

Fabrication Guide

Wear Resistant Hardfaced Plate

RED DOG
HARDFACED PLATE



sole manufacturer of T200X™

Wear Resistant Hardfaced Plate Fabrication Guide

This guide provides practical information on how to cut, form, and fabricate Red Dog Linings wear resistant overlay plates. Unless otherwise indicated, the procedures described apply to standard compositional grades of hardfaced overlay, with structural carbon steel substrates. Special instructions for hardfaced overlay plate with, for example, high strength or stainless alloy substrates are provided where applicable.

Red Dog Linings plate ranges

The Red Dog Linings hardfaced plate range has been developed to combat abrasion, erosion and impact at either ambient or elevated temperatures. The range comprises different hardfacing chromium or tungsten carbide alloys deposited onto a carbon steel or alloy substrate. Additional technical information can be obtained from Red Dog Linings at the address shown on the last page, or by visiting our website at www.rdlinings.com

The recommended method of cutting hardfaced overlay plate is by plasma-arc, as the high chromium and carbon contents of the hardfacing overlay preclude the use of oxy-fuel and most mechanical means. Laser and water jet cutting are also acceptable options. The special properties of the hardfaced overlay alloy and a ductile substrate allows these materials to be formed and fabricated into complex shapes, including concave or convex curves.

Red Dog Linings wear resistant hardfaced liners may be installed into structures using a variety of methods including plug welding, stud welding, and bolting. Fabrications can be produced from hardfaced overlay plate such as our T200X™ by conventional welding of the carbon steel substrate.

For optimum abrasion resistance it is strongly recommended to cap all joints exposed to wear with a hardfacing alloy compatible to the overlay using the Red Dog Linings range of tubular hardfacing electrodes. Premature wear may well be experienced if this practice is not adhered to. Please contact Red Dog Linings for more details of these products.



Water jet cutting

In this process a very high pressured water jet is used, usually mixed with a fine abrasive which enables materials to be cut cleanly and to close tolerances. Plate thickness up to 40mm can be cut.

Air arc gouging

A compressed air supply and a conventional constant current DC welding power supply, with a minimum OCV of 60V (80V recommended) is required for air arc gouging. An arc voltage in the range of 35-56 volts is desirable.

Cutting should be carried out from the carbon steel side of the hardfaced plate by first marking out the cutting lines and then dot punching to ensure continued visibility during the process. After cutting plates from the substrate side, all slag should be removed with an abrasive grinding disc.



Typical parameters for copper coated gouging rods are:

Diameter		Amperage (DC Reverse Polarity)	Minimum Air Flow		Recommended Air Flow	
Up to 6.3mm	1/4"	250 - 400A	3cfm @ 40psi	100l/min @ 3Bar	9cfm @ 80psi	300l/min @ 6Bar
9.5mm and above	3/8"	350 - 600A	6cfm @ 90psi	200l/min @ 6Bar	15cfm @ 80psi	500l/min @ 6Bar



Abrasive saw

Limited straight line cutting can be achieved using an abrasive saw (as used to cut concrete) fitted with a silicon carbide wheel.



Cold Forming

Most standard grades of Red Dog Linings hardfaced overlay plate can be cold formed into curved and conical sections using either rolls or press brakes. Thinner and thicker plates have only limited formability and a number of special chromium/tungsten and tungsten carbide grades can only be used as flat profiles and fabrications (see table and recommendation below).

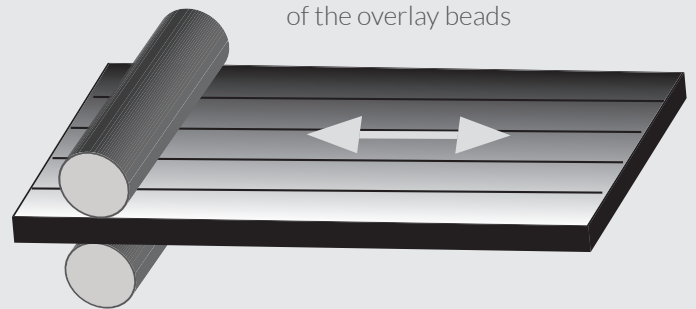
Typical radii achievable – 1000mm long plate.

Red Dog Linings hardfacing inside

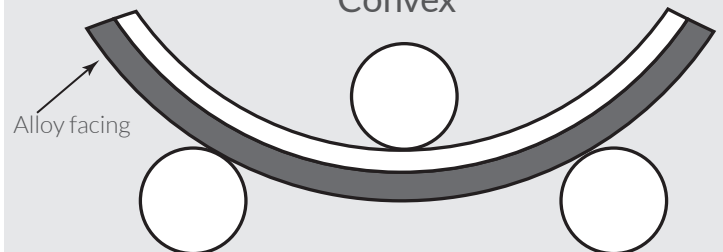
Single Layer Deposits	With Beads
2 on 4	60mm radius
3 on 5	550mm radius
4 on 6	250mm radius
6 on 6	225mm radius
5 on 8	250mm radius
6 on 8	250mm radius
7 on 8	300mm radius
6 on 10	300mm radius
9 on 10	850mm radius
6 on 13	850mm radius
Double Layer Deposits	
10 on 10	950mm radius
10 on 15	950mm radius
Triple Layer Deposits	Not recommended

Cold Forming

Form only in the direction of the overlay beads

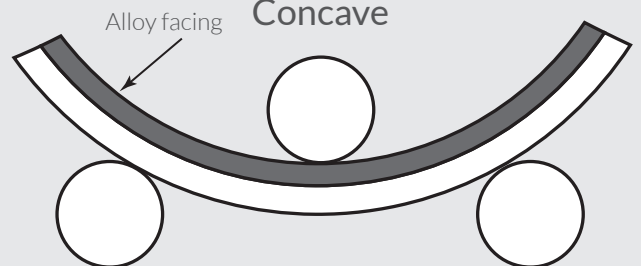


Convex



Convex forming has the effect of increasing and/or widening the stress relief cracks within the alloy facing. Experience shows that this should not present problems if the minimum recommended radius is not exceeded. Above this figure there is an increasing chance of spalling and crack propagation into the carbon steel substrate.

Concave



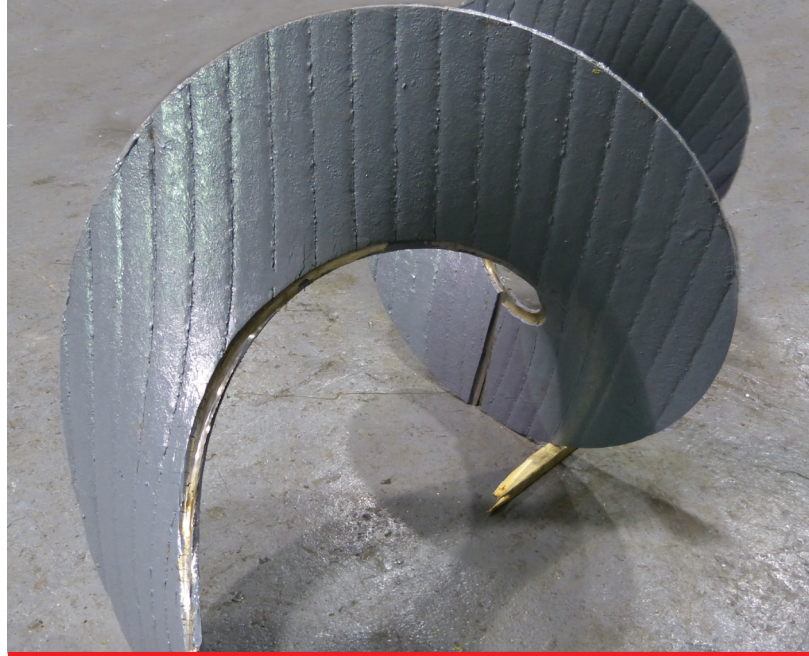
Concave forming puts the alloy facing into compression and the substrate into tension, and has the effect of closing the stress relief cracks within the alloy facing. The high compressive strength of the overlay, combined with the ductility of the substrate, allows far smaller diameters to be formed.

Red Dog Linings hardfacing outside (convex)

Single layer deposits – during forming the cracks will get wider and normally for radii less than 1000mm crack repair may be necessary depending on the application. Crack propagation and eventual fracture of the base material will occur if formed to too small a radius. We do not recommend forming double/triple hardfaced layer deposits.

Note: Direct depositing onto a preformed tube/cone should be considered when hardfacing is required on the external surface.

The above points are for guidance only and Red Dog Linings accepts no implied liability for any instances where damage occurs as a result of the above.



Fabrication

Flat profiles and formed sections can be fabricated into larger items or finished structures using conventional welding procedures. Liners may be fixed to existing structure by bolting or by various welding techniques. All structural welds must be applied to the substrate only and not touch the hardfacing.



Methods of Attachment

Fillet Welding

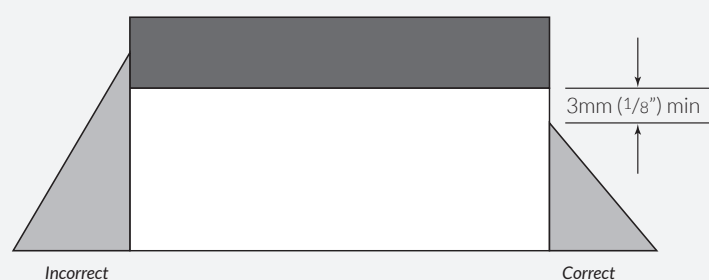
The easiest method for attaching Red Dog Linings hardfaced overlay plate to an existing structure is by a fillet weld. Care should be taken to ensure that the weld is applied to the substrate only and does not overlap the hardfacing or its penetration, as this can lead to carbon contamination and embrittlement of the weld. This is best achieved by stopping the fillet approximately 3mm (1/8") below the alloy/base plate interface which should be clearly visible on a ground edge.

Any common welding process may be used, including:

- Shielded metal arc welding (US-SMAW)
- Manual metal arc welding (UK-MMA)
- Metal inert gas (MIG) or Metal active gas (MAG) using solid wire
- Flux cored arc welding (FCAW) using gas shielded or open arc wires.

Selection of welding electrodes/wires – where the overlaid plate has a standard carbon steel substrate and the structure onto which the plate is to be attached also comprises carbon steel or a steel which does not require preheat, the following types of consumables may be used:

Fillet welding



Ensure that the fillet does not overlap the hardfacing by stopping it above 3mm (1/8") below the surface.

If the structural member requires preheat, either because of its chemical composition, yield strength or thickness, a grade of welding electrode or wire should be selected compatible with normal practice for that base material:

For example:
AWSA5.5 – E8018B2 (EN1599 ECr.Mo1 B32HS)

If the Red Dog Linings overlay has a stainless or alloy steel substrate and the structure to which it is to be welded is a high alloy manganese steel, through-hardened steel, or a type AISI-410 or 304 stainless alloy, then a suitable dissimilar metal alloy such as AWSA5.4 – E309 (EN1600 E23.12 LR21) stainless type electrode or wire should be used.

Coated electrodes

AWSA5.1
or

E7016 EN499 E424 B12HS
E7018 EN499 E463 B32HS

Solid wire for CO₂ welding

AWSA5.18
or

ER70S-3 EN440 G/W 2Si
ER70S-6 EN440 G3 Si1

Flux cored wires

AWSA5.20
or

E70T-1 EN758 T460 RC3H10
E71T-1 EN758 T463 PM1HS

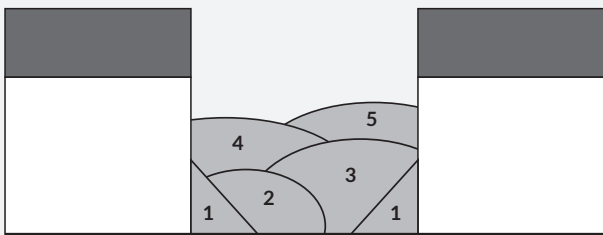
Plug Welding

Red Dog Linings hardfaced overlay plate can be attached to another plate or structure by plug welding through a series of holes. Each hole should have a minimum 25mm (1 inch) diameter, typically set at between 300mm – 600mm (12 to 24") spacing.

Fixing holes should be cut by either air arc gouging or plasma-arc cutting from the substrate side where possible to prevent chromium and carbon contaminating the carbon steel. When gouging plates thicker than 9.5mm (3/8") it is recommended that a hole is first drilled into the substrate to stop just short of the alloy interface before gouging is started.

All slag should be removed from the fixing hole by grinding or chipping/hammering.

The plate is then attached to the structure by welding the outside diameter of the hole through 360 degrees and then filling the remaining space.



Plug welding

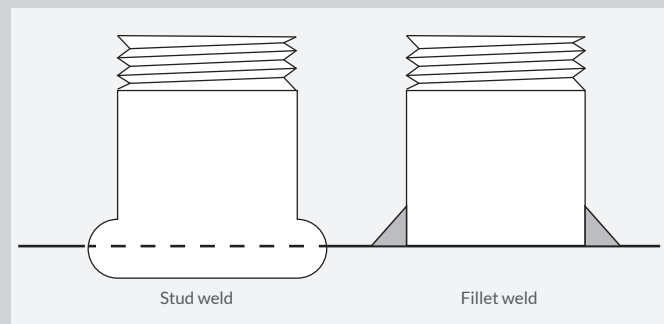
The thickness of the weld should be determined using the same criteria as for fillet welding and should stop 3mm (1/8") short of the overlay alloy layer. When the weld has been filled to the desired level, it can be protected from abrasion by 'capping' with a suitable wear resistant alloy using Red Dog Linings tubular hardfacing electrodes.



Stud Welding

A standard carbon steel stud can be easily welded to the back of the Red Dog Linings hardfaced overlay plate using most types of stud welding equipment. The minimum recommended stud size is 12mm (1/2") and the number and spacing of the studs will depend on the size and shape of the plate being attached.

Studs with a diameter greater than 12.5mm (1/2") may be hand welded with the SMAW (manual metal arc process) using an E7018 electrode. Since only a fillet weld is employed rather than a full penetration weld, a greater number of studs will be needed to secure the plate.



Countersunk Bolts

Suitable holes for countersunk bolts may be produced by direct plasma arc cutting using an orbital tool post, by piercing or gouging a straight hole and welding a pre-machined insert in place, or by a combination of direct drilling and gouging. The minimum recommended bolt size is 9.5mm (3/8") diameter and the number and spacing required will depend upon the size and shape of the plate.

The finished countersunk hole should allow the flat headed bolt to sit approximately 4mm below the surface of the plate. It can be protected from abrasion by 'capping' with a suitable Red Dog Linings tubular hardfacing electrode.

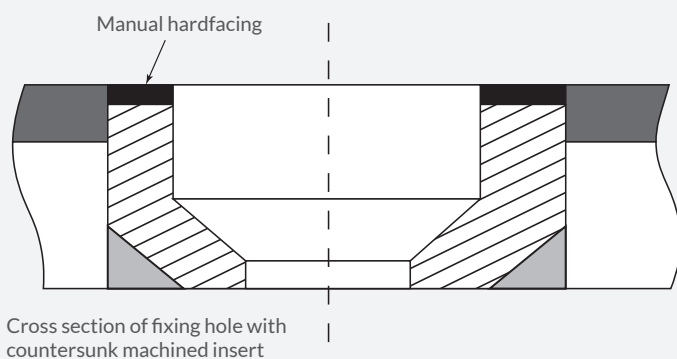
In our experience, direct plasma arc piecing produces an acceptable countersunk hole. Working from the hardfaced side, the straight clearance hole should be cut first and then the plasma torch tilted to cut the countersunk section at an angle to match the fixing bolt.

Pre-machined Inserts

Accurate pre-machined inserts may be used to fix Red Dog Linings hardfaced overlay plates, by cutting a straight hole in the plate and welding the insert in place from the carbon steel side.

Plasma arc cutting from the hardfaced side of the plate is recommended because it creates a naturally tapered hole which provides additional support for the insert.

The insert should be machined to match the bore and a chamfered weld preparation cut into the base. It is then welded into place from the carbon steel side using a low hydrogen electrode (AWS 5.1-E7018 or 7016 type).



Gouging

This process is generally used on site when plasma arc cutting is not available. If a large number of holes are required, welded inserts are recommended and gouging should be used purely to cut the clearance hole.

An alternative method for one or two holes involves gouging a straight hole from the carbon steel side (see also cutting). The countersunk section is then created by gouging a taper from the hardfaced side. The holes may be cleaned with abrasive cone/plug shaped grinding stones.

Structural Calculations

In load bearing applications, the hardfacing must be taken as having no structural strength due to the cracking within the hardfacing. There must also be an allowance made to accommodate the penetration into the base material during surfacing. It is recommended that calculations should be based upon the starting base plate thickness minus 2mm.

For example, a 4 on 10mm plate (4mm hardfacing on a 10mm base plate) must be based on the strength of an 8mm plate, but the weight of a 14mm plate. The standard backing plate is BS EN 10025-S275.

Structural Welding

Red Dog Linings hardfaced overlay plate can be fabricated by welding the mild steel substrate using standard mild steel or low hydrogen electrodes. The following details are a general guide to welding Red Dog Linings hardfaced overlay plate.

Care must be taken to ensure that all structural welds stop short of the hardfacing alloy layer. The only welding carried out on the hardfaced side of the plate will involve the capping of joints, for wear protection, with a compatible Red Dog Linings tubular hardfacing electrode.

Fillet welds

Grind the edge of the hardfaced plate to remove any slag and scale left from cutting. Care should be taken to ensure that the weld is applied to the substrate only and does not overlap the hardfacing or its dilution zone, as this can lead to carbon contamination and embrittlement of the weld and the adjacent area. This is best achieved by stopping the fillet approximately 3mm (1/8") below the overlay/base plate interface which should be clearly visible in the ground edge.

Butt welds

Partial penetration butt welds involve cutting a bevel into the carbon steel base by gouging or flame cutting. A 2mm to 3mm (1/16 – 1/8") 'land' should be left to prevent burn-through to the hardfaced layer when welding. Fit and tack the sections, then weld using the same technique as conventional joining.

Full penetration butt welds require the hardfacing (including the dilution zone) to be completely removed from the joint area by grinding/gouging back to at least 6mm (1/4") past the weld joint area. Fit and tack the bevelled sections, then weld using the same technique as conventional joining.

Welding Technique and Consumables

The root pass must not melt through the 'land' into the hardfacing as this will lead to carbon contamination and embrittlement of the weld.

Welding consumables commonly used for structural welding of C-Mn steels should be employed and conventional welding procedures/techniques should be used.

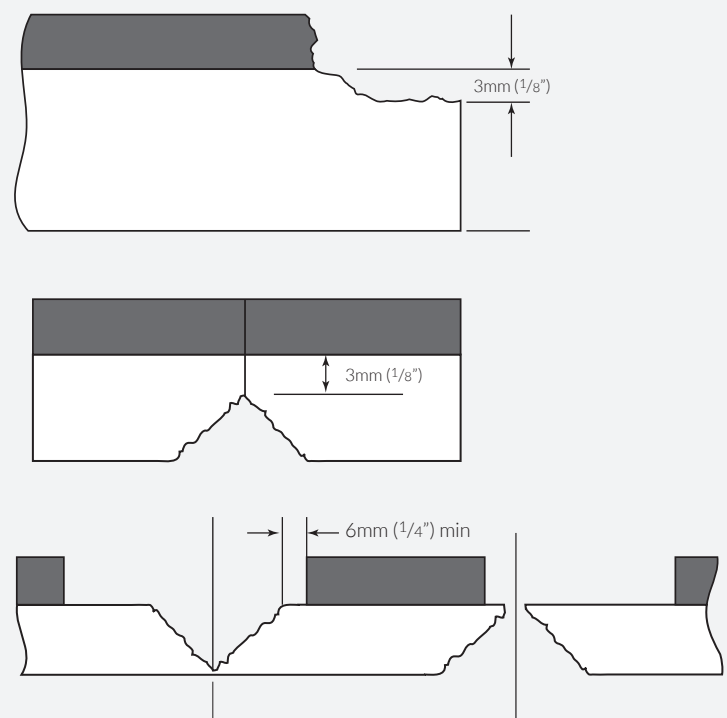
For example:

AWS 5.1 – E7018 (SMAW)

AWS A5.18 – E70S-6 (GMAW) with 75% Argon 25% CO₂

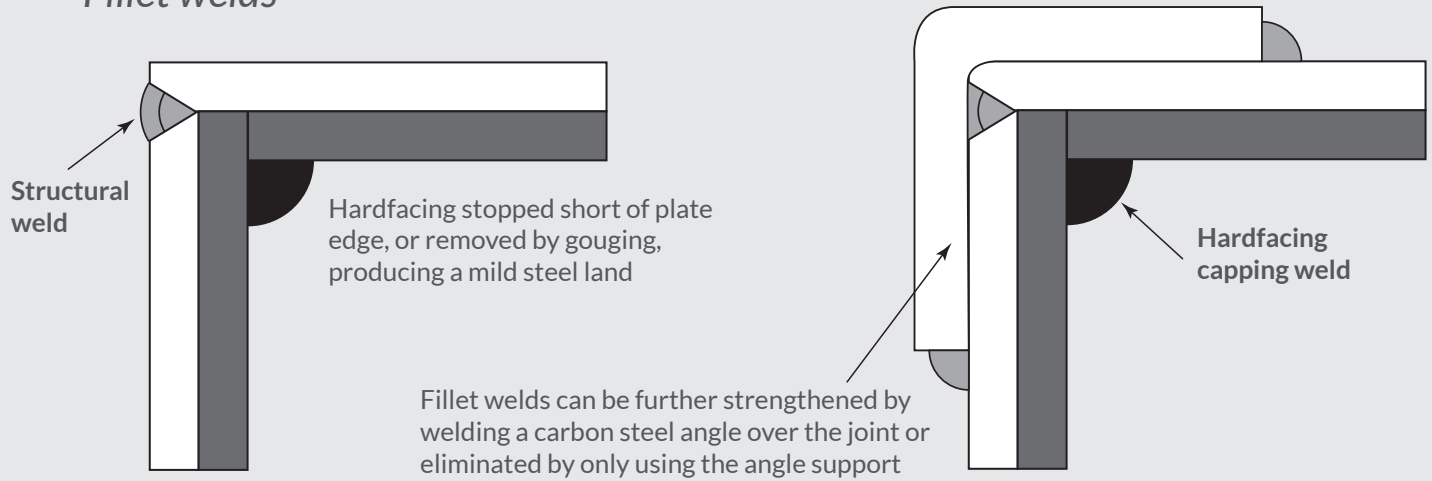
AWS A5.20 – E70T-1 (FCAW)

Note: where the fabrication proves difficult to align with sufficient accuracy to ensure that no contamination by the hardfacing is likely during welding, it is recommended that a 309 type stainless steel welding electrode be used.



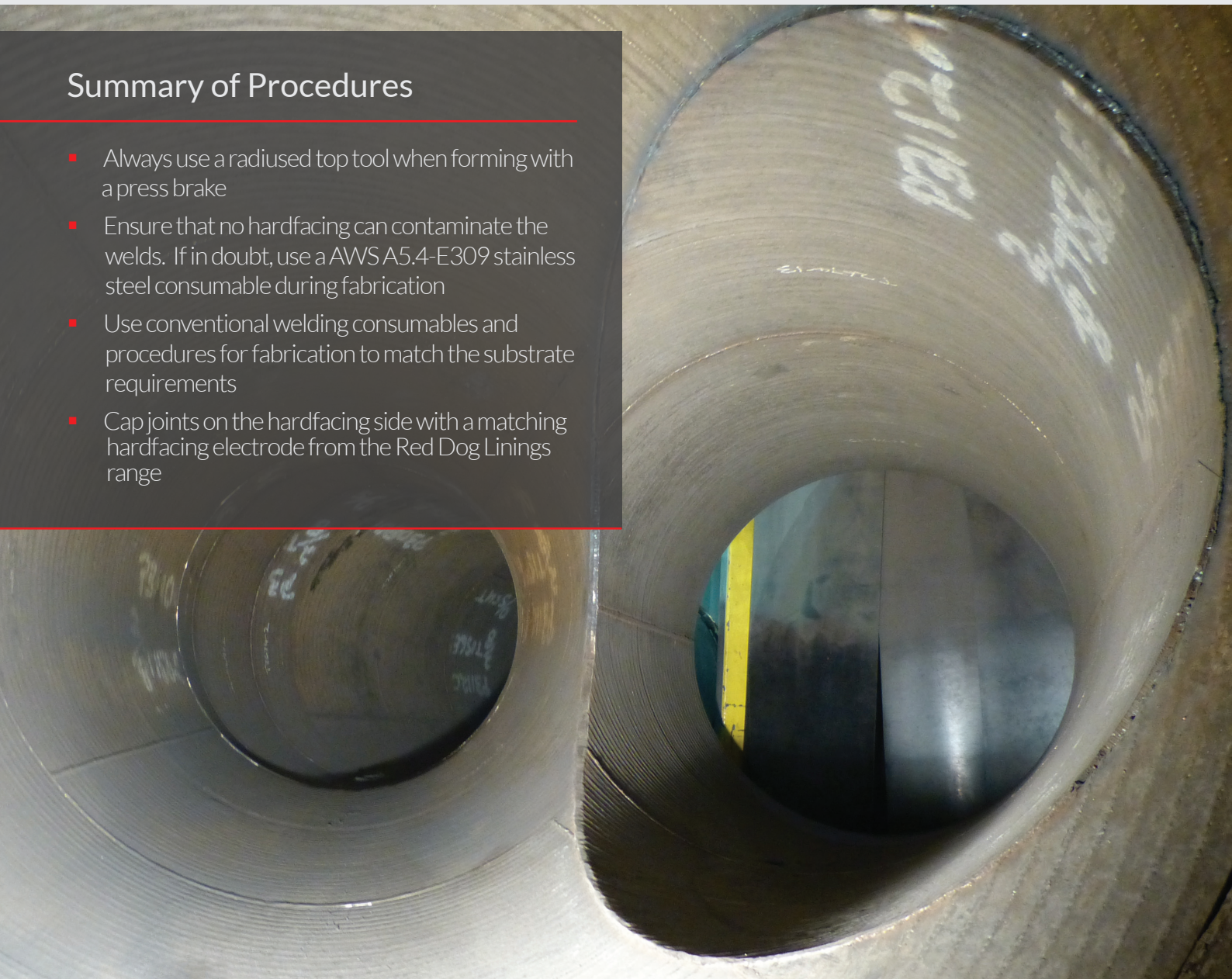
Butt welds

Fillet welds



Summary of Procedures

- Always use a radiused top tool when forming with a press brake
- Ensure that no hardfacing can contaminate the welds. If in doubt, use a AWS A5.4-E309 stainless steel consumable during fabrication
- Use conventional welding consumables and procedures for fabrication to match the substrate requirements
- Cap joints on the hardfacing side with a matching hardfacing electrode from the Red Dog Linings range



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