PANDROL

ATW PLA

PROCESS MANUAL

Issue 06
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Partners in excellence

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This manual provides detailed instructions for successfully carrying out the PLA - One Shot Crucible welding process.

This manual shall be used with the relevant track authority specification documents concerning the installation of Aluminothermic welds.

Only skilled operators who have attended an appropriate training course and hold a valid Certificate of Competence issued either by Pandrol UK Limited, or an approved body, shall attempt this operation.

Operators required to work on Network Rail Infrastructure shall hold a current Sentinel card with the appropriate competence.

When working on Network Rail Infrastructure this manual shall be used in conjunction with the latest version of Network Rail Company Specification NR/L2/TRK/0032 ‘Joining of Rails by Aluminothermic welding’.

Introduction

The manual is made up from the following sections:

Section 1 Safety Awareness

Hazard and risk assessment on process application and material storage.

Section 2 General Instructions - Part 1

The general instructions provide detailed information regarding site assessment and rail preparation.

Section 3 Process Application - PLA Standard Gap Weld

The process application provides the step by step performance of the standard gap welding operation with felt moulds.

Section 4 Process Application - PLA 68mm Wide Gap Weld

The process application provides the step by step performance of the wide gap welding operation using felt and sand moulds.

Section 5 General Instructions - Part 2

The general instructions provide detailed information on weld finishing and inspection.

Appendix A **Rail and Welding Kit Identification**

Appendix B **Welding Premium Grade Steels**

Appendix C **Welding Kits, Consumables and Hardware**

Appendix D **Oxy – Fuel Gas Cutting and Preheating Parts List and Procedures**

Appendix E **Process Requirements**

Appendix F **Weld Inspection of PLA Welds**

Appendix G **Improved 'Pate a Lute' Luting Method**

Appendix H **HWR Process (Head Wash Repair)**

Appendix I **STARTWEL® Electrical Ignition System**

Appendix J **Gasbox Preheating**

1. Safety Awareness

1.1 Hazards

1.1.1 Burns

Burns may be sustained during the welding operation from a number of sources:

- Rail end preparation
- Hot rails, tools and materials used throughout the welding operation
- Preheating
- Ignition and reaction of the portion
- Weld cleaning
- Airborne hot sparks and particles

1.1.2 Fire

Fire may occur through accident or negligence due to the following:

- Sparks from cutting and grinding
- Molten metal spillage and splashes
- Flammable material too close to the welding operation
- Incorrect disposal of hot slag

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It is strictly forbidden to use water to put out a fire caused by the aluminothermic portion.

1.1.3 Explosion

Explosion may occur through accident or negligence due to the following:

- Use of compressed gases
- Molten metal in contact with water
- Molten metal in contact with wet, snow or frozen ballast
- Hot slag or hot slag bowls coming into contact with wet, snow or frozen ballast

1.1.4 Flying Objects

There may be a risk from flying objects in the following circumstances:

- When removing and replacing rail fittings
- When removing vent risers and mould debris
- Splinters from broken tools and grind stones
- Splinters and sparks from hot materials

1.2 Hazard Prevention

1.2.1 Safety Equipment

It is essential that Personal Protective Equipment (PPE) is provided for the welders and worn correctly at all times.

The PPE required for welding includes:

- Flame retardant overalls
- Welders gloves
- Clear goggles
- Dark welding goggles GW 5/6
- Ear defenders
- Welding boots
- Hard hat
- Dust mask

1.2.2 Welder Training & Assessment

Welders shall have attended training courses in welding and all associated skills before performing track welding.

The skill courses required are as follows:

- Pandrol PLA Process Welding Certificate
- Oxy-fuel gas safety
- Abrasive wheels
- The safe operation and use of small plant required for welding including weld shear, profile grinder, disc cutter and angle grinder
- The safe operation and use of approved welding tents and umbrellas

1.2.3 Check of Substances Hazardous to Health

Material safety data sheets, on which to base COSHH assessments, are available for all Pandrol UK products from Pandrol UK Ltd.

1.3 Material Storage and Transportation

1.3.1 Material Storage Area

- Storage buildings shall be dry and well ventilated
- Building construction shall be in accordance with the fire regulations applicable to the substance being stored
- Welding kits shall be stored no more than 4 boxes high
- One-shot crucibles shall be stored no more than 3 boxes high for CJ2 crucibles
- Crucibles shall always be stored in an upright position

1.3.2 Material Transportation

- Transportation of materials shall be in accordance with the fire regulations applicable to the substance being transported.
- Crucibles shall always be transported in an upright position

1.3.3 Spillage of Welding Charge

Spillage of the Welding Charge shall be mixed with 40% sand to prevent combustion and disposed of as industrial waste.

1.3.4 Disposal of Spoiled Portions

Spoiled portions shall be returned to Pandrol UK Ltd for safe disposal. Please contact a member of staff for terms and conditions.

Note: For further detailed advice on all safety issues, please refer to the site specific method statement and risk assessments available from the site contractor in charge.

2. General Instructions Part I

2.1 The Welding Team and their Responsibilities

The procedures contained within this Process Manual are designed for use by a welding team.

Usually, a welding team is made up of a welder and a welder's assistant.

A welding team could also be comprised of two welders or one welder and a welder undertaking a mentoring programme prior to full qualification.

The welder and the welder's assistant shall hold valid certificates of competence, issued by PANDROL or other approved training organisation, for the process being used.

The welder will assume full responsibility for the production of the weld and adhere to the welding procedure.

The welder will mark the weld with his unique identification stamp.

The assistant will work to the instructions of the welder.

2.2 Site Assessment

The welder will be responsible for checking that the track conditions meet with the requirements of the relevant track authority.

Site assessment will include track stability, sleeper type and spacing, proximity of features such as other welds, bolt holes, bond attachments and rail defects such as chair gall, wheel burns and Rolling Contact Fatigue (RCF).

The welder shall take into account the position of the weld with respect to bridge decks and longitudinal timbers.

Rails to be welded shall be identified in respect of rail section, wear and steel grade to establish the correct welding kit and procedures.

2.3 Weather Conditions

2.3.1 Wet Weather

Welding may be undertaken in wet weather providing adequate protection is used; i.e. approved welding tent or large umbrella.

All consumables shall be kept dry, and wet rails dried prior to welding. In severe weather conditions the welder following consultation with their Line Manager may decide to suspend welding for personal safety reasons.

2.3.2 Cold Weather

Welding may be undertaken in sub-zero temperatures, providing preheating pressures can be maintained. If preheating pressures cannot be maintained welding shall be suspended.

It is permissible to weld grade R220 and R260 rails at rail temperatures down to -14°C.

The temperature of luting paste shall not be allowed to fall below -5°C. Welding may be undertaken at ambient temperatures lower than -5°C only if the pastes are protected from the cold.

2.4 Welding Gap Preparation

The preferred method for preparing the welding gap is by disc or saw cutting, alternatively the oxy-fuel gas technique using Propane or Acetylene may be adopted. The correct gap and tolerances are laid down in the operating parameters.

Where oxy-fuel gas cutting of rails is carried out, PANDROL advise that the following points shall be considered:

1. When preparing to cut into C.W.R. (Continuous Welded Rail) it is unsafe to cut into stressed rail using abrasive disc cutting equipment. In these circumstances, the rail may be separated by using flame cutting, providing the cut ends are then inspected and re-cut if necessary, and using the appropriate method for the grade of rail steel. All grades of steel other than R220, R260 or equivalent, shall be re-cut using mechanical means, and then the rail is welded immediately. Full instructions as to the permitted methods of cutting rails shall be provided by the relevant Track Authority.
2. Only standard grade group of rails shall be prepared by Oxy-Fuel gas cutting, i.e. R200, R220 and R260.
3. The operator shall be fully trained with possession of the appropriate certificate of competency for this technique. Check that the rail is of a grade for which flame cutting is permitted (see details above) and the method is approved by the appropriate Track Authority.
4. Only cutting torches equipped with a roller guide shall be used for the purpose.
5. The prepared rail ends shall be thoroughly cleaned after Oxy-Fuel gas cutting, to remove all mill scale, oxide and slag.
6. The rails are to be welded immediately after the cutting and cleaning processes have been completed.
7. Always ensure that traffic (trains running) does not pass over flame cut rail ends.
8. The squareness laterally and vertically of each rail end shall be within a tolerance of ± 2mm.
9. Rails ends shall be free of oil, grease and dirt.

2.5 Joint Alignment

Prior to joint alignment, each rail shall be checked for straightness and that it is free of damage that could affect the correct joint alignment.

Using a 1-metre nibbed calibrated straight edge, the vertical alignment of the two rails is adjusted to 1.5 mm high over the 1 metre span. Four points of contact with the straight edge will occur when this is achieved.

The alignment of the running edge shall be adjusted until continuous contact along the bevelled edge of the straight edge for the full 1 metre is achieved.

Where the webs or feet are of different widths, the difference shall be halved on both sides of the rail.

Twist in the rail alignment may prevent the bottom briquette fitting correctly and may cause weld metal run-outs.

For alignment devices, see the **PANDROL ATW EQUIPMENT CATALOGUE**

2.6 Datum Marks

On completion of alignment and to detect any longitudinal movement., datum marks shall be made on the foot of each rail coincident with the edge of a fastening housing, baseplate, chair, or a mark on the second sleeper, timber, bearer, or support on either side of the joint. When using A-Frames, the third sleeper, timber, bearer, or support shall be used.

These marks shall be checked at the prescribed times.

If rail movement is observed, welding shall be suspended and corrections made before welding is resumed.

3. Process Applications – PLA Standard 25mm Gap Weld

3.1 The Welding Gap

Rails shall be positively identified before welding commences. Rail identification will determine the procedure and consumables to be used.

For the PLA standard weld, the welding gap shall be 25mm+/- 2mm (23 to 27mm). The method of gap preparation is given in **Section 2.4.**

Note: Every effort shall be made to achieve the 25mm gap for PLA standard weld.

3.2 The Welding Kit

The welding kit shall be checked and identified as the correct type **(See Appendix A)**.

The moulds, portion and One-shot crucible shall be in good condition.

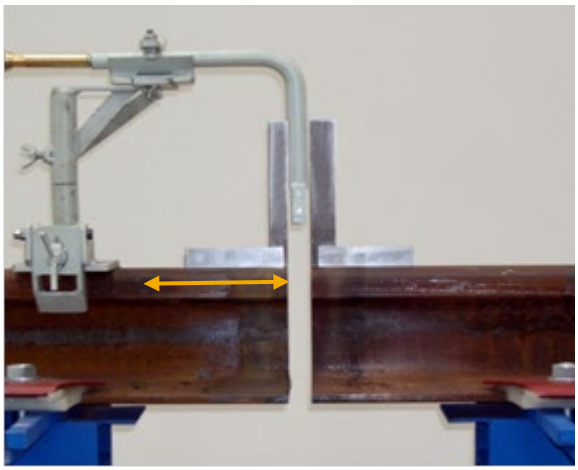
3.3 Setting the Preheater

The preheater is positioned square and central to the welding gap at a **minimum** distance of 110mm from the rail end. 110mm of running surface is required to position an engineer's square to check the preheater alignment **(See Figure 1**).

The preheater shall be set in accordance with the process parameters in **Appendix E**.

The preferred position of the preheater is on the most worn rail where practicable.

Figure 1: Preheater Setting



3.4 Position Clamp Assembly

The clamp assembly shall be positioned so that the arms are central to the welding gap, using the bottom of the rail head as a central mark, to apply even pressure on the moulds (**See Figure 2**).

Incorrect positioning of the clamp may result in uneven contact between the mould and the rail, which could lead to excessive flashing.

Figure 2: Position Clamp Assembly

3.5 Mould Selection and Modification

A key area of making a satisfactory weld is the choice and modification of the moulds. Incorrect choice or modification will result in poor mould fitment and a

weld collar that may not fulfil the required acceptance criteria. Particular areas of concern would be weld collar verticality, flashing and weld metal run-out.

3.5.1 Mould Selection

Mould choice is determined by the amount of wear on the rails to be joined. Each rail shall be measured within 25mm of the rail end with a rail wear gauge. The amount of wear shall be used with the matrix in **Section 3.5.3** to determine the correct type of mould to be used.

Type A moulds are used for welding new and nearly new rail where the amount of wear on both rails is 3mm or less **(see Figure 4).**

HY. Type B moulds are used for welding new, and nearly new rails to worn rails, where the amount of wear does not exceed 15mm on the most worn rail, and the differential in wear (step) on the rails is in the range 4 to 7mm **(see Figure 5).**

HY. Type C moulds are used for welding worn rail, where the amount of wear does not exceed 15mm on both rails and the differential in wear (step) on the rails is in the range 0 to 3mm **(see Figure 6).**

3.5.2 Mould Adjustment

3.5.2.1 Type "A" Moulds

Type A moulds use a 6mm thick strip of felt on both sides of the weld collar to produce a weld with no flashing. The felt will also accommodate some difference in rail height, as well as imperfections in the rail surface.

In situations where the difference in rail height is 2mm or more, it will be necessary to remove part of the thickness of the felt to allow the moulds to fit vertically to the rail with a snug fit. Part of the thickness of the felt shall be removed at the following positions on both mould halves:

On the underside of the head on the least worn side.

On the top of the foot on the most worn side.

The method of felt removal is given in Section 3.6.1. It is not necessary to remove any felt from the bottom briquette.

These moulds can also be used for welding new rails.

Figure 3: Rail Wear Gauge

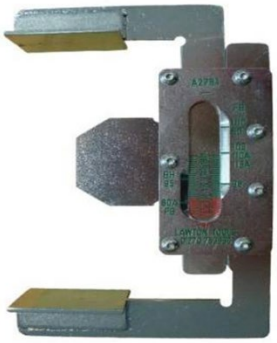


Figure 4: Type A Moulds

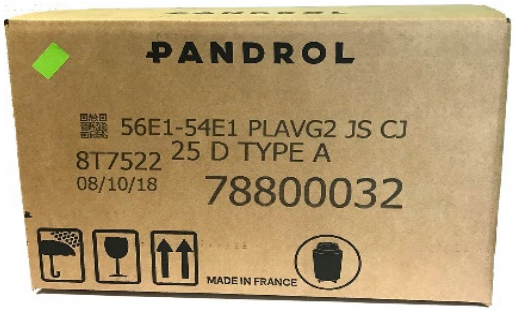


Figure 5: Type B Moulds

Figure 6: Type C Moulds

3.5.2.2 HY Type "B" Moulds

HY Type B moulds are manufactured to fit worn rails with up to 15mm of headwear and 4mm minimum of dissimilar wear. They can be adjusted to fit worn rail combinations with up to 7mm dissimilar wear.

Mould Adjustment

The first mould shall be adjusted and fitted to the least worn rail; this will be achieved by removing material from the 3 x 5mm segments on both sides of the mould by filing away sand to achieve a secure fit-up against the rail profile, as shown in **(Figure 7)**.

The second mould shall be adjusted as per the first mould (least worn rail); this also will be achieved by removing material from the 3 x 5mm segments on the mould by filing away sand to achieve a secure fit-up against the rail profile.

Figure 7: Achieving a Secure Fit

Bottom Briquette

When using the HY Type B moulds, the bottom briquette is manufactured with a 4mm step/slope on the worn side that can accommodate dissimilar wear in the range of 4 to 7mm. No adjustment is necessary.

The HY. Type B moulds and briquette have rail identification on the side, i.e. 110A – 113A PLA. This will indicate the correct way the bottom briquette and mould are to be located; the markings are on the same side.

3.5.2.3 HY Type “C” Moulds

HY Type C moulds are manufactured to fit new to new rail and worn to worn rail, where the amount of wear does not exceed 15mm on both rails and the difference in wear (step) is in the range of 0 to 3mm.

Mould Adjustment

The first mould shall be adjusted and fitted to the least worn rail; this will be achieved by removing material from the 3 x 5mm adjustable segments on both sides of the mould by filing away sand to achieve a secure fit-up against the rail profile, as shown in (**Figure 7**).

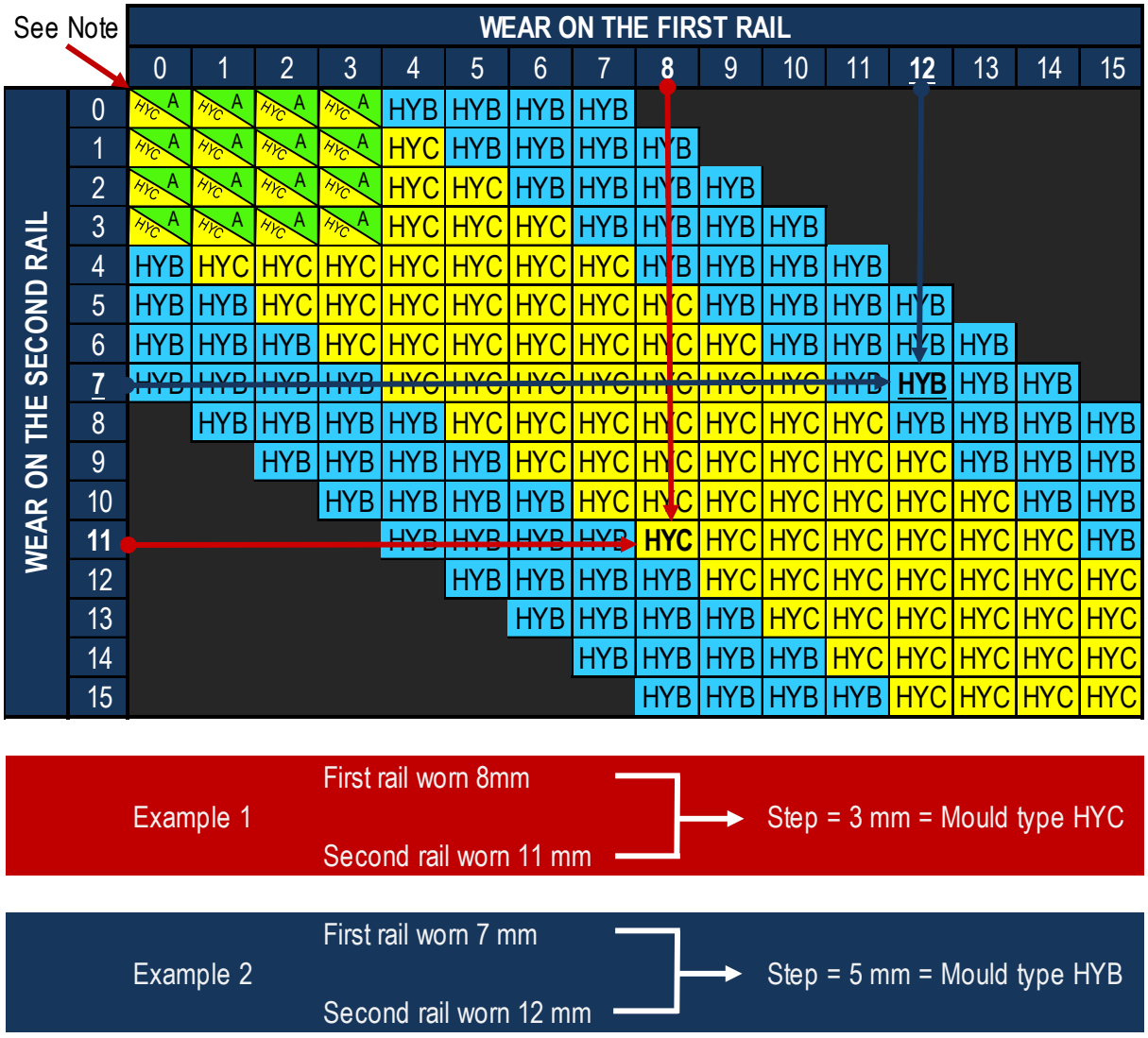
The second mould shall be adjusted as per the first moulds (least worn rail); this also will be achieved by removing material from the 3 x 5mm adjustable segments on the mould by filing away sand to achieve a secure fit-up against the rail profile.

NB: When welding new to new rail with HY Type C moulds; this is achieved by removing the 3 x 5mm segments on the mould, then placing felt from the blue kit packets to seal the luting gap. This is placed within the preformed luting strip of the moulds as shown in (section 3.7.3 **Figure 16**).

Bottom Briquette

The bottom briquette is manufactured exactly the same as with type A moulds and no adjustment is required. Good practice is to check the fitment of the bottom briquette prior to luting to ensure the correct fitment can be achieved.

3.5.3 Mould Selection Matrix



The above Mould Selection Matrix is Pandrol's recommendation and is there for guidance.

Note: Either Type "A" moulds or HYC moulds can be used for welding rails together that both have 3mm wear or less.

Note: There are coloured stickers on the exterior of the Welding Kit Boxes relating to the mould matrix above which help you identify the kits.

Green for Type A Moulds – **See Figure 4 – page 13**

Blue for Type B Moulds - **See Figure 5 – page 13**

Yellow for Type C Moulds - **See Figure 6 – page 13**

3.6 Fitting Type “A” Moulds

Each mould shall be placed into a mould shoe, making sure the recess in the side of the mould locates fully with the locating block inside the shoe **(See Figure 8)**.

Incorrect fitting of the mould into the shoe can result in the poor fitting of the bottom briquette.

The first mould shall be fitted central to the welding gap and supported by the mould clamp. The central aperture and vent risers shall be checked for correct positioning. Verticality shall be checked with a Pandrol mould square **(See Figure 9)**.

The polystyrene insert will assist with centralisation and verticality of the moulds.

If the position of the mould needs to be adjusted, make sure that the mould shoe locking clamp is released before moving the mould.

When the first mould is fitted correctly, the second mould is then fitted. Both moulds shall be checked for squareness and verticality using appropriate tools. **(See Figure 10)**.

Figure 8: Mould Shoe

Figure 9: Correct Positioning

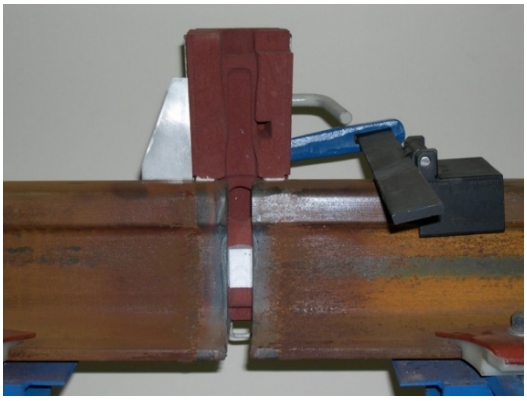


Figure 10: Checking for Squareness

3.6.1 Mould Modification

3.6.1.1 Felt Mould Modification for 2 or 3mm Dissimilar Wear

Type A moulds can be modified by removing part of the felt from the underside of the head on the new rail and above the foot on the worn rail. This will relieve the pressure exerted at these points and allow the mould to fit vertically.

A thin layer of felt may be removed by cutting into it with a sharp edge and peeling away the top layers but leaving the foot tip intact **(See Figure 11)**.

Caution shall be exercised as removing too much felt may lead to excessive flashing.

After modification, the moulds are fitted to the rail joint and checked for verticality, squareness and a snug fit.

Figure 11: Felt Mould Modification

3.6.1.2 Bottom Briquette Modification

The felt on the bottom briquette requires no modification as it is designed for new rail with similar or dissimilar wear up to 3mm.

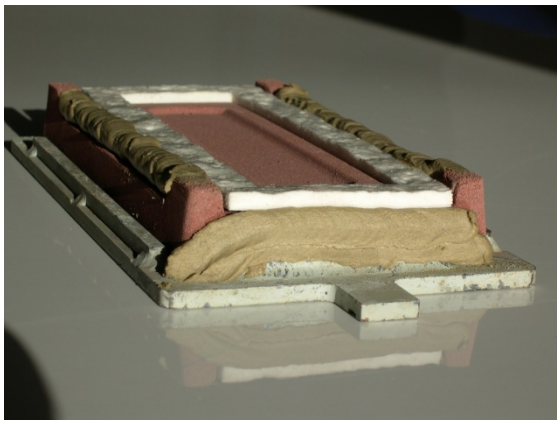
3.6.2 Fitting the Bottom Plate and Bottom Briquette

Before fitting the bottom briquette in the bottom plate, make sure the plate is clean and free from paste.

The bottom briquette shall be placed into the bottom plate. When fitted, the bottom briquette shall fit flat in the bottom plate and not rock.

Cartridge luting paste shall be applied around the edges of the bottom briquette and bottom plate. The paste shall be built up until it is 1-2mm higher than the surface of the felt along the sides **(See Figure 12)**.

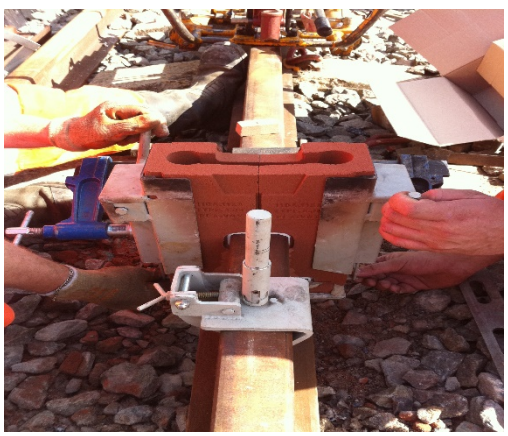
Figure 12: Cartridge Luting Paste



It is not necessary to build up the paste level with felt at the ends, 2 runs of luting paste is sufficient.

The bottom plate shall be placed carefully onto the mould clamp, checking that the locating lugs on the bottom briquette fit square and central to the two mould halves. **(See Figure 13)**.

Figure 13: Checking the locating lugs



Care shall be taken to guarantee that luting paste is not wiped from the bottom briquette during fitting.

Both locking handles shall be operated at the same time whilst the bottom briquette is held in position.

The bottom plate shall be tapped firmly with a small hammer to guarantee a tight fit with the underside of the rail.

After the plate has been fitted, the mould alignment shall be re-checked.

3.6.3 Luting

Cartridge luting paste shall be applied into all the recesses around the perimeter of the rail and mould joints **(see Figure 14).** Additional paste shall be applied to the vertical mould joint above the rail head.

Luting paste shall not be allowed to enter the mould cavity, as this will result in inclusions in the finished weld.

Poor luting can result in weld metal run-outs.

Excessive paste must not be used. If too much paste is applied, it will not dry enough during preheat and it will not form a strong seal. One bead is enough.

Note: Pate A Lute may be used to seal felted moulds also; however it is important that you apply the paste by hand only and do not apply too much pressure as this could dislodge the felt from the moulds and push the felt into the weld collar.

Figure 14: Application of luting paste

3.7 Fitting HY Type B & C Moulds

Where a difference of wear is determined between the two rails to be welded, the correct type of mould shall be identified using the table in **Section 3.5.3.**

3.7.1 Mould Modification

Before any modification is carried out, make sure that the moulds are orientated with the slag overflow (pouring gate) to the least worn side were possible.

HY. Type B and C moulds can be modified by filing as previously explained in **Section 3.5.2.2 & Section 3.5.2.3.**

Example 1: If the first rail has 8mm wear, and the second rail has 11mm wear, step = 3mm = HY Type C mould would be used. This would require both moulds to be modified by removing 7mm material from the 3 x 5mm adjustable segments by filing away sand to achieve a secure fit.

Example 2: If the first rail has 7mm wear, and the second rail has 12mm wear, step = 5mm = HY Type B mould would be used. This would require both moulds to be modified by removing 8mm material from the 3 x 5mm adjustable segments by filing away sand to achieve a secure fit-up.

REMEMBER

Always modify both moulds to suit the least worn rail.

After modification, the moulds are fitted to the rail joint and checked for verticality and a snug fit.

When the first mould is fitted correctly **(See Figure 15),** the second mould is then fitted. Both moulds shall be checked for squareness and verticality using appropriate tools.

3.7.2 Fitting the Bottom Plate and Bottom Briquette

When fitting the bottom plate & bottom briquette, follow the same sequence as in **section 3.6.2.**

NB: When fitting the bottom briquette for the HY Type B moulds, make sure the 4mm step/slope designed to accommodate dissimilar wear is fitted correctly; this can be done by checking that that the rail type markings written on the side of the briquette are fitted to the same side as the rail type markings on the moulds.

3.7.3 Fully Luting

Where moulds have been modified (Both HY. Type B & C) there will be an absence of felt and crevices will be present around the head of the rail. Therefore It will be necessary to fit felt (from the blue kit boxes) to fill the crevices prior to using luting paste **(See Figure 16)**.

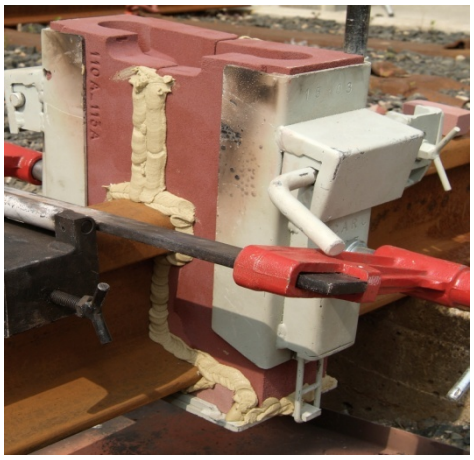
The remaining luting procedure will be as per **Section 3.6.3.**

Mould Fully Luted **(See Figure 17)**.

Figure 15: Correctly Fitted Mould

Figure 16: Modified Moulds

Figure 17: Mould Fully Luted



3.8 The One-Shot Crucible

3.8.1 One-Shot Crucible

The One-Shot crucible is available in the UK for PLA:

CJ2 + Eco-filter used for standard (25mm), wide-gap (68mm) welds and HWR welds.

3.8.2 One-Shot Crucible Procedure

The One-Shot crucible is made from bonded refractory sand and does not require any preparation.

When the crucible is removed from the packaging, check the crucible for damage and make sure the automatic tapping mechanism is not damaged, and clear any loose sand from inside the crucible.

The crucible shall be placed on a dry / grease free surface. There is cardboard supplied in the bottom of the packaging to stand the crucible on if needed.

The contents of the welding portion bag shall be emptied into the crucible, checking that the portion is free of dirt and moisture.

NB: Please note the portion bag is not vacuum packed.

One igniter only shall be placed in the centre of the portion at a depth of approximately 20–30mm ready for use. The crucible lid is then placed on top of the crucible and checked. The crucible is then ready for use **(See Figure 18)**.

Figure 18: Crucible Ready for Use

Wet or damaged crucibles shall not be used. To reduce the risk of moisture contamination, the crucible packaging can be placed over the prepared crucible.

3.9 Preheating

All gas equipment shall be assembled and checked for leaks using the approved leak detection method prior to use. A complete list of preheating equipment and its assembly is given in **Appendix D**.

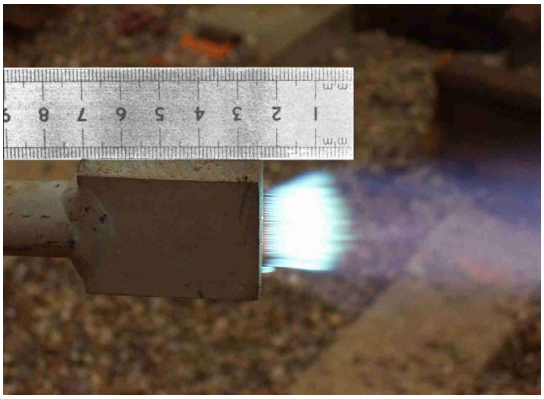
The position of the preheater on its support shall be re-checked to make sure that no movement has occurred and the correct height has been set.

Gas cylinders shall be checked to ensure that there are sufficient contents for the full duration of the preheat procedure.

The valves on the preheater shank shall be fully opened.

The preheater shall be lit and pressures set by adjusting the pressure adjustment screws on the regulator, followed by reading the in-line pressure check gauges.

Figure 19: Preheater Cone Length



3.9.1 Preheating Parameters

The parameters for a 25mm standard gap weld using Oxy-Propane and Oxy-Acetylene preheating are shown below.

	Oxy-Propane	Oxy-Acetylene
Preheating burner	RT22	RT8
Fuel gas pressure	0.6 bar	0.6 bar
Oxygen pressure	1.2 bar	0.6 bar
Cone length	25mm	8mm
Burner height	50mm	60mm
Preheat time	4 minutes	6 minutes

If the correct cone length cannot be achieved, a tolerance +/- 10% can be applied to the fuel gas pressure to facilitate flame adjustment. The flat of the slag bowl handle can be used as a guide to achieve a 25mm cone length.

Incorrect flame cone length may indicate problems with pressure check gauges. If the correct cone length cannot be maintained the gas equipment shall be repaired or replaced.

3.9.2 Preheating

After setting the preheating flame condition, the slag bowl shall be dried to remove any moisture by holding the preheating flame to the outside of the bowl.

The preheater shall be placed into the support and secured with the locking nut **(See Figure 20)**.

At this point the stopwatch shall be started.

During the preheat the following shall be checked:

- Pressures shall be maintained throughout the duration of the preheat.
- The luting paste condition remains intact. Additional paste can be applied during the preheat.
- Datum marks shall be checked for any rail movement.

Figure 20: Preheating

If any problems occur, the welding operation shall be suspended and the problem rectified before continuing.

3.9.3 Attaching the slag bowl

The slag bowl shall be placed along the pouring gate side of the mould **(See Figure 21)**.

Luting paste or pate-a-lute shall be applied between the side of the mould and the slag bowl to prevent molten slag running between the bowl and the mould **(See Figure 22)**.

Attaching the slag bowl one minute before the end of the preheat will allow the condition of the luting paste above the rail to be monitored and reinforced if necessary.

Figure 21: Attaching the slag bowl

Figure 22: Luting paste application

3.10 Completion of Preheating

The preheater shall be removed and the rail ends observed. The rail ends shall appear cherry red without melting or oxidisation.

The sand core shall be fitted in to the aperture of the moulds using the tongs **(see Figure 23)**.

Figure 23: Sand Core

The one shot crucible shall be positioned centrally on the moulds taking care not to block the slag pouring gate **(See Figure 24).**

When using the **Standard Ignition** method the crucible lid is removed and the igniter lit with the preheating torch. The igniter is then inserted into the portion approximately 20 to 30mm and then the lid is replaced. **(See Figure 25).**

TAKE CARE

Light the tip of the igniter only.

This action shall not take more than 30 seconds from removal of the preheater to the insertion of the igniter.

If a delay of more than 30 seconds occurs, welding shall be suspended and the moulds removed to allow the rails to cool. Welding can continue only when the rails have reached ambient temperature and the luting medium has been removed.

N.B. Ensure that a new set of moulds and new luting medium are used.

When using the **Electronic Ignition** (Startwel system) the crucible lid can remain in place **(See Figure 26)**. Please see section (I) for more information.

Figure 24: Positioned Centrally

Figure 25: Standard Ignition

Figure 26: Electronic Ignition

3.11 Reaction and Pour

When the reaction has started, the gas supply shall be turned off at the regulators, the hoses purged and the pressure adjustment screws slackened off.

The reaction shall be timed from the insertion of the igniter or until the crucible taps.

Tapping may be observed from the small gap between the moulds and the one shot crucible. As highlighted **(See Figure 27)**.

The reaction time shall be in the range of 17 to 32 seconds.

On completion of the pour (as soon as slag starts to pour into the slag bowl) the stopwatch shall be started for stripping down procedure.

The weld shall then be left undisturbed for 3 minutes.

Figure 27: Tapping

3.11.1 Tapping Mechanism

The tapping mechanism is the F1 type thimble and is characterised by an inverted aluminium cap, containing a small amount of portion, covering and protecting the tapping mechanism, and a 16mm diameter pouring aperture beneath.

The benefit of the F1 thimble is that it cannot be contaminated with crucible debris and is therefore more reliable.

3.11.2 Secondary Tapping

The one shot crucible has been designed with a secondary release hole if the main tapping mechanism fails to work. The molten steel will be released safely into the mould via the vent riser approximately 2 minutes after the ignition of the portion.

If the crucible taps through the secondary release hole, the weld shall be rejected by the welder, who shall arrange for the weld to be clamped and report the circumstances to the person in charge.

If the secondary release hole fails, the one shot crucible shall be left undisturbed for 30 minutes until the molten steel has solidified and cooled down.

The crucible can then be removed to a safe position.

3.12 Stripping Down Times on Completion of Pour

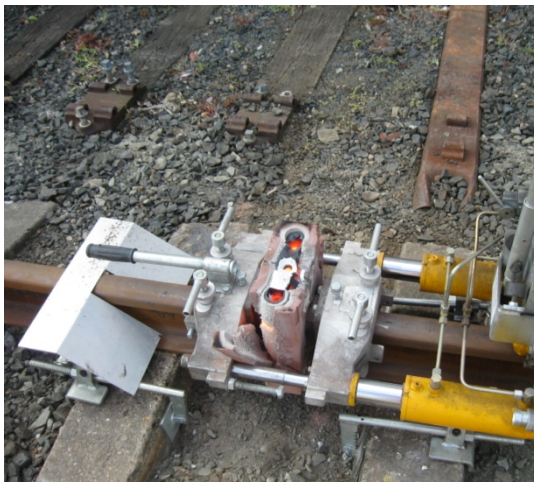
After 3 minutes has elapsed, the one shot crucible may be removed with the crucible fork **(See Figure 28)**. The crucible shall be placed on a steel tray clear from flammable material.

The slag bowl shall be removed and placed on the hot waste/sand tray containing at least 25mm of sand, after first breaking the solidified slag between the moulds and the slag bowl with a small hammer. Breaking the solidified slag will prevent breaking into the moulds too early.

The clamp and mould shoes may be removed after 4 minutes.

Figure 28: Crucible Removal

Figure 29: Shearing



3.13 Shearing and Riser Removal

Prior to weld shearing, luting paste shall be cleaned from the rail head each side of the weld, to prevent impregnation into the hot weld metal. This can be done by using a wire brush.

The weld shear blades shall be adjusted to leave a minimum of 2mm of weld metal above the running surface for profile grinding.

After 5 minutes has elapsed from completion of the pour, the excess weld material can be sheared **(Figure 29)**.

On completion of shearing, if alignment device needs to be moved, wood or nylon wedges can be inserted 10 minutes after completion of pour to permit removal of the device.

If it is not possible to trim the weld using the hydraulic weld trimming machine, the head riser shall be removed when cold, using a suitable angle grinder and abrasive cut-off wheel. The head riser shall be removed to within 5mm of the rail head, and the remaining head riser removed by profile grinding.

The vent riser shall be removed after 30 minutes from the pour and once the weld has cooled down.

IMPORTANT

If the vent riser is greater than 5mm high above the weld collar, it shall be ground down to 5mm or less.

To remove the vent riser, notch the vent riser 50% of its depth and not by more than 5mm from the weld collar surface using an angle grinder and a metal cutting disc. On completion of notching, knock the riser along the rail for complete removal.

3.14 BS95 RBH BULL HEAD RAIL

When welding 95RBH rail section, Type A mould welding procedures shall be followed with the following exceptions.

The as-cast weld incorporates a vent riser support that protrudes approximately 30mm from each foot tip. The vent riser and its support shall be removed separately after 30 minutes from the pour and once the weld has cooled down.

To remove the vent riser, notch the vent riser 50% of its depth, and not more than 5mm from the weld collar surface using an angle grinder and a metal cutting disc. On completion of notching, knock the riser along the rail for complete removal.

IMPORTANT

If the vent riser is greater than 5mm high above the weld collar, it shall be ground down to 5mm or less.

After the vent riser has been removed, if no damage is evident, the vent riser support may be left on. However, if damage to the vent riser support has occurred, cut off the vent riser support using an angle grinder and metal disc, and grind back to within 3mm of the foot of the rail. All sharp edges shall be removed by grinding.

Note: Care shall be taken at all times to protect the rail and weld collar from damage during the grinding and cutting operations.

For mould selection and modification when using HY Type B & C Moulds on BS 95RBH Bull Head rail, follow the same procedure as shown in section **3.5 Mould Selection and Modification.**

When fitting HY Type B & C Moulds on BS 95RBH Bull Head rail, follow the same procedure as shown in section **3.7 Fitting HY Type B & C Moulds.**

4. Process Application – 68mm Wide Gap Weld

4.1 Removing a Defect or Defective Weld from Stressed Track

Before cutting into stressed track, datum marks shall be marked on the rail 100mm either side of the centre-line of the defective weld. These marks will identify how much rail movement takes place when the rail is cut.

Tensors shall be assembled around the defect and a load applied to prevent excessive movement of the rail through adjacent fastenings after it has been cut.

The defective weld or rail defect shall be flame cut through its centre.

When the rail has been cut, the tensor pressure can be released and the amount of rail movement measured.

IMPORTANT

Disc cutting into stressed track is highly dangerous and is prohibited.

THE REQUIRED GAP CAN BE CALCULATED AS:

Required Gap = Welding Gap + Rail Movement

It is essential that the rail is pulled back to give 200 mm spacing between the original datum marks. Failure to pull the rail to this dimension will lead to over or under-stressed track.

Equal amounts of material shall be cut from each rail to produce the required gap.

Various defects require Non Destructive Testing (NDT) prior to welding, reference shall be made to NR/L2/TRK/0032.

4.2 The Welding Gap

The PLA 68mm wide gap weld can be used on 54E1, 56E1, and 60E1 (BS110A, BS113A and CEN 60) rails (or equivalent) with up to 3mm of wear. Oxy-Propane and Oxy-Acetylene versions are available for all rail sections.

Rails shall be positively identified before welding commences.

The welding gap shall be 68mm +/ - 3mm (65 to 71mm). The method of gap preparation is given in **Section 2.4.**

Note: Every effort shall be made to achieve the 68mm gap for the wide gap PLA process weld.

4.3 The Welding Kit

The welding kit shall be checked and identified as the correct type **(see Appendix A).** The moulds, portion and One-shot crucible shall be in good condition.

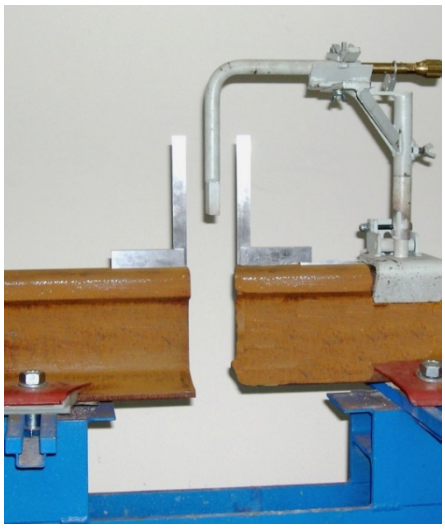
4.4 Setting the Preheater

The preheater is positioned square and central to the welding gap **(See Figure 30)**.

The preheater stem shall be set to guarantee the correct burner height and set in accordance with the process parameters in **Appendix E.**

The preheater shall be positioned on the most worn rail.

Figure 30: Positioning the Preheater



4.5 Position Clamp Assembly

The clamp assembly shall be positioned so that the arms are central to the welding gap using the bottom of the rail head as a central mark to apply even pressure on the moulds. **(See Figure 31)**.

Incorrect positioning of the clamp may result in uneven contact between the mould and the rail, which could lead to excessive flashing.

Figure 31: Positioning the Clamp

4.6 Mould Selection and Modification

4.6.1 Mould Selection

68mm wide gap welds can only be used for welding new and nearly new rail where the amount of wear on both rails is 3mm or less. Mould choice is, therefore, only determined by rail section.

4.6.2 Mould Adjustment

68mm wide gap moulds use a 6mm thick strip of felt on both sides of the weld collar to produce a weld with no flashing. The felt will also accommodate a 3mm difference in rail height as well as imperfections in the rail surface.

In situations where the difference in rail height is 2mm or more, it may be necessary to remove part of the thickness of the felt to allow the moulds fit vertically to the rail with a snug fit. Part of the thickness of the felt shall be removed at the following positions on both mould halves:

- on the underside of the head on the least worn side
- on the top of the foot on the most worn side

The method of felt removal is given in **Section 3.6.1.1.** It is not necessary to remove any felt from the sand briquette.

4.7 Fitting 68mm Wide Gap Moulds

Each mould shall be placed into a mould shoe, making sure the recess in the side of the mould locates fully with the locating block inside the shoe.

Incorrect fitting of the mould can result in a poor fitting of the sand briquette.

The first mould shall be fitted central to the welding gap and supported by the mould clamp. The central apertures and weld collar shall be checked for correct positioning.

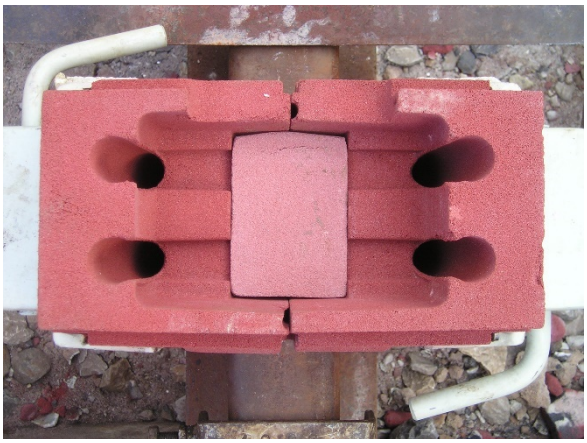
Verticality can be checked using an engineer's square positioned across the gap and against the outside face of the mould **(See Figure 32)**.

If the position of the mould needs to be adjusted, make sure that the mould clamp is released before moving the mould.

When the first mould is fitted correctly, the second mould is then fitted. Both moulds shall be checked for squareness and verticality using appropriate tools. The sand core shall be checked for a good fit in the head riser. **(See Figure 33)**.

Figure 32: Checking Vertically

Figure 33: Check for Squareness



4.7.1 Fitting the Bottom Plate & Bottom Briquette

Before luting and fitting the bottom briquette, check the briquette fits correctly between the moulds **(See Figure 34)**.

The bottom briquette shall be a snug fit with the moulds and the underside of the rail.

If the bottom briquette feels tight in the moulds, file both ends of the briquette equally until a good fit is achieved.

Before fitting the bottom briquette in the bottom plate, check that the plate is clean and free from paste.

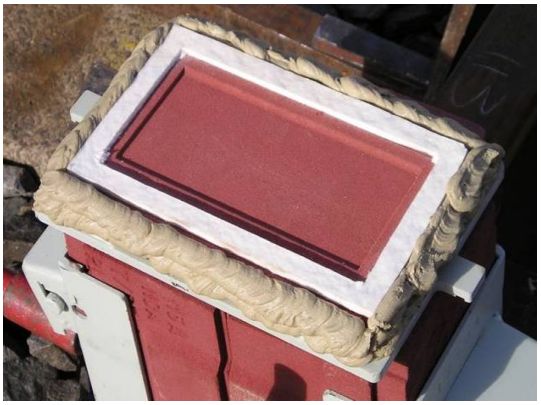
The bottom briquette shall be placed into the bottom plate. When fitted, the briquette shall fit flat in the bottom plate and shall not rock.

Cartridge luting paste shall be applied around the edges of the bottom briquette and bottom plate. The paste shall be built up until it is level, or just above (1mm to 2mm), the surface of the felt **(See Figure 35)**.

The bottom plate shall be placed carefully onto the mould shoe lifting devise to guarantee it fits square and central to the two mould halves.

Figure 34: Check the Briquette fits

Figure 35: Luting Paste



Both locking handles shall be operated at the same time whilst the bottom briquette is held in position.

Care shall be taken to ensure that luting paste is not wiped from the bottom briquette during fitting.

The bottom plate shall be tapped firmly with a small hammer to guarantee a tight fit with the underside of the rail.

After the plate has been fitted, the mould alignment shall be re-checked.

4.8 Luting

Luting is carried out in the same manner as standard gap Type A moulds (Section 3.6.3). Cartridge luting paste shall be applied into all recesses around the perimeter of the rail and mould joints. Additional paste shall be applied to the vertical mould joint above the rail head.

Luting paste shall not be allowed to enter the mould cavity, as this will result in inclusions in the finished weld.

Note: Pate A Lute may be used to seal felted moulds; however it is important that you apply the Pate A Lute by hand only and do not apply too much pressure as this could dislodge the felt from the moulds and push the felt into the weld collar.

4.9 The One-Shot Crucible

4.9.1 One-Shot Crucible

The CJ2 crucible is used for 25mm (standard gap) and 68mm (wide gap) welds.

The CJ2 crucible incorporates an Eco-filter lid.

4.9.2 One-Shot Crucible Procedure

The One-Shot crucible procedure for 68mm wide gap welds is the same as that used for 25mm standard welds **(Section 3.8.2)**

4.10 Preheating

The same general conditions for 25mm standard welds apply to 68mm wide gap welds. Details can be found in **Section 3.9** however, the procedure does vary, please refer to **Appendix E.**

4.10.1 Preheating Parameters

The parameters for Oxy-Propane and Oxy-Acetylene preheating for **68mm wide gap** welds are shown below.

	Oxy-Propane	Oxy-Acetylene
Preheating Burner	RT22	RT8
Fuel Gas Pressure	0.6 bar	0.6 bar
Oxygen Pressure	1.2 bar	0.6 bar
Cone Length	25mm	8mm
Burner Height	70mm	60mm
Preheat Time	7 minutes	7 minutes

If the correct cone length cannot be achieved, a tolerance +/- 10% can be applied to the fuel gas pressure to facilitate flame adjustment.

4.10.2 Attaching the Slag Bowl

The same conditions for 25mm standard welds apply to 68mm wide gap welds. Details can be found in **Section 3.9.3**

4.11 Completion of Preheating

The same conditions for 25mm standard welds apply to 68mm wide gap welds. Details can be found in **Section 3.10.**

4.12 Reaction and Pour

The same conditions for 25mm standard welds apply to 68mm wide gap welds. Details can be found in **Section 3.11.**

The weld shall be left undisturbed for 3 minutes.

4.12.1 Tapping Mechanism

The same general conditions for 25mm standard welds apply to 68mm wide gap welds. Details can be found in **Section 3.11.1.**

4.12.2 Secondary Tapping

The same general conditions for 25mm standard welds apply to 68mm wide gap welds. Details can be found in **Section 3.11.2.**

4.13 Stripping Down Times on Completion of Pour

After 6 minutes has elapsed, the One-Shot crucible may be removed with the crucible fork. The crucible shall be placed on a steel tray clear from flammable material.

After 6 minutes has elapsed and once the crucible has been removed, the slag bowl shall be removed and placed on the hot waste/sand tray containing at least 25mm of sand. Ensure that you break the solidified slag between the moulds and the slag bowl with a small hammer before removal. Breaking the solidified slag will prevent breaking into the moulds too early.

The clamp and mould shoes may be removed after 10 minutes.

4.14 Shearing and Riser Removal

Prior to weld shearing, mould sand and loose paste shall be cleaned from the rail head each side of the weld, to prevent impregnation into the hot weld metal. This can be done by using a wire brush.

The weld shear blades shall be adjusted to leave a minimum of 2mm of weld metal above the running surface for profile grinding.

After 13 minutes has elapsed from completion of the pour, the excess weld material can be sheared.

If it is not possible to shear the weld using the hydraulic weld shearing machine, the head riser shall be removed when cold, using a suitable angle grinder and abrasive cut-off wheel. The head riser shall be removed to within 5mm of the rail head, and the remaining head riser removed by profile grinding.

The vent risers shall be removed after 50 minutes from the pour and once the weld has cooled down.

To remove the vent riser, knock the riser along the rail until fracture occurs for complete removal.

IMPORTANT

If the vent riser is greater than 5mm high above the weld collar, it shall be ground down to 5mm or less.

4.15 60E1 / 56E1 (UIC60 / 113A) Composite Joints

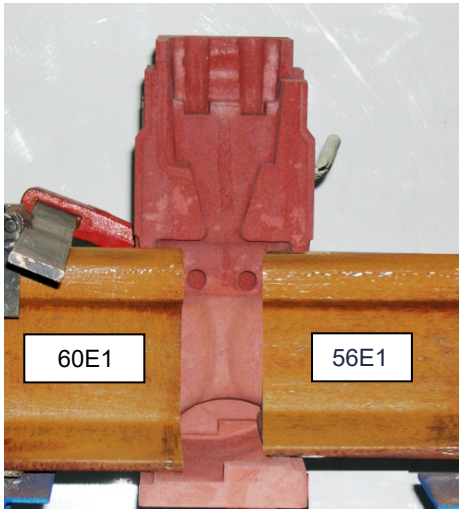
4.15.1 Mould Fitting

Where 56E1 section rail needs to be welded to 60E1 section rail, composite moulds shall be used.

These moulds do not have felt, however no adjustment is necessary. If a gap exists between the moulds and underneath the head of the rail, it is advisable to place a small amount of felt.

These moulds are purposely designed to accommodate the two rail sections **(See Figure 36)**.

Figure 36: Mould fitting



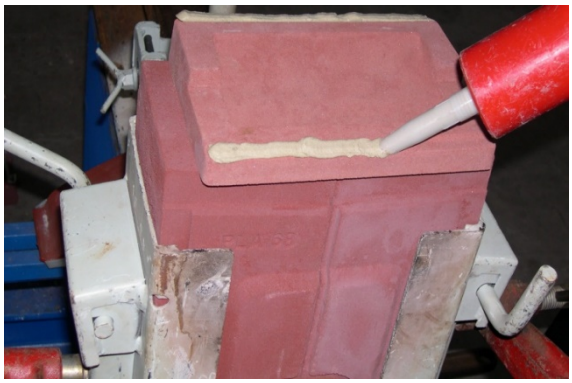
4.15.2 Bottom Briquette

4.15.2.1 Luting Bottom Briquette

Prior to fitting the bottom briquette, there is a requirement to apply cartridge luting paste **(See Figure 37)** as there are no felted strips along the bottom briquette.

The luting paste is only applied along the side, not along the edges.

Figure 37: Apply cartridge luting paste



4.15.2.2 Fitting the Bottom Briquette

The bottom plate shall be placed carefully onto the mould clamp, checking that the bottom briquette fits squarely and centrally to the two mould halves.

Both locking handles shall be operated at the same time whilst the bottom briquette is held in position.

The bottom plate shall be tapped firmly with a small hammer to guarantee a tight fit with the underside of the rail.

After the plate has been fitted, the mould alignment shall be re checked.

N.B. It may be necessary to use a sand file on the moulds for geometry and a snug fit.

4.15.3 Luting

'Pate a Lute' shall be applied into all the recesses around the perimeter of the rail and mould joints, including the underside of the rail and the joint behind the bottom plate hangers.

Pate a Lute is applied from the bucket, by hand. Initially, small quantities of paste shall be pushed firmly into the luting recesses to guarantee correct sealing. Larger quantities can then be applied to reinforce the seal **(See Figure 38 and 39).**

Figure 38: Before 'Pate a Lute'

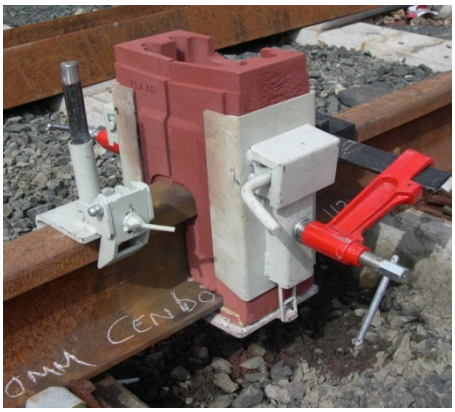
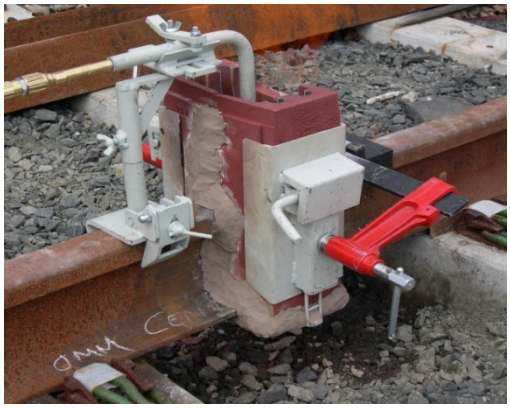


Figure 39: After 'Pate a Lute'



Luting paste shall not be allowed to enter the mould cavity, as this will result in inclusions in the final weld.

4.16 Post Luting Procedure

Following mould fitting and luting, the procedure for 60E1 / 56E1 composite welds is the same as that for conventional PLA 68mm welds. Please refer to sections 4.10 to 4.16 for details.

5. General Instructions – Part 2

5.1 Rail Stressing Equipment

To prevent hot tears when welds are made between rail stressors, the equipment shall remain in position for a minimum time from the completion of the pour.

These times, also specified in the process data sheets in Appendix E, are as follows.

- 25mm standard gap welds – 30 minutes from completion of the pour
- 68mm wide gap welds – 50 minutes from completion of the pour

In addition, newly made welds shall not be subjected to stressing operations or the use of rail stressors in close proximity for the same minimum times given above.

5.2 Removal of Risers on All Rail Types

To minimise the risk of weld collar damage, the following procedure shall be used for the removal of vent risers.

Method for removal:

- For a standard weld (25mm gap), at least 30 minutes from completion of the pour and after the removal of all sand from the base of the risers, notch the risers 5mm above the weld collar using an angle grinder and metal cutting disc. The notch shall be approximately 50% deep and not more than 5mm from the weld collar surface. On completion of notching, knock the risers towards and along the rail for complete removal.
- For a wide gap weld (68mm gap) at least 50 minutes after completion of the pour the vent riser may be knocked along the rail until fracture occurs for complete removal.
- Vent riser stubs on any rail profile shall not project vertically more than 5mm once removal has been completed. Vent risers that are more than 5mm high can be ground back accordingly.
- Extreme care shall be exercised during vent riser removal to avoid damage to the collar or surrounding rail.

IMPORTANT

If the vent riser is greater than 5mm high above the weld collar it shall be ground down to 5mm or less.

Times for riser removal are specified in the process data sheets in **Appendix E.**

5.3 Removal of Mould and Cleaning Weld

The mould material may be removed more easily when cold, using a wire brush and the round end of a ball peen hammer. The use of a needle gun is also allowed.

5.4 Profile Grinding

Before grinding can commence, all insulators, pads and fastenings shall be replaced.

The times for reinstating the track are 30 minutes after the pour for standard PLA gaps (25mm) and 50 minutes after the pour for PLA wide gaps (68mm). If the alignment device needs to be removed, wood or steel wedges can be inserted 10 minutes for PLA gaps (25mm) and 20 minutes for PLA wide gaps (68mm) after completion of the pour to permit the removal of the device.

A minimum amount of time is required from the completion of the pour to the grinding. This is to prevent possible detrimental effects to the finished profile when cold. Times for grinding are specified in the process data sheets in **Appendix E.**

Final profile grinding shall be within the tolerance laid down by the relevant track authority. For Network Rail infrastructure, these tolerances are specified in Network Rail Company Specification NR/L2/TRK/0032.

5.5 Passing of Traffic Over A Newly Made Weld

It is recommended that traffic does not pass over a newly made weld until it has been ground; however, local track authority procedures shall be consulted for emergency action.

5.6 Weld Identification

Welds shall be identified in accordance with local track authority regulations.

5.7 Weld Inspection

The welder shall inspect all their own welds prior to leaving the site.

The weld shall be checked for any visual defects and geometry misalignment.

Defects shall be reported and action taken before leaving the site.

The welding inspector will carry out a further, more detailed, inspection, to local track authority requirements.

For PLA weld inspection guidelines, see **Appendix F**.

Appendices

A. Rail and Welding Kit Identification

A.1. Rail Identification

Prior to welding, both rails shall be identified in respect to the following:

- Rail section
- Rail steel grade
- Rail wear

The amount of rail wear shall be measured, but rail section and grade information can usually be obtained from the rail itself.

All rails manufactured have the basic details of steel type and rail section imprinted on one side of the rail. These are known as rolled markings; other information such as year of manufacture, supplier and process are also imprinted.

A.1.1. Before 1978

Before 1978, rolled markings were not standardised but were usually in the following form

Rail Section	Process	Manufacturer	Year

Rolled markings were imprinted in letters 18mm high, repeated every 2.5 metres along the rail web

An example of these rolled marks would be as follows:

110A OB BSC CARGO FLEET 1965

This translates as:

110 A	Rail section	(from British Standard 11)
OB	Process	(Basic Open Hearth)
BSC CARGO FLEET	Manufacturer	
1965	Year of manufacture	

A.1.2. From 1978

In 1978, roll markings were standardised in the following form

Rail Section	Rail Grade	Manufacturer	Year	Process

Rolled markings were imprinted in letters 30mm high, repeated every 2.5 metres along the rail web.

An example of these rolled marks would be as follows:

BS113A A WORKINGTON 98 O

This translates as:

BS113A	Rail section	(from British Standard 11)
A	Rail grade	(Wear Resisting Grade A)
WORKINGTON	Manufacturer	(Corus Workington)
98	Year of manufacture	
O	Process	(Basic Oxygen)

Where the grade of rail is omitted, this means the rail is R220 (Standard Grade).

Full details of roll markings, including the latest European markings, can be found in Network Rail Company Specification NR/L2/TRK/0032 Appendix A Identification of rails and brand markings.

A.1.3. Latest European Rail Grade Markings

The latest rail grade marking system incorporates a series of horizontal lines 25mm and 50mm long. For example,

BS = Manufacturer / SC = Manufacturing Rolling Mill / Series of horizontal lines 25mm and 50mm long define the grade of rail / 18 = Year of Manufacturer / 56E1 = Rail Section Size and weight.

A full list of the latest European Rail Grade Markings can be found in the Network Rail Company Specification NR/L2/TRK/0032 Appendix A.

A.1.4. Rail Wear

Along with the rail section and grade, rail wear shall be determined to establish the correct moulds to be used.

A validated rail wear gauges shall be used on both rails to be welded.

A.1.5. Kit Identification

Following the positive identification of rail section, grade and wear, the correct welding kit can be chosen using the selection matrix in Section 3.5.3

Each kit is printed with information including its suitability for rail steel type, rail section and wear.

Other information includes the batch number and process details

An explanation of kit markings is given in the following section.

A.1.6. Kit Markings

Figure 40: Typical Welding Kit

Using the above as an example, the kit markings have the following meanings

Box Marking	Information Given	Other Possible Markings	Information Given
56E1-54E1	For use with 56E1 - 54E1 - 109 -110A - 113A rails	95RBH or BS95A	For use with 95RBH Bull Head rails
		60E1	For use with 60E1 - UIC60 - CEN 60 rails
HY TYPE C	For rails with up to 15mm wear and 0 to 3mm step	TYPE A	For rails with up to 3mm wear and 0 to 3mm step
		HY TYPE B	For rails with up to 15mm wear and 4 to 7mm step
		68MM	For 68mm wide gap welds
		60E1/56E1	Composite welds for 60E1 / 56E1 - CEN 60 / 113A
JS	Felt mould		
PLAVG2	Process description		
CJ	For use with one-shot crucible		
25	Nominal gap size 25mm	68	Nominal gap size 68mm
D	For use with standard grade rails	HH or 350HT	For use with premium grade rails
8D1212	Batch number		
Yellow label	Indicates Type C kit	Green	Indicates Type A kit
		Blue	Indicates Type B kit

A.2. Welding Portion Grade Matrix

		1st Rail					
		R220	R260	R350 LHT	R350 HT	HP335	R370CrHT (MHH)
2nd Rail	R220	R260 (D)	R260 (D)	R260 (D) + cooling controlled	R260 (D)	R260 (D) + cooling controlled	R260 (D) + cooling controlled
	R260		R260 (D)	R260 (D) + cooling controlled	R260 (D)	R260 (D) + cooling controlled	R260 (D) + cooling controlled
	R350 LHT			R350(HH) + cooling controlled	R350(HH) + cooling controlled	R350(HH) + cooling controlled	R350(HH) + cooling controlled
	R350 HT				R350(HH)	R350(HH) + cooling controlled	R350(HH) + cooling controlled
	HP335					R350(HH) + cooling controlled	R350(HH) + cooling controlled
	R370CrHT(MHH)						R350(HH) + cooling controlled

More comments:

D = R220 – R260 Standard Grade Steels

HH / R350HT = Premium Grade Steels

For an explanation of Cooling Controlled see Appendix B **(Page 42) - Welding Premium Grade Steels**

B. Welding Premium Grade Steels

B.1. Welding Parameters

The welding parameters are the same as those for R260 grade rail which are specified in Appendix E of this process manual.

B.2. The Welding Kit

The portion type for welding all approved premium grade rails is R350HT (HH).

B.3. Post Weld – Cooling Controlled

Once the weld has been cast and sheared, it is important to leave the head and vent risers in place to retard the cooling rate as stated in the technical briefing document - **INFO_TECH_N°25_EN - Date: MARCH 2017** and shown below **(See Figure 41)**.

Figure 41:

C. Welding Kit, Consumables and Hardware

C.1. Welding Kits

Welding Kits PLA VG2 JS (felted) 25 mm

Product Name	Part Number	PADS Number
56E1 / 54E1 Type A (Standard Grade)	70-00-78800032	0057/050991
56E1 / 54E1 Type B (Standard Grade)	70-00-78800024	0046/014198
56E1 / 54E1 Type C (Standard Grade)	70-00-78800025	0046/014197
56E1 / 54E1 Type A R350HT (Premium Grade)	70-00-78800043	0046/035053
56E1 / 54E1 Type B R350HT (Premium Grade)	70-00-78800052	0046/035030
56E1 / 54E1 Type C R350HT (Premium Grade)	70-00-78800053	0046/035031
60E1 Type A (Standard Grade)	70-00-78800023	0046/014180
60E1 Type B (Standard Grade)	70-00-78800046	0046/035058
60E1 Type C (Standard Grade)	70-00-78800047	0046/035059
60E1 Type A R350HT (Premium Grade)	70-00-78800016	0046/035052
60E1 Type B R350HT (Premium Grade)	70-00-78800056	0046/035032
60E1 Type C R350HT (Premium Grade)	70-00-78800055	0046/035033
BS95 Bull Head Rail Type A (Standard Grade)	70-00-78800030	0046/014950
BS95 Bull Head Rail Type B (Standard Grade)	70-00-78800033	0046/014956
BS95 Bull Head Rail Type C (Standard Grade)	70-00-78800034	0046/014957
39E1 (BS80A) Type A (Standard Grade)	70-00-78800037	0046/014952
39E1 (BS80A) Type A R350 HT (Premium Grade)	70-00-78800038	N/A
49E1 Type A (Standard Grade)	70-00-78800020	0046/035070

Welding Kits Wide Gap 68 mm

Product Name	Part Number	PADS Number
56E1 / 54E1 Gap 68mm (Standard Grade)	70-00-76600001	0046/014184
56E1 / 54E1 Gap 68mm R350HT (Premium Grade)	70-00-76600003	0057/051000
60E1 Gap 68mm (Standard Grade)	70-00-76600002	0046/014187
60E1 Gap 68mm R350HT (Premium Grade)	70-00-76600004	0046/035029
56E1 / 60E1 Gap 68mm Composite (Standard Grade)	70-00-76807002	0046/014199
39E1 (BS80A) Gap 68mm Not Felted (Standard Grade)	70-00-76800016	0046/014201
49E1 Gap 68mm Not Felted (Standard Grade)	70-00-76800013	0046/014200

Welding Kits – HWR (Head Wash Repair) Felted

Product Name	Part Number	PADS Number
56E1 / 54E1 HWR CC (Standard Grade)	70-00-75700011	0046/035085
56E1 / 54E1 HWR CC R350 HT (Premium Grade)	70-00-75700007	0046/035086
60E1 HWR CC (Standard Grade)	70-00-75700002	0046/035068
60E1 HWR CC R350HT (Premium Grade)	70-00-75700008	0046/035087

For a full list of our SRG Groove Rail and APR Crane Rail Products, please contact us directly.

Figure 42: Pandrol Welding Kit Box Example

Figure 43: Pandrol One-Shot Crucible Box Example

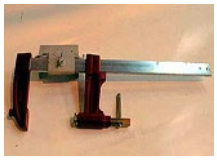
C.2. Consumables

Consumables

Product Name	Part Number	PADS Number	Product Image
One-Shot Crucible CJ2 Filtered Lid (CCF)	71-01-83450123	0046/014181	
Ignitors – Tube of 100	71-00-82632450	0046/014145	
Spare Blue Tube of Luting Paste	71-00-83661112	0046/014182	
Bucket of Luting Paste	71-00-83661130	0046/014188	
Felt for Step Mould (box of 30 strips)	71-00-83661115	0046/014178	
StartWel® Thermic Starter 10 pack	71-00-82632501	0046/14965	
StartWel® Thermic Starter 100 pack (10x10)	71-00-82632502	0046/14966	

C.3. Hardware

Hardware

Product Name	Part Number	PADS Number	Product Image
Pair of Mould Shoes 25mm	72-00-83200001	0046/014142	
Base Plate PLA 25MM	72-00-83100002	0046/014143	
Mould Clamp (Standard)	72-00-S0000136	0046/014139	
Slag Bowl	72-00-81532010	0046/014144	
3 – Level Preheater Burner Support	72-00-S0000253	0046/014140	
One Shot Crucible Fork	72-00-82631411	0046/014828	
Plug Holder	72-00-83432920	0046/014146	
Hot Waste Metal Tray	72-00-11319003	0046/014148	
Mould Clamp (Tight Areas)	72-00-81250902	0046/014141	

Product Name	Part Number	PADS Number	Product Image
Pair of Mould Shoes 68 mm	72-00-83200002	0046/014833	
Base Plate PLA 68 mm	72-00-83100003	0046/014830	

C.3.1. Additional HWR Hardware

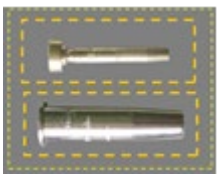
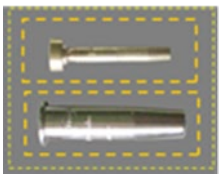
Additional HWR Hardware

Product Name	Part Number	PADS Number	Product Image
Pair of Mould Shoes for HWR	72-00-S0000361	0046/035065	
HWR cutting tool	72-00-S0000344	0046/035062	
HWR preheater holder for RT22 **Note:** To be used only with the 3-level torch support preheater holder. Part Number 72-00-S0000253	72-00-S0000403	0046/035061	

D. Oxy-Fuel Gas Cutting and Pre-heating Parts List and Procedures

D.1. Oxy – Propane – Cutting and Preheating

Product Name	Part Number	PADS Number	Product Image
Propane Regulator 0 – 4.0 Bar	74-00-829EP3LP1551	0046/014168	
Oxygen Regulator 0 - 10.0 Bar	74-00-996ED10OX1542	0046/014167	
Oxygen Flashback Arrestor	74-00-1883TRGB	0046/014840	
Fuel Gas Flashback Arrestor	74-00-1883TLGB	0046/014841	
Oxygen T-piece 3/8 BSP R/H	74-00-H2221	0046/014159	
Fuel Gas T-piece 3/8 BSP L/H	74-00-H2222	0046/014160	
Propane Gauge 0 - 2.5 bar	74-00-8E686	0046/014162	
Oxygen Gauge 0 - 6.0 bar	74-00-8E661OX	0046/014161	
Oxygen Hose 20m long x 10mm bore 3/8 BSP to 9/16 UNF Nut R/H	74-00-OXY20X10	0046/014157	
Propane Hose 20m long x 8mm bore 3/8 BSP to 9/16 UNF Nut L/H	74-00-PROP20X8	0046/014158	

Product Name	Part Number	PADS Number	Product Image
Oxygen Flashguard	74-00-883FGR	0046/014155	
Fuel Gas Flashguard	74-00-883FGL	0046/014156	
Shank 43-2 (UNF) Note: -2 represents Country Manufacture code only	74-00-1401253	0046/014847	
Propane Mixer F43	74-00-48302003	0046/014153	
Propane Preheater RT 22 Hole	74-00-35910229	0046/014152	
Propane Cutting Torch 49-2 Note: -2 represents Country Manufacture code only	74-00-1300440	0046/014169	
Propane Nozzle 3NFF	74-00-62903NFF	0046/014170	
Propane Cutting Nozzle 4NFF (For HWR only)	74-00-62904NFF	0046/035064	
Cutting Wheels	74-00-H2129	0046/014959	

D.1.1. Oxy-Propane Preheating

The Oxy-Propane preheating system for both standard and wide gap welds is shown in Figure 44 Page 49.

Figure 44 shows mostly Harris equipment used throughout the system, this is the recommended set up for PLA welding although any make of regulator, flash back arrestor and in-line check gauge can be used provided they conform to appropriate standard and system requirements.

- Propane regulators can be single stage and shall conform to BS EN ISO 2503
- Oxygen regulators shall be multi-stage and conform to BS EN ISO 2503
- Flash Back Arrestors shall conform to BS EN 730
- In line check gauges shall conform to the requirements of BS EN ISO 5171 and shall be capable of displaying and measuring 0.6 bar Propane or 1.2 bar Oxygen clearly and with an accuracy of +/- 5%

Hoses shall be 20 metres long, with 8mm bore Propane and 10mm bore Oxygen. Failure to use hoses of this length and diameter will result in a preheating flame that could cause over or under heating of the rails.

Hose tail internal diameters must be greater than 5.5mm

Hoses shall conform to BS EN ISO 3821

Hoses shall be fitted to a hose check valve (Flashguard) at the preheater end.

The RT 22 hole preheater burner can only be obtained from Pandrol UK Ltd.

The cylinder's used with PLA Oxy-Propane preheating shall be in accordance with the relevant rail authority.

Figure 44:

D.2. Oxy – Acetylene – Cutting and Preheating

Product Name	Part Number	PADS Number	Product Image
Acetylene Regulator 0 – 4.0 Bar	74-00- 896E1AC404	0046/014839	
Oxygen Regulator 0 - 10.0 Bar	74-00- 996ED10OX1542	0046/014167	
Oxygen Flashback Arrestor	74-00-1883TRGB	0046/014840	
Fuel Gas Flashback Arrestor	74-00-1883TLGB	0046/014841	
Oxygen T-piece 9/16 R/H	74-00-H2226	0046/014848	
Fuel Gas T-piece 9/16 L/H	74-00-H2227	0046/014849	
Acetylene Gauge 0 - 2.5 bar	74-00-8E686AC	0046/014862	
Oxygen Gauge 0 - 2.5 bar	74-00-8E686	0046/014850	
Oxygen Hose 8mm bore x 18m long 3/8 BSP to 9/16 UNF R/H	74-00-OXY8X18	0046/014859	
Acetylene Hose 8mm bore x 18m long 3/8 BSP to 9/16 UNF L/H	74-00-ACET8X18	0046/014860	

Oxygen Flashguard	74-00-883FGR	0046/014155	
Fuel Gas Flashguard	74-00-883FGL	0046/014156	
Shank 43-2 (UNF) Note: -2 represents Country Manufacture code only	74-00-1401253	0046/014847	
Acetylene Mixer E243	74-00-9100314	0046/014843	
Acetylene Preheater RT 8 hole	74-00-35910247	0046/014838	
Acetylene Cutting Torch 49-2 Note: -2 represents Country Manufacture code only	74-00-1300410	0046/014846	
Acetylene 3AC Cutting Nozzle	74-00-62903AC	0046/014851	
Acetylene 4AC Cutting Nozzle (For HWR only)	74-00-62904AC	N/A	
Cutting Wheels	74-00-H2129	0046/014959	

D.2.1. Oxy-Acetylene Preheating

The Oxy-Acetylene preheating system for both standard and wide gap welds is shown in Figure 45 Page 53.

Figure 45 shows mostly Harris equipment used throughout the system, this is the recommended set up for PLA welding although any make of regulator, flash back arrestor and in-line check gauge can be used provided they conform to appropriate standard and system requirements.

- Regulators shall be multi-stage and conform to BS EN ISO 2503
- Flash Back Arrestors shall conform to BS EN 730 and be both pressure and temperature sensitive
- In line check gauges shall conform to the requirements of BS EN ISO 5171 and shall be capable of displaying and measuring 0.6bar propane or 1.2bar oxygen clearly and with an accuracy of +/- 5%

Hoses shall be a maximum of 18metres long, with 8mm bore Acetylene and 8mm bore Oxygen.

Hose tail internal diameters must be greater than 5.5mm

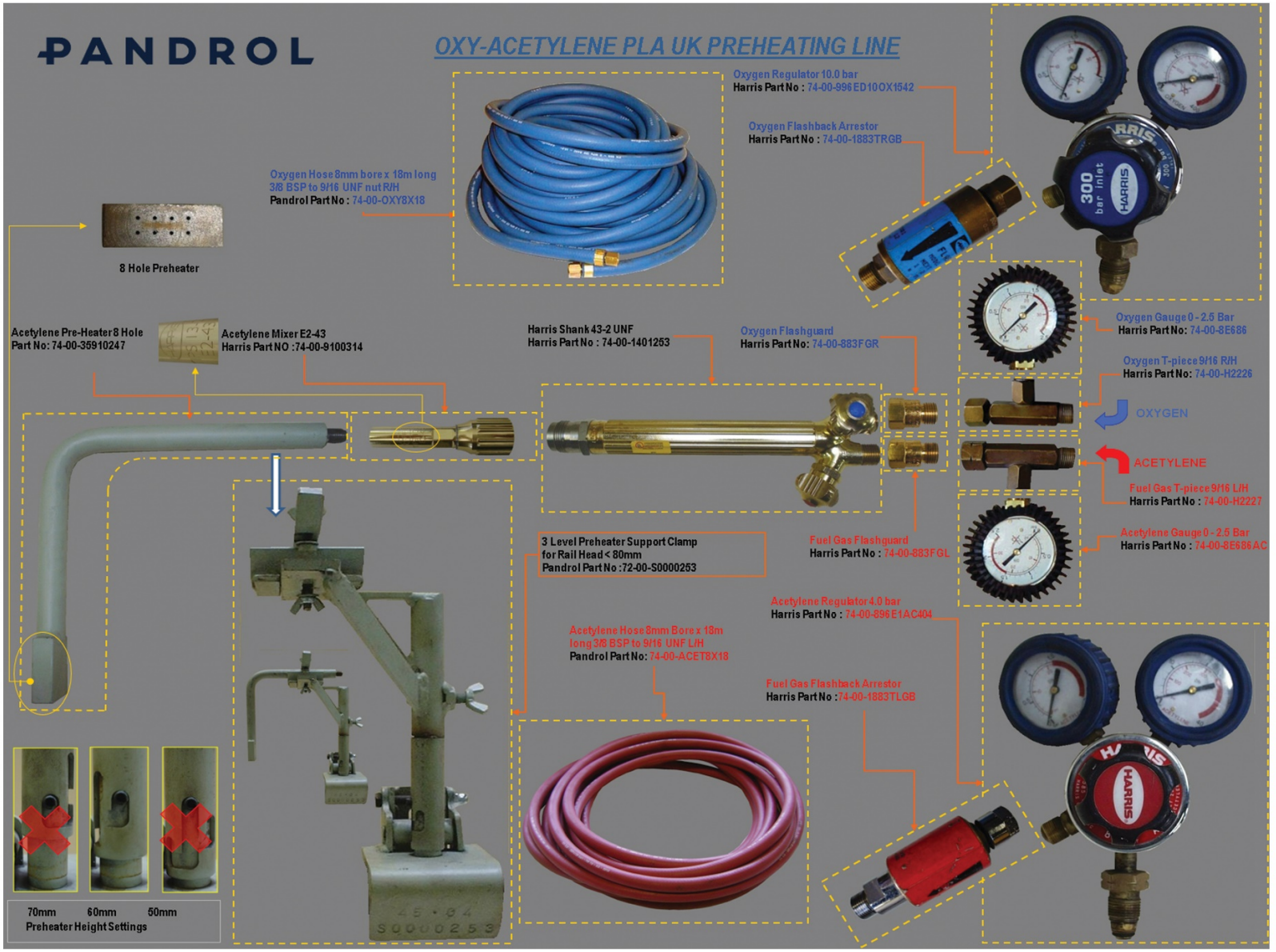
Hoses shall conform to BS EN ISO 3821

Hoses shall be fitted to a hose check valve (Flashguard) at the preheater end.

The RT 8 hole preheater burner can only be obtained from Pandrol UK Ltd

The cylinders used with PLA Oxy-Acetylene preheating shall be in accordance with the relevant rail authority.

Figure 44:



D.3. Preheating Equipment

Oxy fuel gas equipment shall be checked to ensure that it is in good working order and suitable for use, each time it used.

Oxy fuel gas equipment shall be tested every 6 months in accordance with British Compressed Gas Association Code of Practice CP7 or Rail Authority requirements CAL 501.

CP7 recommends that gas equipment is renewed 5 years after the date of manufacture.

Harris Regulators have a unique 8 digit code which provides full traceability at unit level.

Example: “PKJ00001”

The 1st letter is the plant where the unit was manufactured, in this case **“P”** for Poland

The 2nd letter represents the production year. **“K”** = 2017 (See table below)

The 3rd letter represents the production month **“J”** = September (See table below)

The five digit code represents the specific product number. In this case, **1st** regulator produced in September **“00001”** The 5 digit code will start from **0** at the beginning of each month. The numbers will run consecutively for the regulators produced in that particular month.

Plant	Letter
Poland	**P**

Year	Year
J	2016
K	2017
L	2018
M	2019
N	2020
P	2021
Q	2022
R	2023
S	2024
T	2025
U	2026
V	2027

Month	Month
January	A
February	B
March	C
April	D
May	E
June	F
July	G
August	H
September	J
October	K
November	L
December	M

E. Process Requirements

STANDARD GAP 25mm 54E1 / 56E1 / 60E2 (110A – 113A – UIC60) BS95lb RBH / BS80A / 49E1 (98lb)		
Rail Grades	**Rail Section and Wear**	
R220 (Normal) and R260 (Grade A) Premium grades (disc cut only) HP335; R350HT; R370CrHT (MHH) R350LHT; R400HT	54E1 / 56E1 (110A / 113A) 60E2 (UIC60) BS95lb RBH / BS80A / 49E1 (98lb) Up to 15mm worn	
Rail Preparation		
Rail cutting method (disc cutting or flame cutting)	Clean rail ends (wire brush)	
Welding gap 25 +/- 2mm	Inspect rail ends for visual defects	
Preheating	**Oxy – Propane**	**Oxy – Acetylene**
Burner type	RT 22 holes	RT 8 Hole
Mixer type	F43	E2-43
Burner height	50mm	60mm
Oxygen pressure	1.2 bar	0.6 bar
Gas pressure	0.6 bar +/- 10%	0.6 +/- 10%
Cone length	25mm	8mm
Preheating time for 54E1 / 56E1 / 60E2 / BS95lb Preheating time for BS80A / 49E1 (98lb)	4 minutes 3.5 minutes	6 minutes 5.5 minutes
Welding Kit details		
Crucible type	CJ2	
Rail	54E1 / 56E1 or 60E1 or 95lbRBH or BS80A or 49E1 (98lb)	
Kit type	PLA JS CJ VG2	
Welding gap Portion type	25mm 25 - D (Standard) or 25 -R350HH(premium grade)	
Date and batch details	14.01.17 7V2580 (example)	
Maximum time between end of preheat and ignition	30 seconds	
Tapping time	17 – 32 seconds	
Strip down procedure from completion of pour		
Leave undisturbed for 3 minutes	**Minimum times**	
Remove spillage tray	3 minutes	
Remove crucible and slag bowl	3 minutes	
Remove mould clamp and shoes	4 minutes	
Shear weld	5 minutes	
Remove tensors	30 minutes	
Remove alignment device	30 minutes	
Remove vent risers	30 minutes	
Replace fastenings	30 minutes	
Commence grinding	30 minutes	
Welders examination of weld	Immediately after grinding	

Wide Gap 68mm (Including Composite) 54E1 / 56E1 / 60E2 (110A / 113A / UIC60) BS80A / 49E1 (98lb)		
Rail Grade	**Rail Section**	
R220 (Normal) and R260 (Grade A) Premium grades (disc cut only) HP335; R350HT; R370CrHT (MHH); R350 LHT; R400HT	54E1 / 56E1 (110A/113A) BS80A / 49E1 (98lb) 60E2 (UIC60) Up to 3 mm worn 60E2 to 56E1 Composite up to 3mm wear on 56E1 Max	
Rail Preparation		
Rail cutting method (disc cutting or flame cutting)	Clean rail ends (wire brush)	
Welding gap 68 +/- 3mm	Inspect rail ends for visual defects	
Preheating	**Oxy – Propane**	**Oxy – Acetylene**
Burner type	RT 22 holes	RT 8 holes
Mixer type	F43	E2-43
Burner height	70mm	60mm
Oxygen pressure	1.2 bar	0.6 bar
Gas pressure	0.6 bar +/- 10%	0.6 bar +/- 10%
Cone length	25mm	8mm
Preheating time for – 54E1 / 56E1 / 60E1 Preheating time for – BS80A / 49E1 (98lb)	7 minutes 6 minutes	7 minutes 6 minutes
Welding Kit details		
Crucible type	CJ2	
Rail Kit type	54E1 / 56E1 or 60E2 or 60E2 / 56E1 (composite) BS80A or 49E1 PLA JS CJ 68	
Welding gap Portion type	68mm 68 - D (Normal) or 68 - R350HH (premium grade)	
Date and batch details	14/01/17 7D0929 (example)	
Maximum time between end of preheat and ignition	30 seconds	
Tapping time	17 – 32 seconds	
Strip down procedure from completion of pour		
Leave undisturbed for 6 minutes	**Minimum times**	
Remove spillage tray	6 minutes	
Remove crucible and slag bowl	6 minutes	
Remove mould clamp and shoes	10 minutes	
Shear weld	13 minutes	
Remove tensors	50 minutes	
Remove alignment device	50 minutes	
Remove vent risers	50 minutes	
Replace fastenings	50 minutes	
Commence grinding	50 minutes	
Welder’s examination of weld	Immediately after grinding	

HWR 54E1/56E1 (110A/113A) and 60E1 (UIC60)		
Rail Grade	**Rail Section**	
R220 (Normal) and R260 (Grade A) Premium grades (Conditions apply) HP335; R350HT; R370 CrHT (MHH) R400HT	54E1 / 56E1 (110A/113A) 60E2 (UIC60) Can be used over a FlashButt (Conditions apply) Up to 15mm worn	
Rail Preparation		
Rail cutting method (HWR flame cutting devise only)	Clean excavation	
Welding Excavation 80mm/90mm Width 10mm depth Grind excavation (a minimum of 8mm must remain on the running and back edge)	MPI Inspect rail for any visual defects	
Preheating	**Oxy – Propane**	**Oxy – Acetylene**
Burner type	RT 22 holes	RT 8 holes
Mixer type	F43	E2-43
Burner height	110mm	110mm
Oxygen pressure	1.2 bar	0.6 bar
Propane pressure	0.6 bar +/- 10%	0.6 bar +/-10%
Cone length	25mm	8mm
Preheating time	4 minutes	6 minutes
Welding Kit details		
Crucible type	CJ2	
Rail Kit type	54E1/56E1 or 60E2 HWR JS CJ	
Portion type	R1 260 D (Standard) or R1 R350HH (Premium Grade)	
Date and batch details	01/01/17 7V2580 (example)	
Maximum time between end of preheat and ignition	30 seconds	
Tapping time	17 – 32 seconds	
Strip down procedure from completion of pour		
Leave undisturbed for 6 minutes	**Minimum times**	
Remove spillage tray	6 minutes	
Remove crucible and slag bowl	6 minutes	
Remove mould clamp and shoes	7 minutes	
Shear weld	8 minutes	
Remove Lifting Device	50 minutes	
Replace fastenings	50 minutes	
Commence grinding	50 minutes	
Welder's examination of weld	Immediately after grinding	

F. Welding Inspection of PLA Welds

F.1. Weld Inspection

F.1.1. Weld Inspection

The weld acceptance criteria detailed in Table 1 of Network Rail Company Specification NR/L2/TRK/0032 form the basis for the inspection of PLA welds.

Where there appears to be a conflict between the requirements of NR/L2/TRK/0032 and this Process Manual, this is likely to be due to differences between two and three-piece mould configurations.

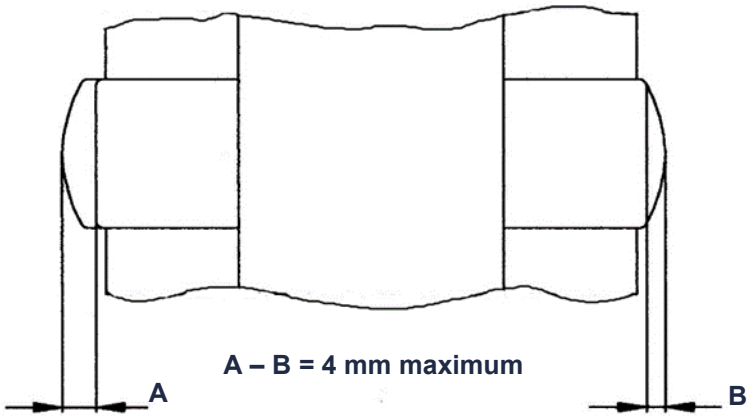
Pandrol PLA welds are produced with three-piece moulds and felt luting strips, the following, additional, acceptance criteria need to be observed.

F.2. Misalignment of Bottom Briquette

F.2.1. Lateral

The maximum lateral misalignment of the collar formed by the bottom briquette is +/- 2mm **(see Figure 46)**.

Figure 46:

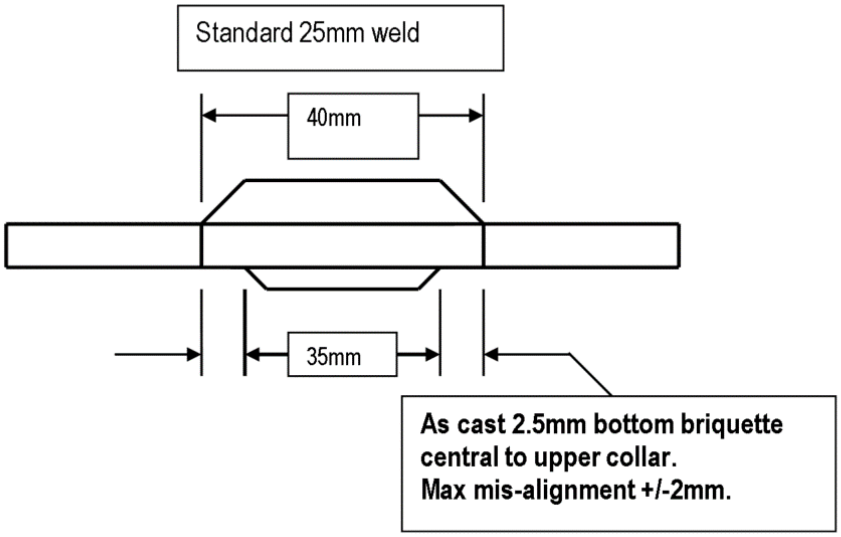


The extremity of the weld collar formed by the bottom briquette shall not be confused with flashing at the foot tip described in Figure 49.

F.2.2. Longitudinal

The maximum longitudinal misalignment of the collar formed by the bottom briquette with respect to the collar on the upper foot surface is +/- 2mm **(see Figure 47)**.

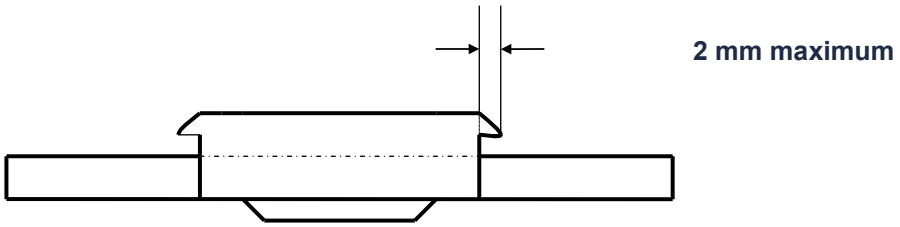
Figure 47:



F.2.3. Undercutting of the Collar Edge

The maximum amount of undercutting of the collar edge by intrusion of felt sealing strips is 2mm **(see Figure 48)**.

Figure 48:



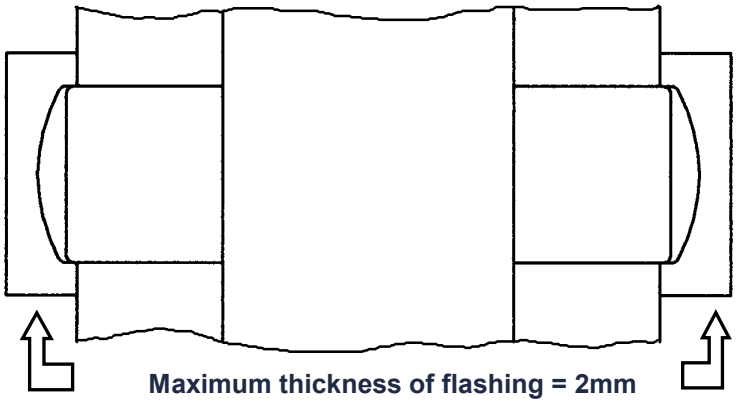
F.2.4. Flashing at the Foot Tip

Flashing at the foot tip (see Figure 49) is indicative of the bottom briquette not being fitted properly or the springs weakening in the shoes and is usually an extension of flashing on the underside of the rail foot.

Flashing at the foot tip is not detrimental to the integrity of the weld. However, if the thickness of the flashing becomes excessive, the corresponding flashing on the underside of the foot could compromise the strength of the weld. To overcome this problem, if flashing protrudes more than 3mm, it shall be ground back to the edge of the weld collar at the foot tip.

The maximum thickness of flashing is 2mm.

Figure 49:



F.2.5. Verticality

When using felt moulds, the collar edge is defined by the position of the felt and not the collar formation on the mould.

The attachment of the felt to the moulds is a manual operation and precise positioning cannot be achieved in every case.

This can occasionally result in three sides of the weld collar being within the verticality tolerance, while the fourth side is not.

N.B. One side of the weld collar out of four exceeding the verticality tolerance is permissible for PLA welds made with felt moulds.

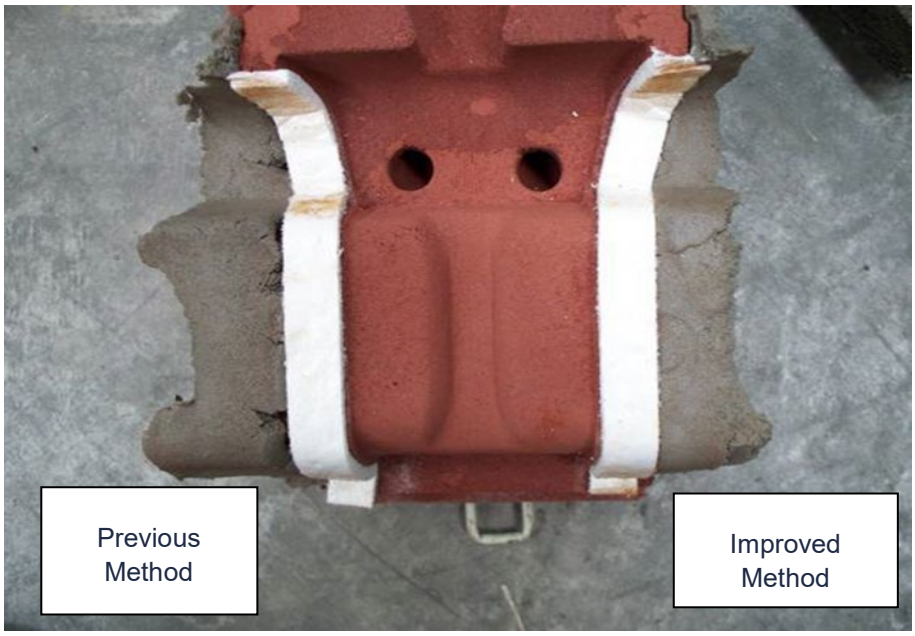
G. Improved ‘Pate A Lute’ Luting Method

The previous method of luting moulds using Pate A Lute did not give satisfactory results. An improved luting method using Pate A Lute has been developed. This method avoids the possibility of porosity or weld metal run-outs.

This method is suggested as an alternative to the standard method that uses luting paste (from tubes) as described in the process manual for both standard and wide gap welds. Therefore, this method could be used with all felted and sanded moulds throughout the Pandrol range.

The picture below shows examples of the previous luting method with ‘Pate A Lute’ and the new improved method.

Figure 50: Examples of luting using both methods



G.1. Improved Procedure for the ‘Pate A Lute’ Luting Method

G.1.1. Preparation of the ‘Pate A Lute’

Take some Pate A Lute from the bucket (71-00-83661130) and shape it into a 100mm cylindrical shape by rolling it between the hands.

Tear 35mm of paste from the roll and flatten it to obtain a flat piece of paste as shown on the picture.

Figure 51: Flattened piece of 35 mm Pate A Lute

G.1.2. Application of Pate A Lute

Figure 52: Paste applied in the luting strip

Apply the flattened paste along the web and into the luting strip using fingers only.

Figure 53: Correct method for applying the Pate A Lute

Compress the Pate A Lute with the finger making sure it comes into contact with the felt.

IMPORTANT

Luting tools shall not be used.

Figure 54: Make sure that the Pate A Lute is in contact with the felt

Continue the process until the whole luting strip is filled.

Figure 55: Application of further layer

Following the first application of the Pate A Lute to the luting strip, a further layer is applied to complete the luting process

G.1.3. Luting the Bottom Briquette with ‘Pate A Lute’

When luting the briquette, prepare the Pate A Lute by rolling it into a cylindrical shape as described previously.

Using the thumb, apply the whole roll along the full length of the briquette making sure that the pate a lute is in contact with the briquette and the bottom plate.

IMPORTANT

The Pate A Lute shall be higher (approx. 3 to 5 mm) than the felt.

Figure 56: Pate A Lute before cutting and levelling

Finally, it is essential to obtain a flat surface between the felt and the Pate A Lute. This is achieved by using a sharp edge to remove the excess Pate A Lute to the same level as the felt.

Figure 57: Pate A Lute after cutting

G.1.4. Fitting the Bottom Briquette

Figure 58: Bottom briquette after fitting

Fitting of the bottom briquette is carried out by following the standard procedure as described in the process manual.

Figure 59: Compress using the thumb

When the briquette has been fitted correctly, use the thumb and run it along the paste to compress it against the rail and briquette. If required, additional Pate A Lute can be applied.

Figure 60: Luting Completed

A further layer is applied along the back of the bottom plate and above the rail head to the top of the mould to complete the luting process as described earlier in the process manual.

H. HWR Process (Head Wash Repair)

The HWR process can be carried out on the following rail profiles and grades.

There are four HWR kits available, please see below:

- 54E1 / 56E1 (110A/113A) 220 / 260 (Standard Grades)
- 54E1 / 56E1 (110A/113A) HP335 & R350HT (Premium Grades)
- 60E1 (UIC60) 220 / 260 (Standard Grades)
- 60E1 (UIC60) HP 335 & R350HT (Premium Grade)

Note: HWR is now permitted for Flash Butt Weld head repairs providing the new HWR JS (Felted Moulds) are used.

This section provides additional information to that given in form TEF/3003, on the type, size and location of defects that may be removed by the HWR process.

Squat type defects:

- Maximum excavation size (finish ground surface) - 90mm long, full railhead width, 8mm above the lower edge of the head

Squat type defects are defects repaired using the HWR method subsequently found to be defective following NDT, may be re-repaired using the same method.

Wheel burns:

- Only one overlapping repair is permitted (2 x HWR in total)
- The overlap is measured from the edge of the fusion zone 30mm inside the existing HWR
- Maximum length of visibly damaged area - 150mm

Wheel burns are subject to weld straightness check before repair (no dipped joints).

Defect location:

- HWR is now permitted above flash butt welds providing that the new felted HWR moulds are being used
- HWR is not currently permitted above bolt holes
- Where repairs are to be carried out near a bolt hole, the edge of the excavation shall be a minimum distance of 125mm from the edge of the nearest bolt hole measured vertically through the railhead
- Repairs are not permitted where heavy or severe RCF is present, however, repairs may be installed into light or moderate RCF provided that there is a minimum of 100mm of clean rail either side of the proposed repair
- Where multiple defects are to be removed, a minimum distance of 100mm shall be observed between repairs, however, a minimum time of 2 hours shall be observed between finish profile grinding and commencement of the next repair

H.1. Excavation Procedure

The gas cutting pressures are set at:

- Propane 0.4 bar (Nozzle Type 74-00-62904NFF)
- Oxygen 3.5 bar
- Acetylene 0.4 bar (Nozzle Type 74-00-62904AC)
- Oxygen 3.5 bar

Complete arcs of the gun to warm the rail up. The Excavation process should be made smoothly in one fluid movement. **(See Figure 61)**

To achieve the excavation, Pandrol have developed a special cutting device for the excavation. **(See Figure 62)**

There are different tools available on the market, but if you are using the special cutting device developed by Pandrol, place it on the top of the rail, in the centre of the defect to be removed.

Pandrol's special cutting device uses the underside of the head as a datum and will always leave 10mm of rail head after cutting.

Figure 61:

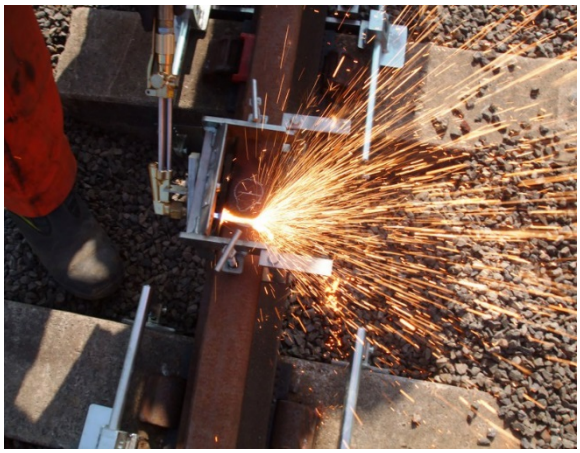
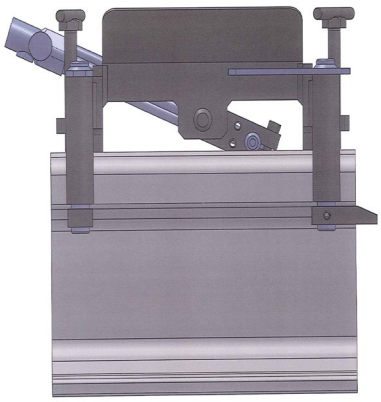


Figure 62:



According to the Network Rail standard, the excavation is made by flame cutting. The geometrical parameters are as follows:

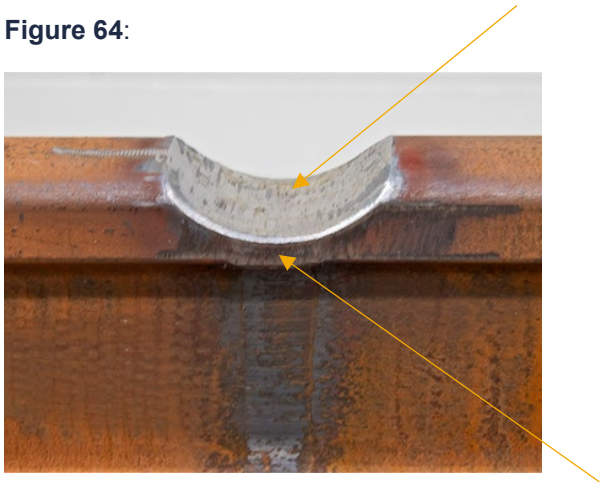
The size of the excavation to be full head width **80mm** – **90mm** long maximum excavation after grinding.

A minimum amount of **10mm** of rail head must remain after flame cutting. **(See Figure 63)**

Figure 63:

The excavation is then ground with an angle grinder to remove any excessive gouging. (See Figure 64)

Figure 64:



A minimum of **8mm** of rail head must remain upon completion of the grinding.

H.1.1. HWR on a Flash Butt Weld (FBW)

The FBW must be inspected to ensure the weld upset does not protrude more than a maximum of 1 mm. However, if the FBW upset protrudes more than 1mm, it will be necessary to grind back the excess FBW metal upset. **(See Figure 65)**

Figure 65:

IMPORTANT

When grinding the excess FBW metal, please ensure you use a flap type grinding disc only! This is to prevent causing damage to the existing rail.

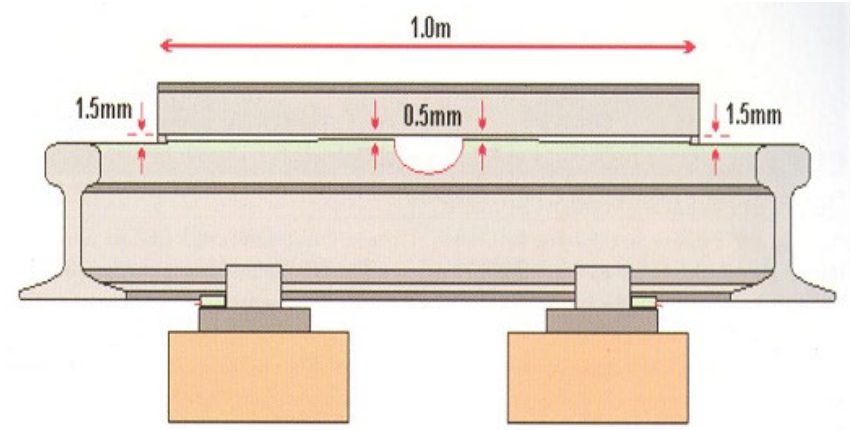
H.1.2. HWR Welding Procedure

The rail lifting criteria must be followed to ensure the correct grinding tolerances are achieved on completion of the weld. **(See Figure 66)**

Rail lifting criteria

- Below 100mph = 0.5mm peak over 1m
- Above 100mph lift = 1.0mm peak over 1m

Figure 66:



Once the peak has been achieved, a Non-Destructive Test shall be carried out following the Network Rail standards. **(See Figures 67, 68 and 69 below)**

Figure 67:

Figure 68:

Figure 69:

Once this procedure has been completed, clean the rail and the excavation.

The rail wear shall then be measured by using the rail wear gauge as described in the process manual page 13 or 3.5.1

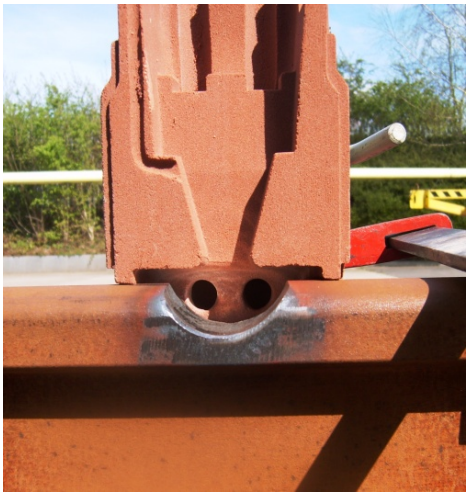
HWR moulds incorporate the Hybrid Wear System.

The moulds are filed in accordance with the wear measured.

Figure 70:

Modify both moulds to suit the rail wear

Figure 71:



Fit the first mould onto the rail ensuring the mould is central to the excavation.

Figure 72:

The second mould is fitted and clamped together following the standard procedure and checked to ensure the felt is compressed against the rail.

Figure 73:

The gap around the rail head is filled with felt, the same method for Hybrid moulds (as per page 19. Item 3.7.3)

Figure 74:

Both moulds are luted by using Pate A Lute and following the luting procedure described in this process manual Appendix G.

Figure 75:

The preheater holder is then placed on the top of the rail. The height of the preheater shall be 110mm. Check the preheater for vertically and its alignment within the mould.

Figure 76:

Pressures are the standard pressures used for welding with the PLA process. (See Appendix E)

Figure 77:

On completion of the preheating, the pre-charged One-Shot Crucible is placed on the top of the moulds and the portion is ignited.

Please see (Appendix E) for strip down, Shearing, Cleaning and Grinding times.

I. STARTWEL® Electrical Ignition System

STARTWEL® is the electrical ignition system for aluminothermic welding charges, developed and patented by Pandrol.

It has been designed to guarantee constant and reliable ignition.

In addition to the quality STARTWEL® brings to welding, it also makes work safer for track technicians.

On ignition, a drop of molten metal falls inside the crucible and causes combustion of the aluminothermic charge.

The ignition point is always in the same place, thus obtaining reliability and constancy in weld repetition.

CAUTION

The charge must always be horizontal in the crucible

I.1. Conditions for Use and Storage

I.1.1. Storage

Store in the original packaging, in a dry and adequately ventilated room. Keep away from heat, sparks, flames and any source of ignition. Do not expose thermic starters to electric current.

I.1.2. Safety and Use

The safety pin must imperatively remain “clipped in” and be removed only during use.

Use only the STARTWEL® electric handle to power up the starter. The thermic starter can only be powered up when it is in a housing appropriate for its use. Use only for ignition of an aluminothermic charge, to the express exclusion of any other use. Risk of burning in the event of improper use.

I.1.3. Fire

The molten steel produced by the aluminothermic reaction may cause violent projections on contact with snow, ice, water, damp floors or frost.

In the event of a fire, use dry sand to the exclusion of any other product.

WARNING

It is strictly forbidden to use water to put out a fire caused by the aluminothermic portion.

I.2. Using the STARTWEL® Electrical Ignition System

Figure 78:

LED	Capacity
●●● LED	> 2/3
●●○ LED	> 1/3
●○○ LED	< 1/3
✱ LED	Reserve

Check the battery charge status by pressing the button (LED indicator)

Figure 79:

1 Flashing green LED = recharge the battery

Figure 80:

If the cap is a filter cap, use a tool to clear the position provided for the starter.

Figure 81:

Remove the pin from the starter.

NOTE

This operation must be carried out away from the crucible.

Figure 82:

Insert the starter in the hole in the cap.

Figure 83:

Position the ignition indicator so that it is visible.

Figure 84:

Place the electrodes of the electric handle on the terminals of the STARTWEL® starter.

Figure 85:

Press and hold the trigger until ignition.

Figure 86:

Charge has started when the red light becomes visible.

WARNING

Do not use the electric trigger on the STARTWEL® starter with the pin in place or on any conductive surfaces: Copper, Aluminium, Steel, etc.

Figure 87:

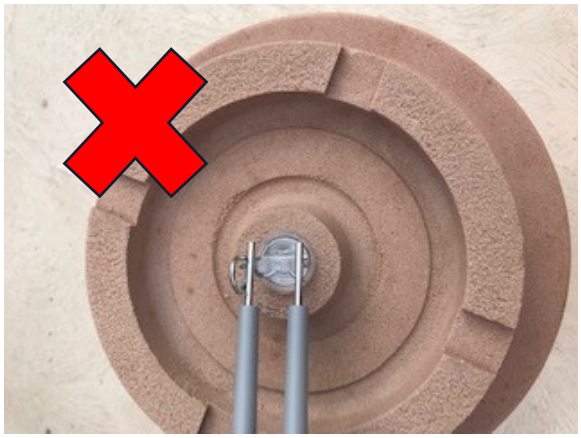


Figure 88:

I.3. Components of the STARTWEL® kit

Figure 89:

	Component	Part N°	PADS N°
	StartWel® (Ignition System Complete case)	73-00-82632507	0046/014969
1	StartWel® Handle (only)	82632509	0046/014962
2	Rechargeable battery	82632504	0046/014964
	Complete Handle (Starter+battery)	82632503	0046/014963
3	StartWel® Thermic Starter 10 pack	71-00-82632501	0046/014965
	StartWel® Thermic Starter 100 pack (10x10)	71-00-82632502	0046/014966
4	Li-Ion Battery Charger		0046/014967
5	StartWel® metal case (only)	82632506	0046/014968

J. Gas Box Oxy-Propane Preheating

J.1. 2nd Generation Gas Box Features

Note: For instructions regarding the 1st generation of Gas Box, please refer to the process manual issued in January 2013.

The 2nd generation of Gas Box is easily recognisable by looking at the:

- Valves – Brass taps on the 1st generation **(Figure 90)** Blue and red on the 2nd generation **(Figure 91)**
- Gauges – Blue on the 1st generation **(Figure 90)**, white on the 2nd generation **(Figure 91)**.

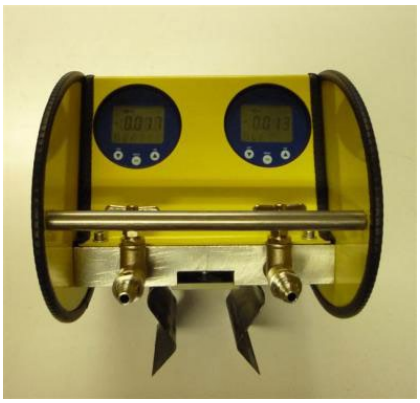


Figure 90 - 1St generation

Figure 91 - 2nd generation

The Gas Box is fitted with 2 digital gauges. The Gas Box can be clamped safely onto the rail head by using the clamp underneath the Gas Box.

The digital gauges provide accurate pressures with an accuracy of one thousandth of a bar. They work with a lithium battery that can be changed via the top panel on the Gas Box (Figure 94 page 78). The digital gauges are set to switch off automatically after 5 minutes of use. This time can be modified in the settings menu.

The Hoses

There are 2 hoses, one for the Propane and one for the Oxygen. They are connected to the gas box on one end and connected to the torch and mixer on the opposite end. They are 1.50 meters long and they have a 10mm diameter. It is essential that neither of these be altered.

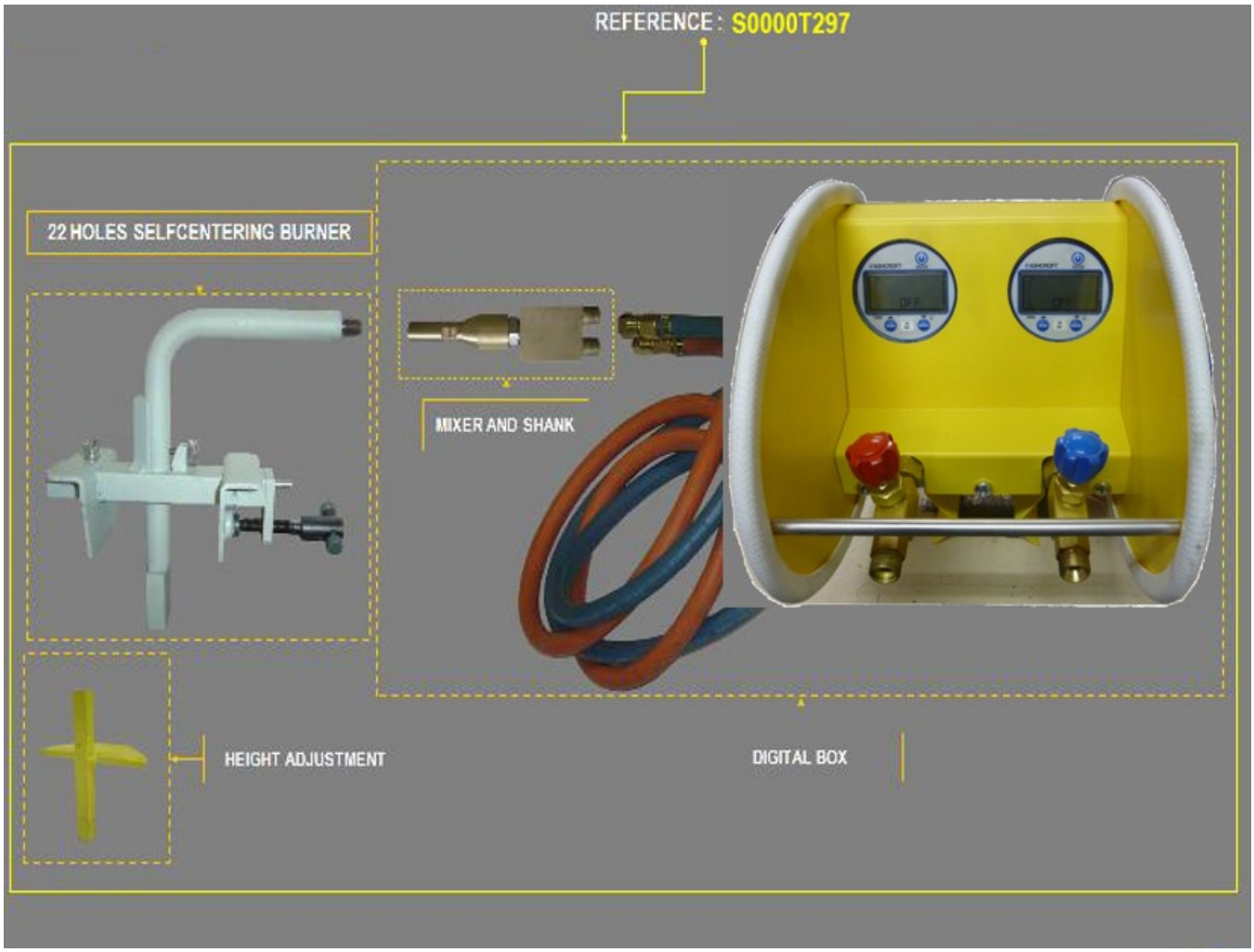
Self-Centring Burner

The burner head has a support that is adjustable in height and widths to fit the range of moulds supplied by PANDROL. The moulds have a notch where the torch support sits (see figure 92). The torch support is then secured to the moulds by using the thumb screw. Care should be taken not to over tighten the support as it may crack the moulds. **(See Figure 92)**

(Figure 92)

J.2. Recommendations when using the Digital Gas Box

- The two taps of the Gas Box must be closed
- Turn the cylinders on and adjust the regulators to the following pressures – Propane 1.5 bar / Oxygen 2.5 bar
- Turn the Gas Box flow gauges on and ensure that the pressure unit is displayed as “custom”
- Light the preheater by gradually increasing the Propane and Oxygen flow on the Gas Box. Adjust the Propane pressure between 0.25 bar and 0.30 bar. The Oxygen pressure is to be adjusted to 0.50 bar (between 0.50bar and 0.51bar) on the Gas Box gauges.
- Ensure that the cone length measures 20mm.
- If you fail to achieve the 20mm cone length, adjust the Propane tap to obtain the correct cone length (20mm). Never modify the Oxygen pressure outside the parameters given.
- Place the torch support onto the centre of the moulds as shown in figure 92. Tighten the thumb screw to secure the support to the moulds. Ensure that the support is sitting centrally within the moulds. It is essential that the pressures are checked and maintained throughout the duration of the preheat.
- The flame that comes out of the risers during the preheat must be symmetrical and measure approximately 300 - 400mm above the moulds.



(Figure 93)

J.3. Preheating Parameters

	Propane	Oxygen	Burner Height	Time
PLA 25	***0,25 – 0,30***	***0,50 – 0,51***	***50mm***	***4 minutes***
PLA 68	***0,25 – 0,30***	***0,50 – 0,51***	***70mm***	***7 minutes***

J.4. Using the gauge

Several options can be found on the gauge for customisation or maintenance:

- Turning the gauges On / Off:

  To turn the gauge on and start the pressure readings, press the button “Enter”. The gauge can be turned off by pressing the enter button for 5s.
- Resetting the gauge to Zero.

  At start up, and when the cylinders are closed, the gauge must display 0. If not, press the “zero” button for 1 second to reset the pressure sensor.

- Adjusting the backlight timer

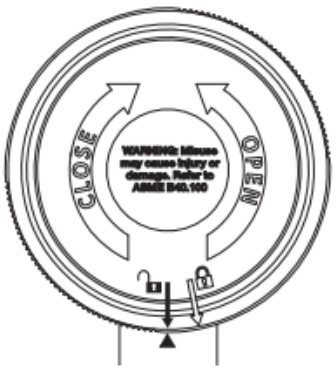
  Go to the menu then scroll across until “LIGHT” is displayed. Then press “enter” and then the arrow to select the duration of backlighting. Once chosen, press enter to confirm your choice.

- Changing the battery

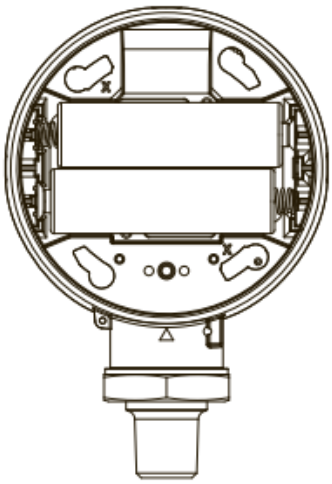
  To change the battery, you must first remove the top panel of the Gas Box (6 screws) to access the gauge. Then follow the instruction below. **(Figure 94)**

Changing Batteries:

Grip knurled back cover and rotate counter-clockwise until the 'unlock' icon is in alignment with the arrow – this is on the housing at the base of the pressure connection.

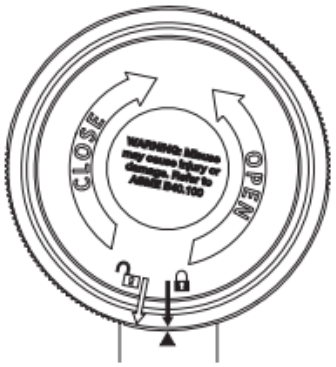


Remove cover by pulling straight back and replace AA alkaline batteries accordingly; ensure that the batteries are in the proper polarity position.



For reattachment of cover, align the 'unlock' icon with the arrow, push cover straight in then turn clockwise until the arrow is in alignment with the 'Lock' icon.

Note: Reinstallation of the back cover may cause the unit to read negative pressure. This is a temporary issue as the internal case pressure will be relieved by the case vent and equalize with atmospheric pressure (90% of the offset will equalize within 1 minute, the remaining 10% may take up to 5 minutes).



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More information can be found on ASHCROFT website

Gauge model: DG25

http://www.ashcroft.com/installationandmaintenance_pdf/upload/manual_digital_gauge_dg25.pdf

PANDROL

Find out more at

pandrol.com

Pandrol
Gateford Road
Worksop
Nottinghamshire
S81 7AX

+44 (0) 1909 476101
chris.mckeown@pandrol.com

Partners in excellence