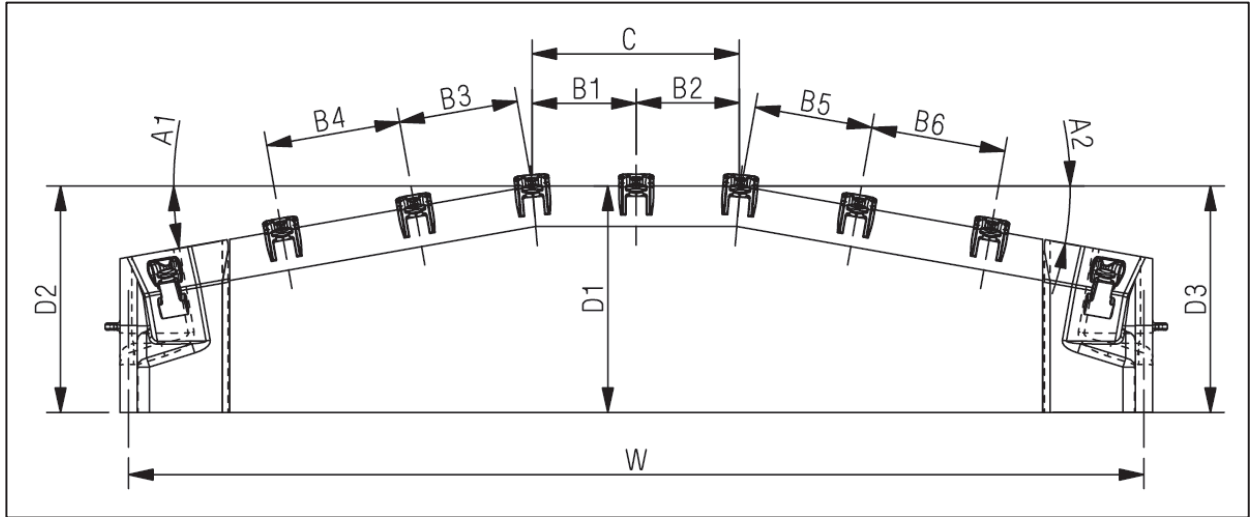


Figure 37 Fabricated lip key dimensions

GENERAL TOLERANCES								
PRODUCTION METHOD	LINEAR & CYLINDRICAL DIMENSIONS (± mm)						ANGULAR DIMS. (±)	FLATNESS (mm)
	FROM - INCL.	<50	51 - 250	251 - 500	501 - 1000	>1000		
FABRICATED	WHOLE No.	1.0	1.5	2.0	2.5	3.0	1.0°	2 PER 1000
	DECIMAL	0.5	1.0	1.5	2.0	2.5	0.5°	

Figure 38 Fabrication Tolerance as per AS1100-1992 standard

3.3. GAUGING INSPECTIONS

3.3.1. Inspect the bevel angle and thickness of the fabricated lip by gauging as per procedure PGP0051. Perform inspection at various locations along leading edge. Refer Figure 39.



Figure 39 Lip profile gauging

3.3.2. Inspect all boss fillet welds as per Gauging Procedure PGP0051. Refer Figure 40.

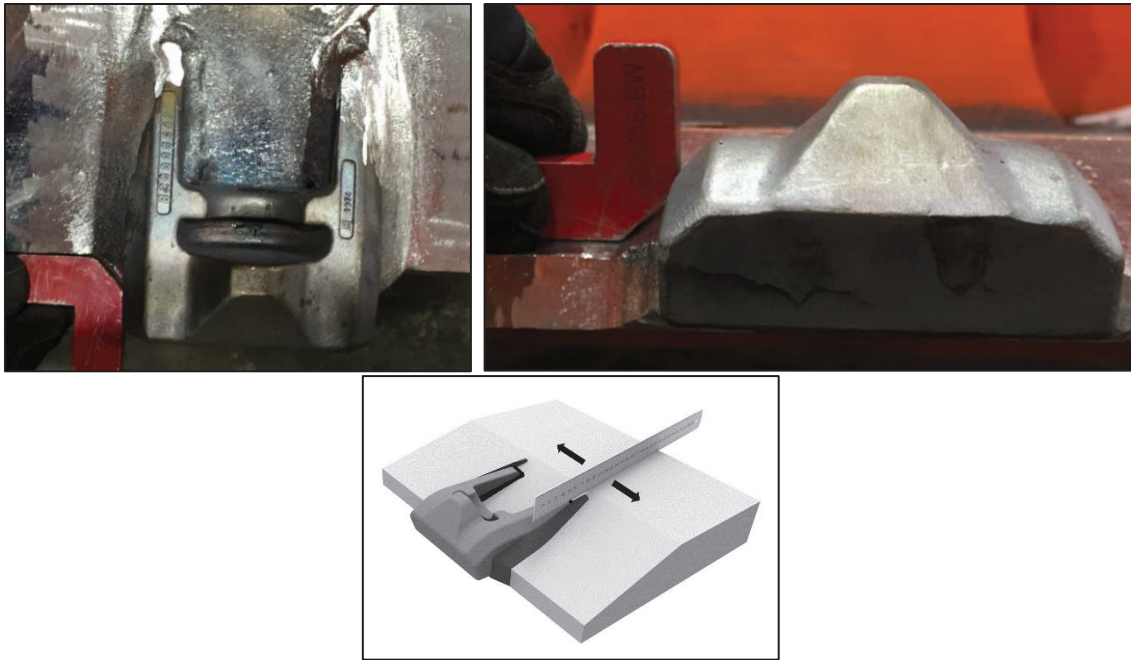


Figure 40 Boss weld gauging

3.4. VISUAL INSPECTIONS

3.4.1. Inspect weld between lip plate and cast corner for

- Clean welds
- No excess weld at top, bottom or at the leading edge side of the cast corner. All inflated weld joints and fillets areas, which may obstruct the fitment of shroud and affect the visual appearance of the Lip, must be leveled

Incorrect Example:

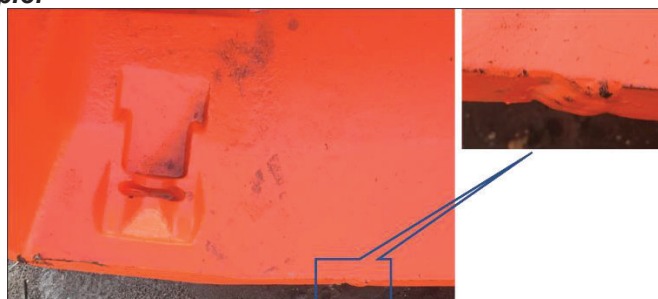


Figure 41 weld incorrect example

correct Example:



Figure 42 cast corner weld visual inspection

3.4.2. Inspect all Boss part welds for

- Clean welds
- All weld joints are smooth and blended.
- No under or over welds and no weld undercuts.
- All inflated weld joints and fillets areas, which may obstruct the fitment of shroud and affect the visual appearance of the Lip, must be leveled.

Incorrect Example:

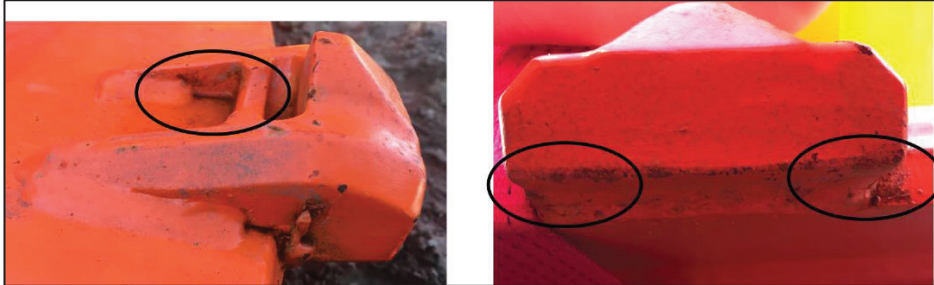


Figure 43 Incorrect welds

Correct Example:

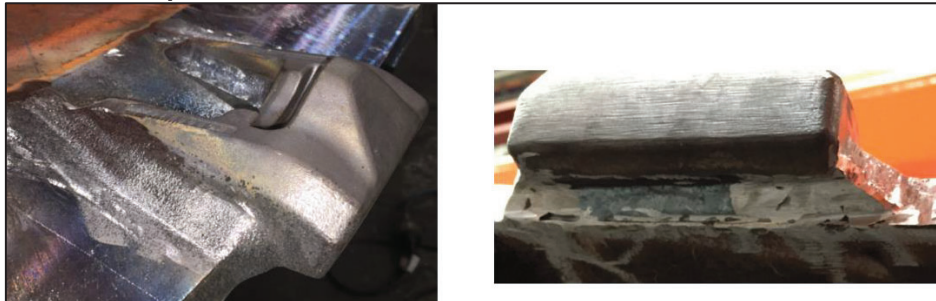


Figure 44 Visual inspections on weld

3.5. MPI INSPECTIONS

- 3.5.1. Check with Fabricator if Dye penetrant or MPI inspection had been carried out during Cast corner and Boss Welding stages.
- 3.5.2. Complete MPI inspections on all Cast corner and Boss welds of the lip. Rectify cracks if any and redo MPI to ensure all cracks are removed.

3.6. SHROUD FITMENT INSPECTION

- 3.6.1. Temporarily fit all shrouds to the lip as per the lip layout drawing using mechanical aids. Inspect the positioning and gaps between the shrouds to ensure they are laid out as per the lip playout drawing.

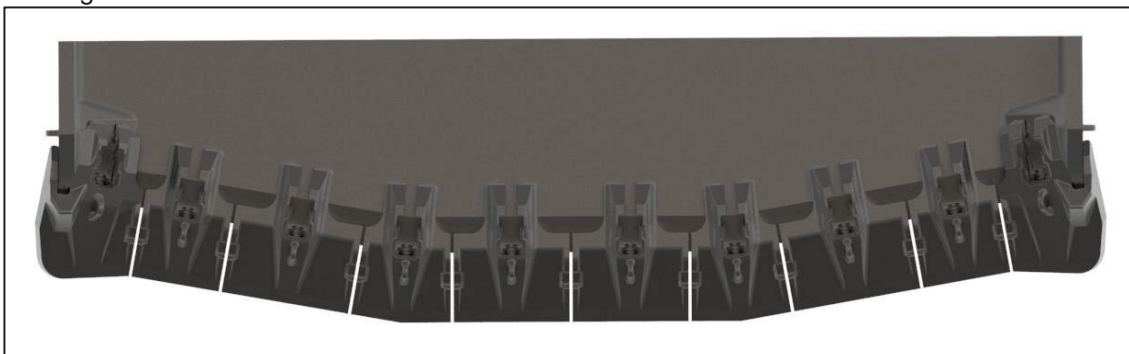


Figure 45 Temporary shroud positioning

3.7. INSPECTIONS AFTER PAINTING

- 3.7.1. Visually check if the paint color is as per customer specifications. For Sandvik LHD lips, lip colour will be Sandvik Orange.

4.0. LIP DISPATCH

4.1. PREPERATION

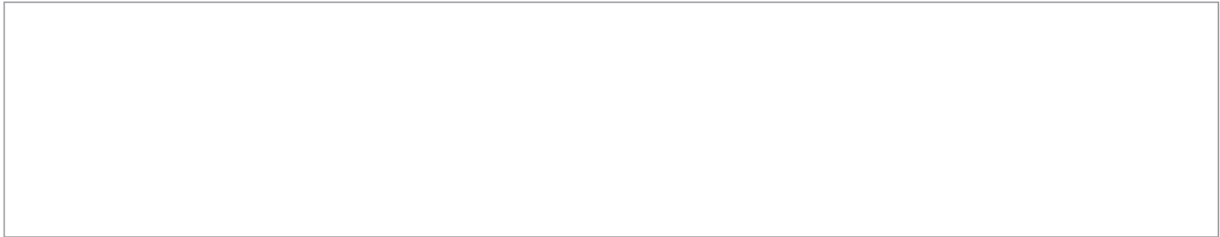
4.1.1. Dispatch the painted lip together with below listed loose parts if applicable. Follow Sandvik lip layout drawing for the part numbers and the required quantities.

- Shrouds
- Lock assemblies
- Profile Bar or Cast Pofile Bar Kits
- Infill plates

NOTE: DO NOT weld the profile bar or Cast profile Bars to the lip prior to attaching the lip on the bucket.


4.2. SAFETY

4.2.1. Ensure safe working procedures are utilized while preparing the lip for dispatch. All loose parts must be securely strapped prior to dispatch.



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5.0. REVISION NOTES

Rev #	Notes	Prepared By	Checked By	Approved By	Date
0	Initial Release	J.Jose	B.Dallard	R. Schmitz	12/07/2017
1	Layout updated. Steps revised.	J.Jose	B.Dallard, D.Köhler	R. Schmitz	28/11/2017
2	Trademarks updated	J.Jose	D.Köhler	R. Schmitz	15/03/2018
3	Step#2.15.3& 2.15.4 and Figures# 25, 26, 32 & 33 updated to reflect weld as per BU00037748/C.	J.Jose	R. Bayal 	M.Javadi	23/06/2021
4	1. Document title changed to reflect both lip fabrication and inspection.	J.Jose	R. Bayal, C.K Soon	M.Javadi	29/07/2021
	2. Step#2.1.3 hardox plate inspection step added				
	3. Step#2.4.3, Wing center inspection added.				
	4. step#2.11.2, no excess weld at front, top & bottom of cast corner				
	5. step#3 & 4 added.				
5	Revise SWP0008 to SWP0004	E.Hung	A.Martinez	A.Martinez	25/10/2023