

# GENERAL WELDING PROCEDURE FOR SHARK™ BUCKETS

SHARK™ BUCKETS

## 1 INTRODUCTION

This document is generic manufacturing guide for fabricating SHARK™ buckets.

Bucket fabricator determines the safe way of working and the welding order of parts. Provided guidance about the manufacturing process steps is covered on a general level.

Exact preheating temperatures are determined in the manufacturing drawings as there may be differences in materials and plate thicknesses between different buckets.

This document determines which welding consumables are to be used in specific weld seams of the bucket.

## 2 QUALITY CONTROL

The welding contractor requires significant welding knowledge and shall provide the engineering capability, experienced supervision, qualified welding personnel and suitable welding and associated activity equipment to successfully implement this procedure. The local health and safety regulatory requirements shall be applied during all production activities.

Bucket manufacturer supplies Sandvik welding procedure specification (WPS) of following critical welds of the bucket:

- Welding of bush and center lug plate (shown in figure 4).
- Welding of cast corner and lip plate (shown in PWP0021).
- Welding of boss to the lip plate (shown in BU00037748).

### 2.1 STANDARDS

Following welding standards are to be for all weld quality and weld markings:

- ISO 5817 – Welding – Fusion-welded joints in steel, nickel, titanium and their alloys.

Procedure: PWP0025

Rev: 1

Page 1

- ISO 2553 – Welding and allied processes. Symbolic representation on drawings. Welded joints.

Following standard is used for dimension tolerances:

- ISO 13920 – Welding – General tolerances for welded constructions – Dimensions for lengths and angles – Shape and position.

### 3 MATERIALS

Sandvik uses its own steel type designations which determines minimum requirements for the materials that are used for the bucket frame and the lip plate. Bucket manufacturer will ensure that all minimum requirements are met with the steel types that are used. Sandvik steel type designations are described in document STA-02-030E and it includes following requirements:

- Yield strength  $R_e$  (N/mm<sup>2</sup>)
- Elongation A5 (%)
- Carbon equivalent CE (IIW) max.
- Tensile strength  $R_m$  (N/mm<sup>2</sup>)
- Charpy-V impact strength (J)
- Delivery condition

Sandvik steel type designations, structural steels:

- S001
- S002
- S003
- S004
- S007
- S009
- S021

Sandvik steel type designations, hollow bars:

- S008

Sandvik steel type designations, wear resistant steel plates:

- S005
- S006

Sandvik SHARK weldable steel type designations are used for cast corners of the lip weldment, weld on heel shrouds, cast profile bars and half-arrow products. Welding of these items have been described in documents PWP0005, PWP0011, PWP0017.

Sandvik SHARK weldable steel type designations:

- SS2000
- SS2500
- SS2300

#### 4 PREHEATING

Preheating temperatures are in firsthand determined in the weldment drawing. If the weldment drawing lacks the preheating temperature information, see the weld temperatures in Table 1.

Material	Target Pre-heat temperature °C	Max Inter-pass temperature °C
Sandvik Q&T Castings/wear steel (350-500HB)	160-190	230
Lip plates (ASTM A514 Steels)	As per the manufacturer's recommendation	As per the manufacturer's recommendation

**Table 1.** Preheat Inter pass temperatures.

Refer to Weld Procedure PWP0001 for more details.

BISALLOY® steel grade	JOINT COMBINED THICKNESS ( $t_1 + t_2 + t_3$ ) (mm)				
	<30	≥30 ≤40	>40 <50	≥50 <100	≥100
<b>Minimum Preheat Temperature °C High Strength Structural Grades</b>					
60 [AS 3597 Grade 500]	Nil*	Nil*	Nil*	75	140
70 [AS 3597 Grade 600]	Nil*	50	50	75	140
80 [AS 3597 Grade 700]	Nil*	50	50	75	140
100 [AS3597 Grade 900]	Nil*	50	50	75	140
<b>Minimum Preheat Temp °C Abrasion Resistant Grades</b>					
Wear 320	Nil*	50	75	125	150
Wear 400	Nil*	50	75	125	150
Wear 450	Nil*	50	100	125***	**
Wear 500	100	150	150	150	**
Wear 600	150	150	150	**	**
<b>Maximum Interpass Temperature °C</b>					
80 - 450 Grades	150	150	175	200	220
500 Grade	150	175	175	200	220
600 Grade	150	175	175	220	220

\* Chill must be removed from plates prior to welding.

\*\* Refer to Bisalloy Steels for availability, preheat/interpass requirements.

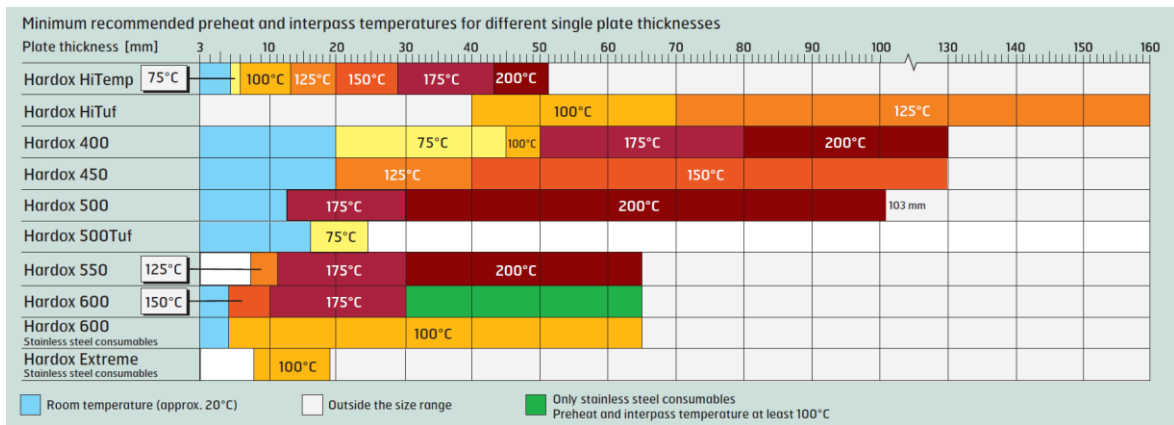
\*\*\*A reduced 100°C min preheat can be used for product ≥50 – 60 JCT

**Figure 1.** Preheat and interpass temperatures for Bisalloy steels (Bisalloy Technical guide. 2017).

Procedure: PWP0025

Rev: 1

Page 3

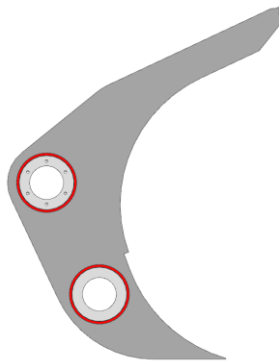


**Figure 2.** Preheat and interpass temperatures for Hardox steels (SSAB Welding handbook. 2019).

## 5 PROCEDURE

This chapter describes main steps of fabricating mass mining LHD bucket weldment. There may be structural differences in buckets between different machine types which will affect to the manufacturing procedure. Typically, cheek plates, center lug plates and prefabricated lip are made as sub-weldments which are then welded to the bucket frame.

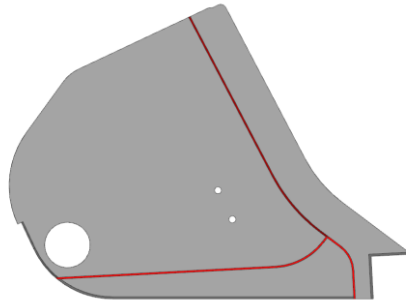
### 5.1 WELDING OF THE BUSHES TO CENTER LUG PLATES



**Figure 3.** Pre-machined bushings are welded to the center lug plates.

- Preheating temperature is determined in the weldment drawing (or refer to Section 4).
- Critical weld. Full penetration is required. Welding class ISO 5817-C.
- Weld finishing such as toe blending is determined in the weldment drawing.
- Ensure that the pre-machined threaded holes in the bushings are oriented similarly as in the weldment drawing.
- See the accepted filler materials and welding processes for the bushing welds in Table 2.

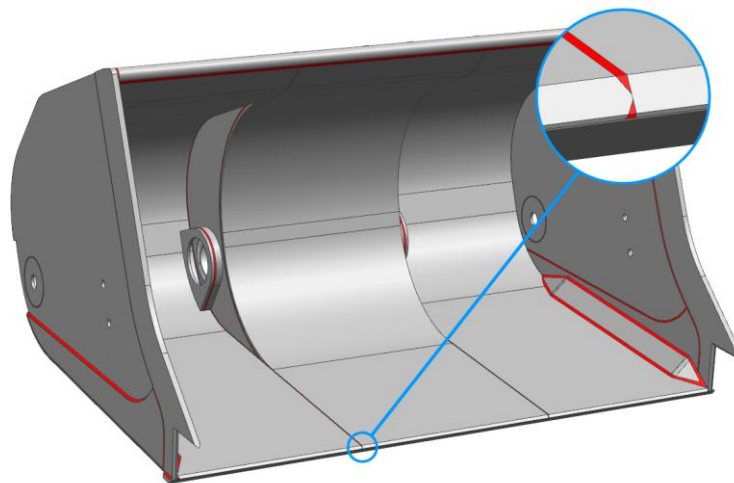
## 5.2 WELDING OF THE CHEEK PLATES



**Figure 4.** Cheek plates weldment

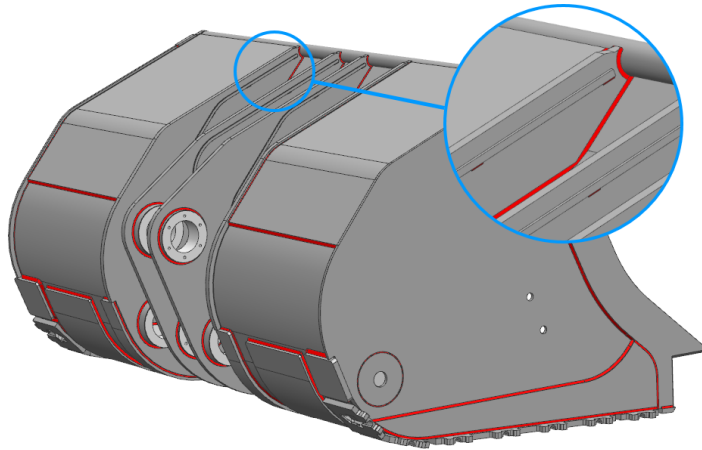
- Preheating temperature is determined in the weldment drawing. (or refer to Section 4).
- See the accepted filler materials and welding processes for the cheek plate welds in Table 1.

## 5.3 WELDING OF THE BUCKET FRAME



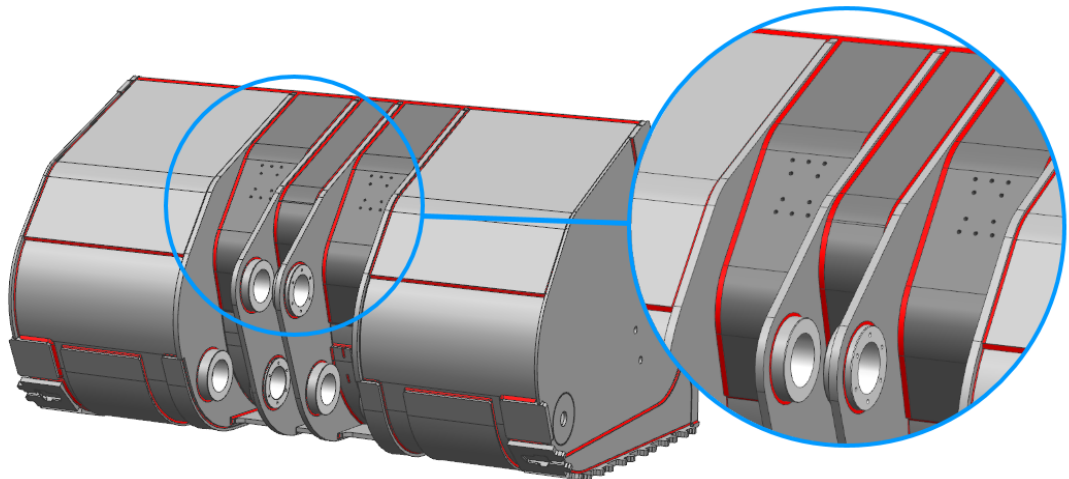
**Figure 5.** Bucket frame. Air gap on the double beveled weld between floor plates is not a requirement.

- Preheating temperatures are determined in weldment drawing (or refer to Section 4).
- See the accepted filler materials and welding processes for the welding of bucket frame in Table 2.



**Figure 6.** Supporting strips that are used underneath outer wrapper plates of the cradle are typically welded on with stagger welds.

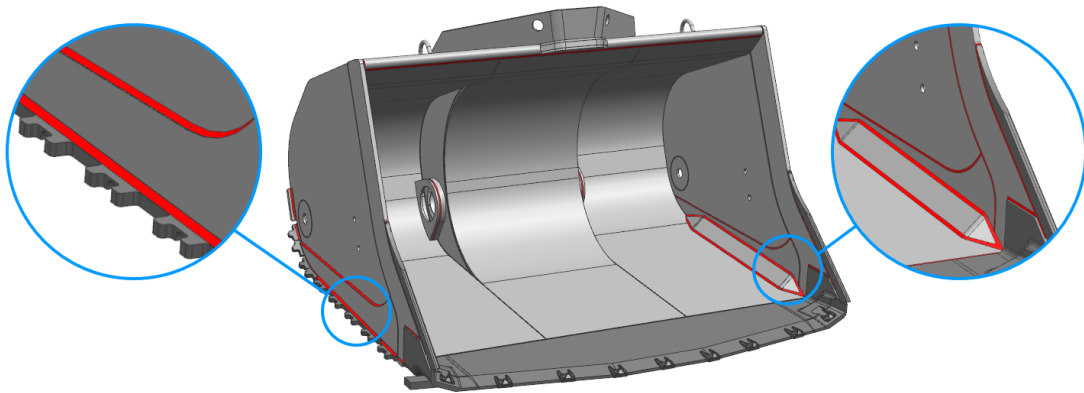
- Supporting strips on the center cradle are used as backing material for the welds of outer wrapper plates. Supporting strips will also help with locating the outer plates.



**Figure 7.** Outer wrapper plates shown dark grey. Parts are installed on top of strip plates.

- Root opening is left between vertical lug plates and outer wrapper plates to achieve full penetration of the welds.
- See the accepted filler materials and welding processes for the welding of bucket frame in Table 2.

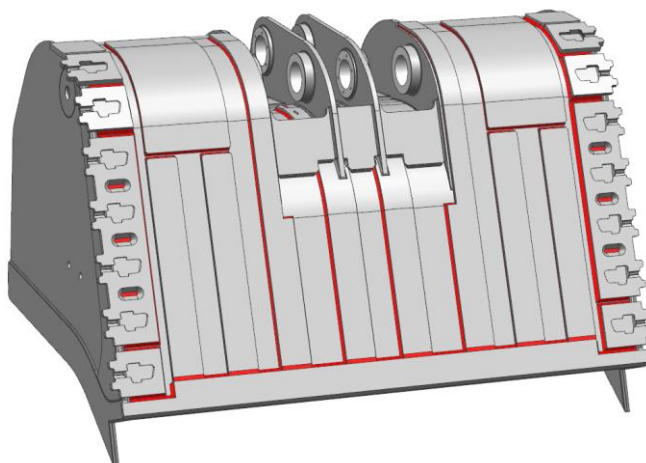
#### 5.4 WELDING OF THE LIP PLATE, ADAPTOR PLATES AND GROUSER BARS



**Figure 8.** Welding of the MHS (mechanical heel shroud) adaptor plates, grouser bars and lip sub weldment are detailed in separate documents.

- See document PWP0021 for welding of cast corners to lip plate
- See document PWP0011 for welding of the pre fabricated lip to the bucket frame.
- See document PWP0017 for welding of the mechanical heel shroud adaptor plates.
- See document PWP0005 for welding of the grouser bars.
- See the accepted welding filler materials in the product specific welding procedure (PWP) documents.

#### 5.5 WELDING OF THE WEAR STRIPS



**Figure 9.** Welding of the wear strips.

- Preheating temperatures are determined in weldment drawing (or refer to Section 4)..

Procedure: PWP0025

Rev: 1

Page 7

- See the accepted filler materials and welding processes for the welding of the wear strips in the Table 2.

## 6 HARDFACING

Hardfacing is used in some bucket designs to protect selected welds from washout and in some items to increase wear life of the component.

Preheating temperatures for hardfacing are mentioned in the weldment drawing. Typical preheating temperatures are specified in Table 1, Section 4, and depend on the plate thicknesses. By default, buffer layer is not required unless specified otherwise in the weldment drawing. See the Lincoln Lincore® and Weartech® consumable documentation for the correct welding parameters.

Row No.	Welding Process	Preferred Consumable	AWS	Location
1	FCAW 138	Lincoln Lincore® 60-G	<b>AS/NZS 2576</b> 2355 B5	Weld protection
2	FCAW 136	Lincoln Lincore® 60-O	<b>AS/NZS 2576</b> 2355 B7	Weld protection
3	FCAW 136	Lincoln Weartech® SHS® 9800U	<b>AS/NZS 2576</b> 2465 B7 *	Grouser bars

**Table 2.** Hardfacing consumables used with the buckets.

\* Nearest equivalent



## 7 WELDING CONSUMABLES

Row No.	Welding Process	Preferred Consumable	AWS	ISO	AS/NZS
1	GMAW 135	Lincoln SupraMig Ultra®	<b>AWS A5.18</b> ER70S-6	<b>EN-ISO 14341-A</b> G46 3 4Si1 / G50 5 M 4Si1	-
2		Lincoln Ultramag S6	<b>AWS A5.18</b> ER70S-6	-	<b>14341-B</b> G 49A 3UM/C S6
3		Lincoln LNM 28	<b>AWS A5.18</b> ER80S-G	<b>EN-ISO 16834-A</b> G Z Mn3 Ni1 Cu	<b>14341-B</b> G55 SN2M1
4		Lincoln LNM Ni1	<b>AWS A5.18</b> ER80S-Ni1	<b>EN-ISO14341-A</b> G46 5 M 3Ni1	<b>14341-B</b> G55 SN2M1

**Table 3.** Welding consumables for welds of the bucket frame.

Row No.	Welding Process	Preferred Consumable	AWS	ISO	AS/NZS
1	GMAW 135	Lincoln SupraMig Ultra®	<b>AWS A5.18</b> ER70S-6	<b>EN-ISO14341-A</b> G46 3 4Si1 / G50 5 M 4Si1	-
		Lincoln Ultramag S6	<b>AWS A5.18</b> ER70S-6	-	<b>14341-B</b> G 49A 3UM/C S6
2		Lincoln LNM 28	<b>AWS A5.18</b> ER80S-G	<b>EN-ISO 16834-A</b> G Z Mn3 Ni1 Cu	<b>14341-B</b> G55 SN2M1
3		Lincoln LNM Ni1	<b>AWS A5.18</b> ER80S-Ni1	<b>EN-ISO14341-A</b> G46 5 M 3Ni1	<b>14341-B</b> G55 SN2M1
4	FCAW 138	Lincoln Outershield® MC710-H	<b>AWS A5.18</b> E70C-6M-H4	<b>EN-ISO 17632-B</b> T49 3 T15-0 / 1 MA UH5	<b>17632-B</b> T49 3 T15-0/1 MAK U H5
5	FCAW 138	Lincoln Outershield® MC80D2-H	<b>AWS A5.28</b> E90C-D2-H4	<b>EN-ISO 18276-B</b> T62 3 T15-0/1 MA 3M2 H5	-
6	FCAW 138	Lincoln Outershield® MC715Ni1-H	<b>AWS A5.28</b> E80C-Ni1M H4	<b>EN-ISO 17632-A</b> T 46 5 1Ni M M 2 H5	<b>17632-B</b> T55 5 T15-1 MAN1 UH5
7	FCAW 136	Lincoln Outershield® MC81Ni1-H	<b>AWS A5.29</b> E81T1-Ni1M- J	<b>EN-ISO 17632-A</b> T 50 5 1Ni P M 2 H5	<b>17632-B</b> T55 6 T1-1 MAPN3 UH5
8	FCAW 136	Lincoln Innershield® NR-555	<b>AWS A5.29</b> E81T8-G	<b>EN-ISO 17632-A</b> T465ZYN1H10	-

**Table 4.** Welding consumables for wear strips, adaptor plates, heel shrouds, grouser bars, profile bars and half-arrow products.

## 8 WELDING PARAMETERS AND ALTERNATIVE WELDING PROCESSES

- See document PWP0001 for recommended welding positions and welding parameters.
- Submerged arc welding with solid wire (SAW 121) may be used for welding of the bushings, cheek plates or the lip plate.
- Lincoln Hyperfill™ twin wire welding process may be used to improve productivity of the welding.

## 9 REFERENCES

Bisalloy Technical guide. 2017. <https://www.bisalloy.com.au/wp/wp-content/uploads/2019/12/bis0164-c1113p0-brochure-technical-guide-welding-aussiemade-lowres.pdf>

SSAB Welding handbook. 2019. <https://www.ssab.com/support/steel-handbooks?di=discover1352A480FAD5448CA4B44E55ABF58980#wffmcc9714a93a964dc5abe2810ef07a729a>



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## 10 REVISION HISTORY

Rev #	Notes	Prepared By	Checked By	Approved By	Date
0	Initial Release	I.H.	M.J.	M.J.	31.8.2020
1	Added weld temp table	R.L	M.J	M.J	11.10.2023