GOLDSCHMIDT
Smart Rail Solutions

Code of Practice

for the

THERMIT®- Quick Welding Procedure

SkV-A

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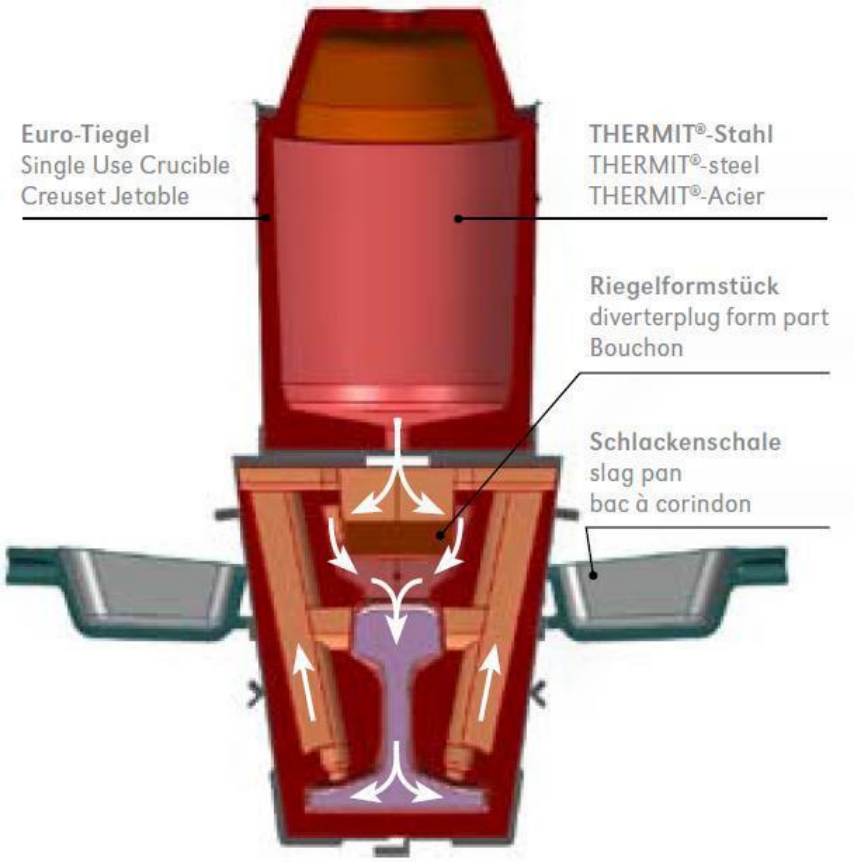
Preliminary remarks.

This Code of Practice describes the steps for executing THERMIT® welding procedures and includes supplementary information.

THERMIT® welding is to be classified as a safety-critical activity. All operators shall have passed a training course approved by Goldschmidt Australia Pty Ltd and be in possession of a Level One or Level Two welding certificate for relevant THERMIT® welding procedures being utilized.

Typical Pouring System for SkV-A Single Use Crucibles.



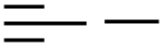
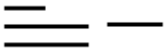
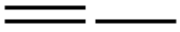
1.0 Data sheets.

1.1 Data sheet Rail grades and portions (Vignol rails).

Prior to the beginning of flame cutting and welding work, the steel grade shall be determined according to the rolling mark.

If different welding grades are welded to each other, the THERMIT® portion shall be used according to the steel grade with the lower hardness.

Special steel grades incl. bainitic steel grades on request.

Rail grade former designation	Rail grade designat acc. to CEN	Brand	Rolling mark	Portion grade to be used
700 (680 N/mm²)	R200	S700	ohne	Z70
800 (780 N/mm²)	R220	S800		Z70 – 80
900A (880-1030 N/mm²)	R260 As Rolled	S900		Z90 Alternative: Z100 on specia request
900A (880-1030 N/mm²)	R260V		V	on request
900B (880-1030 N/mm²)	R260Mn			Z90
1100 (1080 N/mm²)	R320Cr			On demand
head-hardened (880/1180 N/mm²)	R350HT Head Hardened			Z110, Alternative: Z90 HC with po weld heat treatment
	R350LHT			Z120, Alternative: Z90 HC with he post-treatment on request
	R370CrHT	R370LHT		Z130, Alternative: Z90 HC with he post-treatment on request
	R400HT			Z140, only single-use crucible

1.2 Data sheet Standard gap for SkV-A (propane / oxygen).

WELDING PROCESS	RAIL SIZE	PREHEAT TIME [MINUTES]	GAP SIZE [MM]	TORCH HEIGHT [MM]	GAS PRESSURES OXYGEN [KPA]	GAS PRESSURES PROPANE [KPA]	MOULD REMOVAL [MINUTES]	CROWN GAP [MM]	TORCH TYPE
SkV-A	30,31,75lb,37	2.5	23-27	40	400	75	4.0	1.5-2.0	22 Hole Preheater
	80lb, 41,47,50	3							
	53,60	4							

The appropriate pre-heat and weld data sheet for your project will be made available upon request.

Safety Note: Propane/Oxygen is the preferred heating mix for all open-air works. It may also be used in underground areas with adequate ventilation and with the prior approval of the local rail authority.

The designation of the portion is composed of the designations for the rail profile, the quality of the Welding material (refer to “Data sheet Rail and portion grade”) and the welding procedure.

For profile transition, use the THERMIT® portion, the pre-heating and trimming time of the relevant larger rail profile. Do not attempt to modify moulds to suite transition.

1.3 Data sheet Standard gap for SkV-A (Acetylene / Oxygen).

The appropriate pre-heat and weld data sheet for your project will be made available upon request.

Safety Note: Acetylene/Oxygen can be used in confined space welding including underground works and tunnels, local rail authority may allow LPG/Propane if adequate airflow is available.

The designation of the portion is composed of the designations for the rail profile, the quality of the welding material (refer to “Data sheet Rail and portion grade”) and the welding procedure.

For profile transition, use the THERMIT® portion, the pre-heating and trimming time of the relevant larger rail profile.

2.0 Accident prevention.

When carrying out THERMIT® connection welds, the accident prevention regulations of the relevant railway network authority must be complied with. In addition, the following regulations must be followed:

- Principles of prevention.
- Grinding work and powered working means.
- Railway track service.
- Work around tracks.
- Welding and cutting with gases.
- Handling of gases and liquid gases.
- Fire prevention. Water must not be utilised near aluminothermic portions.

Ensure the minimum number of welding personnel (two welders) are present to execute all welds.

Welding portions, crucibles, moulds, automatic tapping thimbles and ignitors must be protected from water, dampness and moisture.

A SAFESTART Tin or Enviro Single Use Crucible cap or SmartWeld Spark is to be utilised to ignite portion correctly.

The connected gas fittings must be checked for leakage using soapy water. The torch sleeve nut must be tightened by means of a spanner. It is important not to over tighten.

When igniting the torch, first open the oxygen valve and then the combustion gas valve. When shutting off, first close the combustion gas valve and then the oxygen valve. In the case of flame flashback, which is recognized by a whistling noise, immediately close both valves and cool the torch in water with the oxygen valve opened. The suction test must then be carried out.

Do not stand closer to the welding point than is necessary for the work during the THERMIT® reaction. A minimum of three (3) metres is recommended.

Always wear protective clothing, ensure nylon clothing or gloves are not within welding area.

Shade 5 visors or goggles during flame cutting, pre-heating, the THERMIT® reaction and when the steel is poured into the mould must be worn.

Ensure that reacting welding portions and hot reaction products do not encounter water and are not extinguished by water. If necessary, cover with dry sand.

After completion of steel pouring, lift the tapped single-use crucible from the moulds using an approved crucible removal tool or method after a minimum of one minute from completion of pour.

Remove slag pans after a minimum of three minutes from completion of pour. Place hot slag pans and hot single-use crucibles onto a dry non-combustible surface. Protect the surroundings from radiant heat and slag and steel spatter.

Protective clothing and goggles must be worn when carrying out grinding operations, grinding machines must not be operated without guards. Take precautions against flying sparks.

Safety harnesses of approved design must be used when working at heights. Scaffolding is required when catwalks are missing.

Pay attention to all requirements given in the relevant safety data sheets.

Training welds should never be carried out on live track.

All personnel involved should have undergone the necessary local railway safety inductions.

All work on site should be covered by a relevant railway permit and all necessary contact and emergency numbers provided in brief before starting works.

3.0 Storage, selection, preparation, and handling of welding materials.

The following welding materials must be available in sufficient amounts:

- THERMIT® portions,

- Moulds,
- Propane, or Acetylene
- Oxygen,
- Single-use crucibles with SAFESTART cap.
- Sealing sand or alternatively,
- Sealing paste

The materials must be stored dry and frost-free and condensation free environment. The packages must be undamaged. The materials must be used immediately after having opened the packing. Pallets shall not be stacked.

3.1 Thermit® portions.

Prior to the beginning of welding and flame-cutting work determine the steel grade by the rolling marks on web of rails. The profile and steel grade of a rail define the type of the THERMIT® portion used. For the designation of the relevant THERMIT® portions refer to the “Data sheet Rail grades and portions” and the relevant data sheet.

Protect welding portions from moisture. Moist portions must not be used even if they are thought to have been dried. Undamaged and in date (5 years from date of manufacture) portion bags only shall be used. If portions are affected by moisture or out of date, contact Goldschmidt Australia’s technical department for instructions regarding how to dispose.

3.2 Moulds.

The mould shall be selected such that they match the rail profile.

Store moulds in a dry place and protect them from frost and moisture. At the site they should be kept dry. Do not use damaged moulds. Two-part moulds can be used for suspended and supported joints. Three-part moulds are also available for all applications. Check condition of moulds and ensure moulds are in date (30 months from date of manufacture).

Partly transition moulds are available for welding different rail profiles; also, for rails of the same profile with different level of wear (step moulds). Refer also to section 4.9, adaptation of moulds by filing.
If moulds are affected by moisture or out of date, contact Goldschmidt Australia's technical department for instructions regarding how to dispose.

3.3 Gases.

Propane / oxygen is the preferred gas mix to be used with the pre-heating torches. However, acetylene / oxygen may be carried out below ground level if adequate airflow is not available.
The required purity according to DIN 51622 or DIN EN 589 with at least 95 percent by weight of propane and propene (propylene) must be guaranteed. The propane content must be higher.
Propane cylinders with a volume of at least 20 kg must be used when gas is drawn from individual cylinders.

Acetylene:

Please refer to the specifics for pre-heating with acetylene / oxygen.

3.4 Crucibles.

For the SKV-A welding process there are two types of single-use crucibles available, SAFESTART Enviro (EC) and SAFESTART Tin Crucibles (TC).

3.5 Tapping thimbles.

The single-use crucibles are provided with an integrated automatically opening closure. Opening time from reaction to pour is between 17-38 seconds.

3.6 Sealing sand and sealing putty.

The sealing sand must be uniformly moist (earth-moist, 6 – 8 % moisture), carry out a falling weight test also known as a drop test to ensure sand is of correct consistency.

Correct Incorrect

Do not use sand which is too moist. Prepare dry sand with 500-550mL of water prior to the beginning of welding work.
Sealing putty is also available and is packaged into approximately 2 x 1kg blocks per weld kit.

4.0 Execution of welding.

The equipment and consumables must be complete and in good condition prior to the beginning of welding work. Grinders, shears, gas/firefighting equipment and fish plates must be checked prior to cutting track and starting works.

4.1 Cleaning and examining the rail ends.

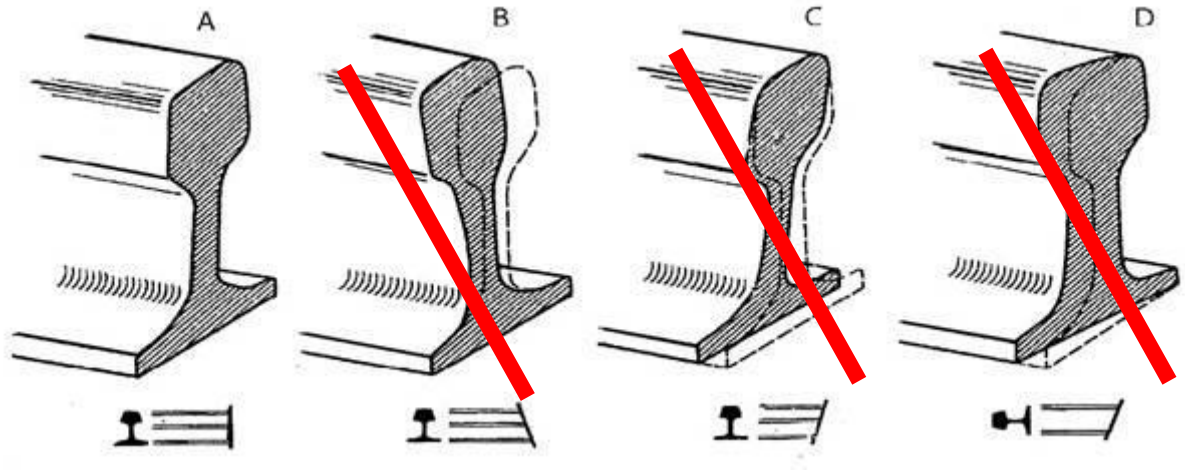
Rail ends must always be cleaned for a minimum of 50mm on running surface, running and surface flanks, web and foot before welding. Rail ends may not be welded with defects at fishplate holes or with holes made by flame cutting. A minimum distance of 65mm from edge of rail to bolt hole must be observed prior to start of welding.

If possible, cut out rails with excessively worn ends and low-lying deformed rails as occurring sometimes at steel fishplate joints.

4.2 Preparation of welding gap.

Welding gap for the SkV-A welding process is 23-27mm, preferably, prepare the welding gap by a mechanical separating cut.

Pulling the rails, disk cutting, sawing, or flame-cutting can all be used for the preparation of the welding gap. However, the requirements of the Railway Authority must be followed. The cuts shall be straight and at right angle at all sides. The allowances for gap widths shall be kept.



4.3 Rails with fishplate holes.

After preparation of the welding gap, the closest drilling-hole edge must be at least 65 mm from the rail end. Make sure that this drilling hole is free from cracks.

4.4 Welding under traffic.

Flame cutting is only permitted in closed tracks.

If traffic must be passed over a prepared welding gap before the weld has been executed, the rail must be secured according to the relevant railway authority rules and regulations.

4.5 Rail Cutting with Rail saw.

Ensure user has completed the necessary safety induction and has been certification for its use. Ensure user is wearing required PPE.

Set up work area with rail saw, safety equipment (fire extinguishers and dry sand) and clear other staff from within the work area.

Inspect rail saw for any defects and ensure it is within the correct inspection cycle.

Set up the rail saw, clamping on the rail in the appropriate position. Note: Never use freehand without rail clamp.

Ensure guards for rail saw are appropriately placed. ensure no personnel stand in front of rail saw!

Start the rail saw in accordance with the operator's manual. Check that the blade is not in contact with anything when the machine is started.

Apply the cutting blade gently with high rotating speed (full throttle) through the head, web and foot of rail. Stop cutting if someone enters the work area.

Let the machine work without forcing or pressing the blade. Feed down the machine in line with the blade. Pressure from the side can damage the blade and is very dangerous.

Move the blade slowly forwards and backwards to achieve a small contact area between the blade and the material to be cut. This reduces the temperature of the blade and ensures effective cutting.

Maintain full speed until cutting is complete. Stop the rail saw and wait for the blade to stop moving.

If the cut cannot be completed from one side, the rail saw must be shut down, turned around and re-clamped into position. Guide the cutting blade down towards the rail and check that the cutting blade is centred in the cut. If necessary, adjust the rail clamp so the blade ends up centred in the middle of the cut.

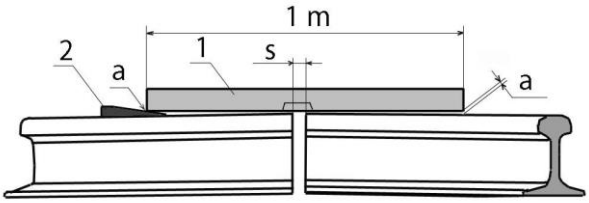
4.6 Rail alignment.

The rail fasteners must be loosened on at least two sides of the welding joint at least two sleepers the first fasteners each must be demounted. The two intermediate layers beside the welding gap shall be removed.

Prior to alignment subject the rail ends to a visual inspection for straightness. Extremely deformed rail ends, or the rail ends described under section 4.1 should be cut out, if possible.

Rail alignment may be made with alignment tools and/or wedges.

The height alignment and rail crown must be set using either a 1 m straight edge or the crown check unit according to data sheet (1.5-2mm).



1: 1-meter straight edge.

2: Crown measuring wedge, or 1.8mm calibrated straight edge.

a: Crown – refer to data sheet.

s: Welding gap – 23-27mm.

The final alignment on the rail must be checked after the weld has cooled down and, if necessary, the amount of crown adjusted for further welds.

Horizontal alignment must be carried out on the running edge using a 1-m straight edge.

The joint must be aligned without mismatch of the rail feet also known as lateral twist.

The wedges must not be removed until after the weld has cooled down (minimum 20 minutes from completion of trimming.

Influences on vertical shrinkage and resulting crown are shown as following:

Influences		**vertical shrinkage and resulting crown will**
gap width	nearer to upper limit	increase
	nearer to lower limit	decrease
height of rail head, equal rail profiles	new rail	increase
	worn rail	decrease
track condition	bad, means untamped sleepers	increase
	good, means tamped sleepers	decrease
removing wedges too early before the weld has cooled down		increase

4.7 Setting the clamping device.

The pre-heater clamp should be set 40mm from tip of torch to top of rails running surface and must be set vertical and central to the rail.

4.8 Torch adjustment.

The pre-heating torch must then be set centrally to the welding gap as well as vertically to all rail axes.

4.9 Mould fitting and luting.

Ensure that the moulds are not damaged and remove any loose materials before use.

For two-piece moulds, adjust and fit the first mould half into the mould protector, utilise a torch to ensure the mould is central to the weld gap. With the second half of the mould, adjust against the first mould half ensuring all gaps are removed. Now insert the second mould into the mould protector.

Both mould halves must:

- Fit together without mismatch – check with your finger at the mould head and foot.
- Be perpendicular to the longitudinal axis of the rail.
- Fit together without leaving a gap under the foot.
- Be central to the welding gap.

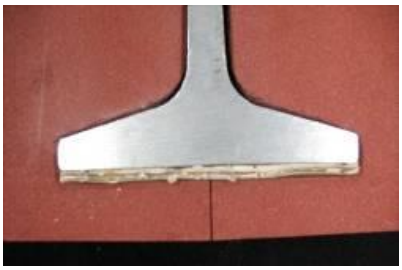
If wear is less than 3 mm, it is possible to rework the moulds by filing. However, the collar geometry must be kept.

Refer also to section 3.2.

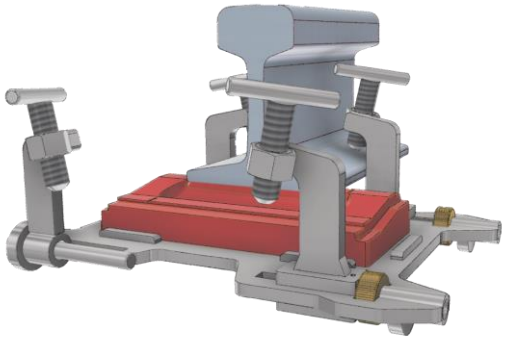
Slightly tighten the toggle screws of the clamping devices slightly at both sides of the mould.

Check the seat of the plug by inserting into the moulds as a trial.

If rails of different heights or differently worn rails are to be welded, the spaces between the mould and the rail under the foot and head must be filled with felt or cardboard to prevent sand or paste from being pushed inside the mould.



The joints between the rails and the moulds/mould shoes as well as the bottom joint must be sealed by luting sand, or, alternatively by luting putty. Firmly press the paste into the circumferential groove.
For 3-piece moulds ensure the sand base plate has been adjusted/rubbed to rail profile, ensuring there are no gaps between rail and sand base plate. Place sand base plate into base plate support (picture below). There is an option for welders to place a thin layer of sealing paste on underfoot base plate. IMPORTANT to note only a thin layer is required on either side of base plate and sealing paste must not contact the reinforcement of underfoot plate. Sealing paste is only for use on base plate and not to be used anywhere else on moulds. Ensure sand base plate is central to the weld gap secure t-screws. Re-check to ensure sand base plate is central to the weld gap.



Adjust/rub and fit the first mould half centrally to the welding gap, tighten t-screw on clamping device lightly. Adjust/rub second half against first mould half ensure all loose materials such as mould residue are removed. Tighten second mould ensuring moulds are vertical and square. Ensure moulds are not over tightened. Ensure there is no mismatch between moulds and sand base plate. Place large riser card at top of moulds.

4.10 Completing luting operations.

Utilizing either luting sand or luting putty for two-piece mould system ensure the pull is packed first, followed by both feet. If three-piece system is utilised welders are to start luting from under the foot of rails. Welders are to work their way up to the top of the moulds. It is vitally important that the welders take care ensuring that the first layer is pushed firmly into the luting groove between the mould and rail. A second layer is than applied to all areas. Make sure that no luting sand or luting putty falls into the mould. Protect the toggle screws.

4.11 Use of slag pan and slag plug.

Now place one slag pan onto the mould shoe on the side with the lowest cant, dry moist slag pans and insert dry sand into slag pan and on running surface of rails on either side of moulds to protect from splatter. Place slag plug on opposite side.

4.12 Rail covering sheets.

Protect the rails beside the mould by placing covering sheets.

4.13 Preparation of Tin and Enviro crucibles.

The Tin or Enviro crucible shall be kept dry, closed and protected from damage during transport. The Tin or Enviro crucible. Tin or Enviro crucible crucibles cannot be dried and thus, must not be used if any sign of moisture is present.

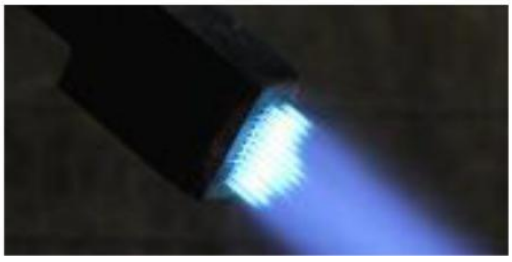
Remove the lid from the empty Tin or Enviro crucible. Check the inside and outside of the crucible for damage. Damaged Tin or Enviro crucibles must not be used. No sand residues or foreign bodies shall be inside on the tapping thimble. Then fill in the THERMIT® portion. Ensure correct portion size and grade is utilised. Cover the Tin or Enviro crucible by placing the SAFESTART crucible cap. Protect crucible and filled in THERMIT® portion from moisture.

4.14 Propane/oxygen pre-heating BOC Gas Equipment.

First, open the oxygen valve at the handle and then partially open the propane valve after approx. 3 s. Ignite the flame by a suitable gas ignitor. Set the torch flame at the propane valve so that the flame cores, (inner cones), have a length of approx. 15 to 20 mm.

Propane/oxygen Harris Gas Equipment.

Open the oxygen valve at the handpiece ¼ of a turn, open the acetylene valve at the hand piece ½ a turn, after approx. 3 s. Ignite the flame by a suitable gas ignitor. Set the torch flame at the oxygen valve and ensure acetylene valve is opened to its maximum, adjust with oxygen valve so that the flame cores, (inner cones), have a length of approx. 15 to 20 mm.



Dry the slag pans for a short period of time before positioning the pre-heating torch with torch saddle centrally on top of the mould and fix it by the set screw.

The torch flame shall not be operated at excess oxygen. When pre-heating, the torch flame is to be set as a neutral flame with a minimal combustion gas excess as follows:

Regulate the propane (or Oxygen valve if Harris gas equipment is being utilised) supply at the valve of the handle until the torch flame develops a rattling noise.

Then close the propane (or Oxygen valve if Harris gas equipment is being utilised) valve at the handle so far only until this rattling noise just disappears.

4.15 Preheating parameters.

Check gauges are to be utilised at a minimum at the start of each shift or when bottles are required to be changed.

The pre-heating time depends on the rail profile (refer to below data sheet). Check the time by a timer. The time runs as soon as the flames are fully developed over the mould risers (approx. 30cm).

WELDING PROCESS	RAIL SIZE	PREHEAT TIME [MINUTES]	GAP SIZE [MM]	TORCH HEIGHT [MM]	GAS PRESSURES OXYGEN [KPA]	GAS PRESSURES PROPANE [KPA]	MOULD REMOVAL [MINUTES]	CROWN GAP [MM]	TORCH TYPE
SkV-A	30,31,75lb,37	2.5	23-27	40	400	75	4.0	1.5-2.0	22 Hole Preheater
	80lb, 41,47,50	3							
	53,60	4							

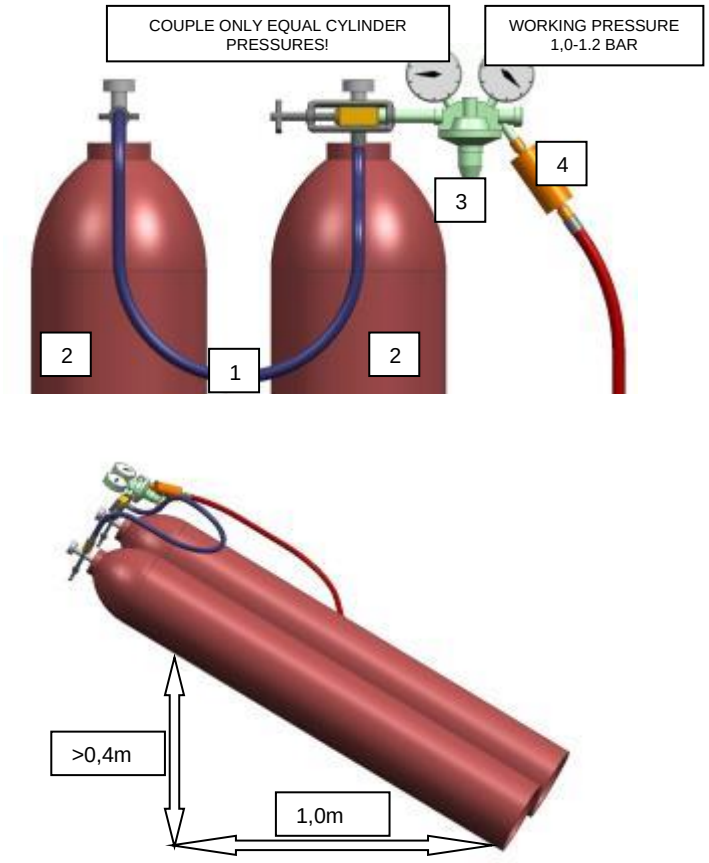
On completion of the pre-heating time inspect colour and if colour is a uniformed bright orange or yellow remove the torch saddle together with the torch.

4.16 Features for flame cutting and pre-heating with acetylene/oxygen.

Use the specific devices for this type of gas for flame cutting and pre-heating with acetylene/oxygen.

The usual rules of work shall be applicable here, however, couple at least two 50 litre acetylene cylinders (both with equal cylinder-pressures) parallel as a battery for pre-heating.

This configuration and the minimal acceptable inclination of the cylinders during usage are shown as follows:



Legend

1: two-cylinders coupling acetylene

2: acetylene cylinders 50l – both with equal cylinder-pressures

3: single step pressure reducing valve for acetylene HESA, Hi Lo or Murex

4: flashback arrestor acetylene (should be high pressure flow 5 bar)

Set a neutral flame pattern for flame cutting and pre-heating.

The torch flame shall not be operated at excess oxygen.

4.17 Weld execution.

The steps “insertion of plug”, “positioning of crucible” and “ignition of portion” must be carried out quickly one after the other.

Remove the preheating torch and face away from all personnel.

Plug insertion:

Press the plug into its seat in the head of the mould using fire tongs and lightly tap to secure in position.

Crucible positioning:

Place the Tin or Enviro crucible centrally onto the mould shoe, ensure crucible is sitting within the tabs on mould shoes.

Ignition of THERMIT® portion:

When utilising SAFESTART CAP crucible place preheat flame 20 -40mm above SAFESTART CAP starter mix at the centre of the cap remove preheater once ignition has been observed.

4.18 Crucible tapping.

Tapping is automatic for all crucible types. Ignition to tapping time must be within range of 17-38 seconds from ignition of crucible. Restart stopwatch once pour is completed, remove crucible after a minimum of 1 minute from completion of pour, remove slag pans after a minimum of 3 minutes from pour. Slag must never be poured onto wet ground. Place hot slag pans and hot Tin and Enviro crucibles in a safe position on dry non-flammable ground.

In the case of crucible not tapping: Keep the crucible on the mould and wait until the metal of the crucible inside is solidified for a minimum of 30 minutes. Carefully take down the crucible from the mould.

Carefully remove the mould shoes after the waiting time (4 minutes) after completion of pour.

4.19 Welding whilst rail temperatures are dropping.

When the rail temperatures drop, the rail shrinks and applies tensile stress to the weld. If this occurs during solidification, these tensile stresses could result in cracks in the weld material. Rail shrinkage must be counteracted by means of rail pullers or rail heating. This is very important if the rails were elongated thermally during track neutralization.

4.20 Mould head removal.

Remove the mould head carefully after the waiting time after pouring as indicated in the sequence below. To do so, carefully tilt the mould head and check whether the welding material is still liquid. If so, gently place the mould head back to original vertical positioning.

1. Minimum time of 4 minutes after the completion of the Thermit reaction and pour, the rail clamp and mould protectors may be carefully removed.
2. Immediately after removal of rail clamp and mould protectors, commence removal and loosening of excess luting material and loose sand using the hot set, taking care that the hot set is used parallel to the rail running surface to prevent scarring of rail surface from contact with sharpened end of hot set. Once excess luting material is loosened from rail and luting groove, use wire brush to remove all loose debris.

3. Following the cleaning of the rail head, gentle scribe a line across the moulds above the rail head using the hot set to facilitate the breakoff point of excess mould. Gently tap top of moulds to crack along said line. Alternatively utilise mould removal tool.
4. After a MINIMUM of 5 minutes have elapsed from Thermit reaction and pour begin removing the excess mould head. Following the below procedure.

The starting point of trimming process is visually to determine as follows:

a) If mould head is removed to early the welding material (molten steel) is coloured white or light-yellow and liquid in appearance.

Start the trimming when a visible film or skin of oxide with blisters appears on surface, this is recognizable by a dotted or spotty darkened blue appearance.

b) If mould head is removed later the welding material is coloured already yellow. Then immediately start the trimming.

Influences on the waiting time after pouring until mould head removal are shown as follows:

Influences		**waiting time will**
rail temperature	High	Extend
	Low	reduce
crucible type	single-use crucible	Extend
	long-life crucible	Reduce
gap width	nearer to upper limit	Extend
	nearer to lower limit	Reduce
Height of rail head, equal rail profiles	new rail	Extend
	worn rail	Reduce
portion grade Z120		Extend
Pre-heating time (unacceptable deviation from code of practice)	too long	Extend
	too short	Reduce
Flame pattern for pre-heating. (unacceptable deviation from code of practice)	Operated at excess oxygen. - hard flame	Reduce

4.21 Weld finishing.

Remove excess metal from the rail head by means of a hydraulic rail trimmer. If the trimming shoe shape B is used, do not bend the risers in red-hot condition to ensure an even area of fracture after later knocking off. Leave the risers at the rail foot and knock them vertically in the direction into the rail head by a hammer after a minimum of 30 minutes from completion of shear.

4.22 Grinding for readiness-for-service / rough grinding.

Rough grind the welds without touching the running surface of the rail. Remove any sand and cast metal residues from all sides – also below the rail foot – by means of a blunt scrap chisel or wire brush from the cold weld. Avoid notches.

Welding residues must be removed from the site. Make sure that only sufficiently cooled down welding residues are transported in vehicles. Alternatively, all waste may be removed in a hot works bin or crate.

4.23 Final grinding.

Final grinding must be carried out only when the weld has cooled down fully and the track has been restored to service condition (wedges removed, intermediate plates refitted, fasteners reassembled and fixed). The geometrical tolerances required for the running surface and running edge as well as the marking of the welds are defined by the railway authority.

When grinding and cleaning the weld, wear the personal protective equipment, in particular goggles.

Ensure fire prevention, protect the environment from flying sparks, if necessary, use the spark guard on the grinding machine.

4.24 Permanent way finishing work.

The permanent way operations such as tamping of sleepers, adding missing ballast, etc. must be completed before the welded track is put back into operational service for trains and railway vehicles.

5.0 Welding and permanent way.

5.1 Rail materials.

Prior to the beginning of welding and flame cutting work, determine the steel grade according to the rolling marks.

5.2 Fitting rail length and location of welding point.

The relevant railway authority will define the minimum fitting rail lengths depending on the speed category of the track. These definitions must be complied with when planning the welding work.

When using short fitting rails make sure that they have been welded at one side at least prior to the passage of traffic. The welding point should be in the central area between the sleepers, with a minimum of 100mm from edge of sleeper.

5.3 Welding at low and high rail temperatures.

Railway authority guidelines, if any, for working at low and high temperatures must be observed.

No welding should be carried out at temperatures below -3° C without additional measures.

5.4 Welding during rain.

Protect the welding point and all welding materials from moisture and rain, a tent may be utilised providing moisture and rain do not encounter the THERMIT® weld.

Dry moist rails always – not only during rain - by slightly heating. Refer to document:

WI_GA_TS WELDING IN WET WEATHER/ADVERSE WELDING CONDITIONS.

5.5 Welding in curves.

When welding canted rails, the top surface of the mould plug must be filed to ensure that it is horizontal when fitted into the mould.

5.6 Cutting and welding of continuously welded rails.

Stress compensation and the associate final weld shall be carried out in tracks only in the form of the permanent way of which is suitable for the continuously welded track, which has been provided with enough ballast and which meet the height, distance and direction requirements of the railway authority, which will also regulate execution of stress compensation.

Preparation of the continuously welded track and working in the continuously welded track is subject to specific regulations to be defined by the relevant railway authority.

5.6.1 Temperature range.

The railway authority will specify certain ranges of rail temperatures for THERMIT® welds to be completed in track.

5.6.2 Cutting of rails at rail temperatures above the neutral temperature.

Normally, the track must not be cut under these temperature conditions. If cutting is necessary in emergency cases, consider the compression in the rail. Separating cuts are possible only by specific measures to maintain the gaps.

A special procedure for flame cutting must be used, details of which are available on request. The appropriate range of the neutral temperature will be defined by the railway authority.

If a non-normal state of stress is observed when cutting into continuously welded rails, this must be reported to the railway authority. The opposite track must also be neutralized normally.

Specific measures must be initiated at the transition from the continuously welded rail to the fishplate jointed track and other non-welded sections, which will be defined by the railway authority.

5.6.3 Neutralization of rail (stress compensation).

The specific procedures and conditions for stress compensation will be defined by the railway authority.

1. Loosening the rail to release the stress.
2. Calculation of the change in length for the rail section to be neutralized.
3. Lengthening the rail by the calculated change in length by means of artificial heat or pulling machine.
4. Re-securing the rails.
5. Final weld to be executed immediately after re-securing. If rail tensors are utilised to maintain destress, rail tensors are to be left on rail a minimum of 20 minutes from completion of pour.

5.6.4 Closure welds.

The closure weld connects two fastened and neutralized rails. The closure weld completes neutralization.

When carrying out the weld, regulate the hydraulic system and/or the heat supply to the rail to maintain the set length. No tensile stresses shall be applied to the weld before the weld has cooled down to approx. 500 °C. If rail tensors are utilised, rail tensors are to be left on rail a minimum of 20 minutes from completion of pour.

5.6.5 Curves, bridges and connections to switches.

Curves and connections to switches shall normally be neutralized and stressed in the top stressing temperature range. The details of curves, bridges and connections to switches will be defined by the railway authority.

5.6.6 Welding in switches and crossings.

Only those switches which are installed correctly in height, direction and which have been properly tamped and filled shall be welded. Both the position of the stock rails to each other and the right-angle position of the switch rail to the tongue rail shall be checked at the marks and corrected, if necessary. The details will be defined by the railway authority.

The welds shall be carried out in pairs, beginning from the heart and initially in the straight and then in the branching track. The joints at the beginning of the switch, and the end of the switch shall be executed as final welds in the top stressing temperature range.

As soon as all other joints have been welded, the joints at the tongues will be welded. For this purpose, check that the shrinkage dimension of the weld of 2 mm above the mark, is kept at the tongues.

Sometimes it is impossible to use the usual mould shoes when welding around the crossing due to the minimum area between rails. Parted mould shoes are available for these purposes.

5.7 Welding of head hardened rails.

The chemical composition of (head hardened) rails with fine Pearlite content corresponds approximately to that of the steel grade R350HT. Goldschmidt Australia designation of Z110 portion is to be utilised for R350HT rails.

5.7.1 Portion grade selection.

When welding different rail grades Goldschmidt Smart Rail Solutions recommend using the below portions.

R260 to R260:	Z90 grade portion
R350HT to R350HT:	Z110 grade portion
R260 to R350HT:	Z90 grade portion

6.0 Responsibility of the Railway Authority.

Definition: When used in this code of practice, the railway authority shall be understood to be the organization stipulating the rules, which is responsible for the railway directives and work regulations for welds and the upstream and downstream work in the track involved.

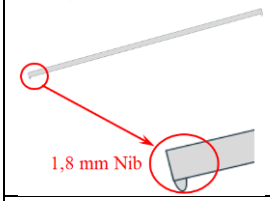
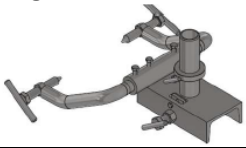
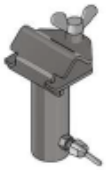
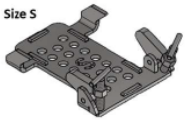
THERMIT® welding work shall be carried out in any case in connection with other work at the permanent way. The quality of the weld will also always depend on the upstream and downstream work at the permanent way. Thus, this code of practice includes notes for other work at the permanent way if they might affect the quality of the final product, the welded track.

7.0 List of equipment.

The following equipment is required for issue to a welding crew:

Tool description	Quantity per weld	Goldschmidt Part Number
Rail saw	1	n/a
Railsaw blades	1	n/a
Wire Brush	1	n/a
5 inch grinder	1	n/a
Wire brush attachment for 5-inch grinder	1	n/a
Hammer drill	1	n/a
Needle scaler attachment for hammer drill	1	n/a
2lb hammer	1	n/a
4lb hammer	1	n/a
Straight edge (1m long – flat)	1	n/a
Straight edge (1m long with 1.8mm nibs)	1	E01702
Starrett gauge	1	n/a
Feeler gauge set	1	n/a
Wedge, 250 x 15 x 30mm	4	E01900
GIB Head Wedge	4	E-G-PLGHW
Gauge Alignment Wedge 40x140mm.	4	E-G-PLWWS
Wedge Metal (Large)	4	E01903
Clamping device for single-use-crucible (SUC)	1	E00208
Burner clamp	1	E00104
Gap gauge (25 x 40mm)	1	E03718
Mould protectors' standard 3-piece Paste	1	E035105
Mould protectors' standard 2-piece Paste	1	E035104
Underfoot baseplate support (small)	1	E035200
Slag pans (standard) - Pair	1	E01004
Hot set head	1	E01500
Hot set handle	1	E250710
Lifting handle for single-use-crucible (Tin)	1	E11900
Rail protection cover – small	1	E02300
Rail protection cover – large	1	E02200
Tongs 262C flat nose 450mm (18')	1	E03900
Long handle shovel/spade	1	n/a
Rail thermometer	1	E02000
Tommy bar (crowbar) – Goldschmidt specific size	1	E01800
Tool description	**Quantity per weld**	**Goldschmidt Part Number**
Hydraulic rail shear U-L4	1	E14106
Rail head grinder GP4000 D	1	E15016
Welding tent 3m x 3m	1	ESS3005SRW
Burner Tip Cleaners	1	E10800
Harris Thermit Pre-heating kitset (propane)	1	E10900-3 SET

8.0 Welding tool pictures.

Rail saw 	Rail saw blades 	Wire brush 	2lb and 4lb Hammers 
5 inch grinder 	5 inch grinder wire brush attachment 	Hammer drill 	Needle scaler attachment for hammer drill 
Straight edge (1m long with 1.8mm nibs) 	Starrett gauge 	Feeler gauge 	Gap gauge 
Wedge, 250 x 15 x 30mm 	GIB Head Wedge 	Gauge Alignment Wedge 40x140mm. 	Wedge Metal (Large) 
Clamping device for single-use-crucible 	Burner clamp 	Mould protectors' standard 3-piece Paste 	Underfoot baseplate support (small) 
Slag pans 	Hot set head 	Hot set handle 	Lifting handle for single use crucible 
Rail protection cover small 	Rail protection cover large 	Tongs 262C flat nose 450mm (18') 	Rail thermometer 

Hydraulic rail shear U-L4 	Rail head grinder GP4000 D 	Welding tent 3m x 3m 	Harris Thermit Pre-heating kitset (propane) 
Tommy Bar 	Burner Tip Cleaners 	Mould protectors standard 2-piece Paste 	

9.0 Harris Thermit Kit Set.

Tool description	Quantity per weld	Goldschmidt Part Number	Picture
Oxy. Multistage Reg, 0-1000kPa outlet pressure	1	E10901	
LPG Single stage, LPG Reg high flow	1	E10902	
Fuel gas high flow flashback, arrestor reg.	1	E10903	
Oxy. Gas high flow flashback, arrestor reg.	1	E10904	
LPG 10mm x 20m, Twin hose, with fittings	1	E10905	
LPG Test gauge, 0-250 kPa Liquid filled	1	E10906	
Oxy Test gauge, 0-600 kPa Liquid filled	1	E10908	
Handle (blowpipe) Gen high flow, high flow with flash guards	1	E10910	

Adaptor from F43 mixer, to heating tub tip	1	E10912	
Storm case large 340 x 480 x 10cm, Harris	1	E10913	
ACET & LPG High flow mixer, Model E243	1	E10914	
Straight adaptor with SNAP SAF	1	E10918	
Pre-heater, Oxy-Propane., 22 Hole	1	E03610