GOLDSCHMIDT
Smart Rail Solutions

Code of Practice

for the

THERMIT®- Quick Welding Procedure

SkV-Elite

THERMIT AUSTRALIA PTY LTD · A GOLDSCHMIDT COMPANY · 170 Somersby Falls Road · Somersby NSW 2250 · Australia
Phone: +61 2 4340 4988 · Fax: +61 2 4340 4004 · E-Mail: technicalservices.ta@goldschmidt.com
ABN 68 003 167 511 · PO Box: 76 Kariong · NSW · Australia · 2250

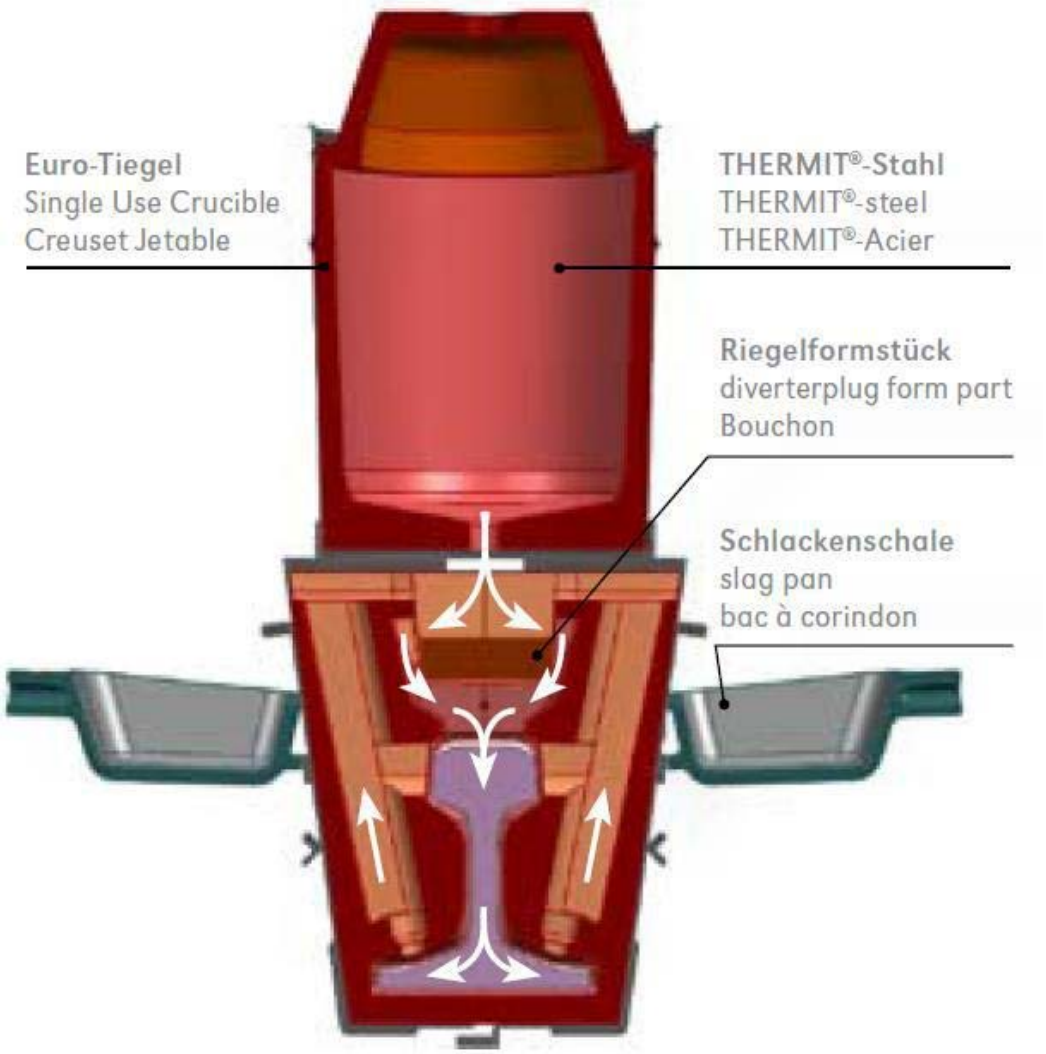
Table of contents

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 Thermit 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-Elite Single Use Crucibles



1. 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 designation 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 special 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 post weld heat treatment
	R350LHT		= — —	Z120, Alternative: Z90 HC with heat post-treatment on request
	R370CrHT	R370LHT	= — —	Z130, Alternative: Z90 HC with heat post-treatment on request
	R400HT		= —	Z140, only single-use crucible

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

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.

When using the Long-Life crucible, use portions with the suffix “LLC”.

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.

For portion grade Z120, the trimming should start as late as possible after approximately 7 minutes.

1.3 Data sheet Standard gap for SkV-Elite (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.

When using the Long-Life crucible, use portions with the suffix “LLC”.

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

For portion grade Z120, trimming should start as late as possible after approximately 7 minutes.

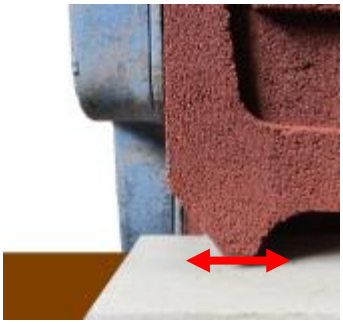
1.4 Data sheet Wide Gap SkV-L65 and SoW-L70 (propane / oxygen) and special instructions

The appropriate pre-heat and weld data sheet for your project will be included in the Appendices.

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

For L70 may be used single-use Tin Crucible high design with crucible cap wide gap

Speciality of sealing at L70:



~29 mm

at worn rails

minimum 30 mm

Sequence of hot treatment:

1. At the earliest, 7 min after pouring, carefully remove the mould shoes.
2. At the earliest, 8 min after pouring, remove the mould below the mould head using the hot scrap chisel while the mould head remains. Starting at the foot, remove all mould residues upwards up to approx. the level of the running surface.

3. At the earliest, 10 min after pouring, remove the mould head.
4. Attach trimming unit and start trimming after the following waiting times from pouring:
   -for long-life crucible and low rail temperatures (below approx.15°C):
   gap width 65mm 11.0 min gap width 75mm 11.5 min
   -for long-life crucible and higher rail temperatures (above approx.15°C)
   gap width 65mm 11.5 min gap width 75mm 14.0 min
   When using the high design of the single-use crucible, the indicated trimming times may increase by up to 0.5min.
   For portion grade Z120, the trimming should start as late as possible.

2. Accident prevention

When carrying out THERMIT® connection welds, the accident prevention regulations of the relevant Accident Insurance Authority must be complied with. In addition, the following regulations have to be followed:

- Principles of prevention
- Grinding work and powered working means
- Railway track service
- Work in the area of tracks
- Welding and cutting with gases
- Handling of gases and liquid gases
- Fire prevention

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 moisture.

Ignitors and welding portions must be packed, stored and transported separately. Loose ignitors must not be carried in clothing. A SmartWeld Spark or SafeStart Tin or Enviro Single Use Crucible is also available.

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 come in contact with water and are not extinguished by water. If necessary, cover with dry sand.

After completion of steel pouring, lift the tapped single-use crucible or Long-Life 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 3 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 PWAY safety inductions.

All work on site should be covered by a PWAY permit system and all necessary contact and emergency numbers provided.

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

The following welding materials must be available in sufficient amounts:

- THERMIT® portions,
- Moulds,
- Igniters,
- Propane, or Acetylene
- Oxygen,
- Single-use crucibles
- Long Life crucibles
- Sealing sand or alternatively,
- Sealing paste

The materials must be stored dry and frost-free in a condensation free environment. The packages must be undamaged. The materials must be used immediately after having opened the packing. Ignitors and THERMIT® portions must be kept separately.

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.

Profile and steel grade of a rail defined 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! Keep them in the portion container at the building site. Moist portions must not be used even if they have been dried.

Undamaged and in date (5 years from date of manufacture) portion bags only shall be used. Do not mix the content of several portion bags unless defined additional portions are required explicitly in the code of practice and the relevant data sheet for wide gap welds only.

3.2 Moulds

The mould shall be selected such that they match the rail profile and the welding gap (standard gap, or L70).

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 (2 years 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

3.3 Ignitors

Traditional Ignitors shall be kept separately from portions and not in the portion containers or clothing

For the transport on vehicles to the site design approved single over packs type 4G (Dangerous Goods) are deliverable on request.

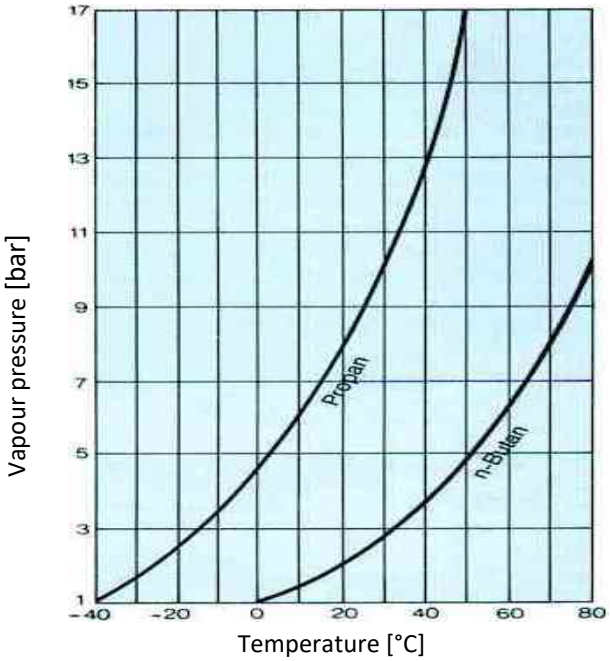
Due to these safety and travel restriction Thermit Australia now also recommends the use of SafeStart Crucible systems or alternatively electronic ignition devices which can be shipped together with the rest of the shipment.

3.4 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.

Propane:

A sufficient vapour pressure and mass flow of the liquid gas must be ensured during the whole pre-heating time as follows:



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. In exceptional cases at least two cylinders have to be coupled in parallel as a battery for gas tapping and/or electrically operated blankets for the cylinders must be used.

See also section 4.19.

Acetylene:

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

3.5 Crucibles

For the SKV-Elite there are four types of single-use SafeStart Enviro, Tin Crucible and Long-Life Crucibles.

Refer to sections 4.17 Preparation of single-use crucible I, II and SafeStart Crucible for standard gap and 4.18. Preparation of single-use crucible I for gap L70.

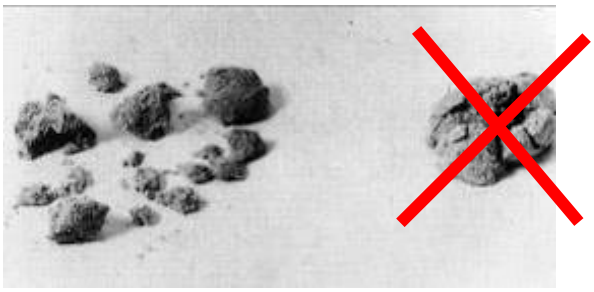
3.6 Tapping thimbles

The single-use crucibles I and II are provided with an integrated automatically opening closure.

The Long Life Crucible requires additional ATT-Elite self tapping thimble per weld.

3.7 Sealing sand and sealing paste

The sealing sand must be uniformly moist (earth-moist, 6 – 8 % moisture): If necessary, carry out a falling weight test.



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 or use pre-mix luting sand. Check the paste prior to use. Use paste only which can still be kneaded.

4. 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 starting.

4.1 Cleaning and examining the rail ends

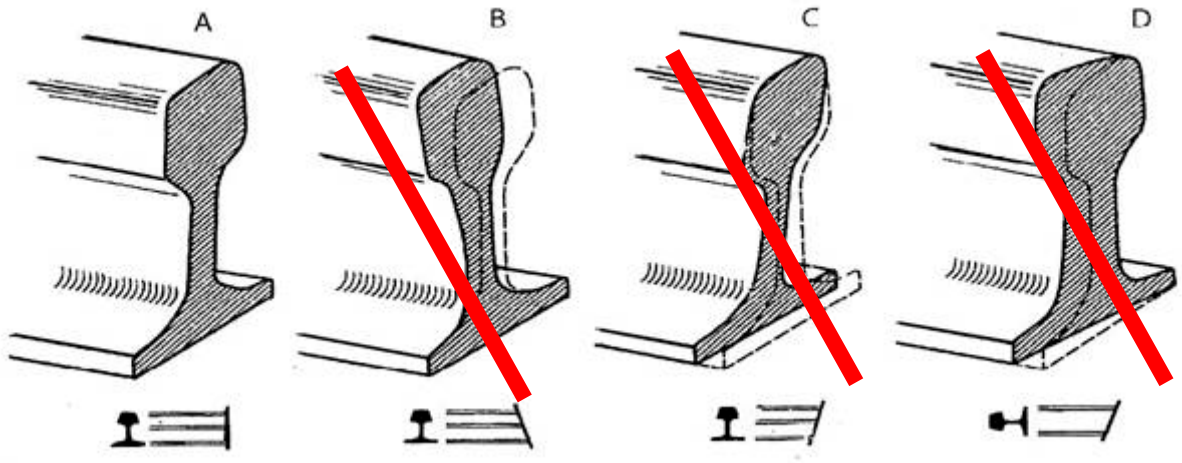
Rail ends must always be cleaned before welding. Rail ends may not be welded with defects at fishplate holes or with holes made by flame cutting. A minimum distance of 65mm from edge of rail to bolt hole must be observed prior to start of welding.

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

Preferably, prepare the welding gap by a mechanical separating cut. Prepare the welding gap widths according to the data sheets.

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

Fame 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 Railway Authority regulations.

4.5 Rail Cutting with Rail saw

Ensure user has completed the necessary safety induction and has certification for its use.

Ensure you are 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.

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.

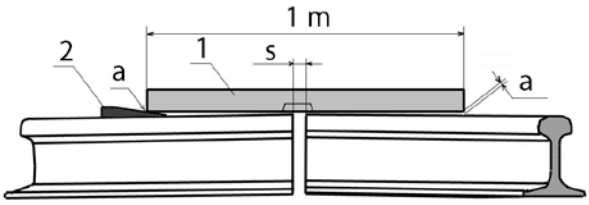
If the cut cannot be completed from one side, the rail saw must be shut down, turned around and re-clamped into position. Guide the cutting blade down towards the rail and check that the cutting blade is centred in the cut. If necessary, adjust the rail clamp so the blade ends up centred in the middle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

4.6 Rail alignment

The rail fasteners must be loosened on at least two sides of the welding joint at least three sleepers (for L70 at 4 sleepers each), 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 regulations, if any, of the Railway Authority shall be followed.

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: 1-meter straight edge
2: Crown measuring wedge
a: Crown – refer to data sheet
s: Welding gap – refer to data sheet

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. Railway Authority regulations may specify exceptions to this rule.

The wedges must not be removed until after the weld has cooled down.

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 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. The correct mould for the rail profile to be welded must be used. The moulds must now be inserted into the mould shoes (protectors).

For two-piece moulds, adjust and fit the first mould half from outside centrally to the welding gap and the second half from inside against it. Between fitting the first and second mould halves, cover the running surface and the welding gap by the board trims from the mould box until the gap of the running surface is closed.

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.

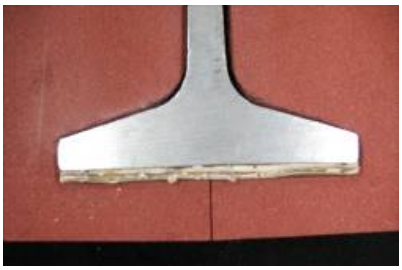
If wear is less than 3 mm, it is possible to rework the moulds by filing. However, the collar geometry must be kept.

Refer also to section 3.2.

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

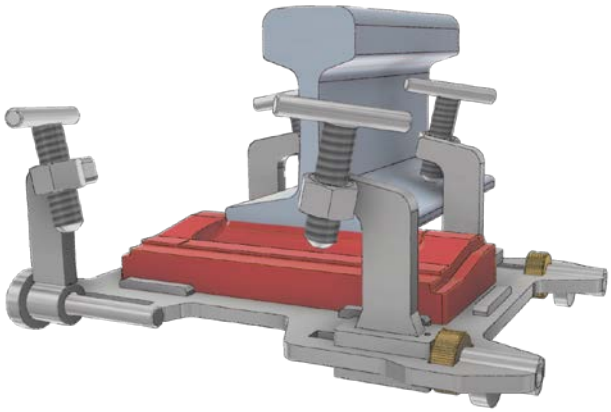
Check the seat of the plug by inserting into the moulds as a trial.

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 cardboard (at L70 as U-shaped) from the mould box to prevent sand or paste from being pushed inside the mould. The cardboard caulking must project beyond the mould surface or, in the case of paste luting, into the paste groove. Follow the hints for use given as attachments in the mould boxes.



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 paste. 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). 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. Place 1.3mm luting card between mould and running surface. 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 two riser cards at top of moulds.

Make sure that no luting sand or paste falls into the mould. Protect the toggle screws.

4.10 Supported joints on sleeper or with base plate

Welds of this configuration use the same mould as for suspended joints but special mould shoes and base plates are required here. If the joint is not direct on top of a sleeper, use an additional base plate. If necessary, loosen the ribbed baseplates and move them to the side. Bolt holes in the sleepers must be plugged. Wooden sleepers must be protected from fire by covering them with sand.

After mould fitting, support the mould base plate by ramming luting sand into the gaps between it and the sleeper.

4.11 Use of slag pans

Now insert the slag pans into the mould shoes. Dry moist slag pans and foot of rail using the torch to remove all moisture. Place slag pan sand evenly in both slag pans.

4.12 Rail covering sheets

Protect the rails beside the mould by placing covering sheets.

4.13 Preparation of single-use crucible I and II and Long-Life crucible

The single-use crucible shall be kept dry and closed and protected from damage during transport. The single-use crucible need not be dried. Moist single-use crucibles cannot be dried and thus, must not be used.

For unfilled single-use crucibles only:

Remove the lid from the empty single-use crucible. Check the inside and outside of the crucible for damage. Damaged single-use crucibles must not be used. No sand residues or foreign bodies shall be inside on the tapping thimble. Then fill in the THERMIT® portion. Use E portions only.

Cover the single-use crucible by the single-use crucible cap. Protect crucible and filled in THERMIT® portion from moisture.

For Safe Start Crucible caps ensure no damage has occurred during transport.

The Long-Life Crucible must be preheated uniformly to 100°C on the exterior if crucible using a soft flame. This is to remove all moisture. Crucible must be centered over the moulds and pouring plug. ATT-Elite thimble is to be inserted and no gaps are to be present between thimble and bottom of crucible cone. Cover metal section of thimble with thimble applicator and even spread remaining contents of thimble container around the inserted thimble. Insert correct portion ensuring all contents remain in crucible.

Get an ignitor, SafeStart Crucible cap, or SmartWeld Spark ready for use.

4.14 Preparation of single-use crucible I for L70

Remove the lid from the empty single-use crucible. Check the inside and outside of the crucible for damage. Damaged single-use crucibles must not be used. No sand residues or foreign bodies shall be inside on the tapping thimble.

Initially carefully fill in only the THERMIT® basic portion and then place the “crucible cap wide gap” onto the single-use crucible.

Then fill in the additional portion as required in the data sheets L70 through the opening of the “crucible cap wide gap”!

THERMIT® basic portion and additional portion shall be used as E portion only.

Get an ignitor ready for use.

4.15 Propane/oxygen pre-heating Hesa or BOC Gas Equipment

First of all, 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 it's maximum, adjust with oxygen valve so that the flame cores, (inner cones), have a length of approx. 15 to 20 mm.

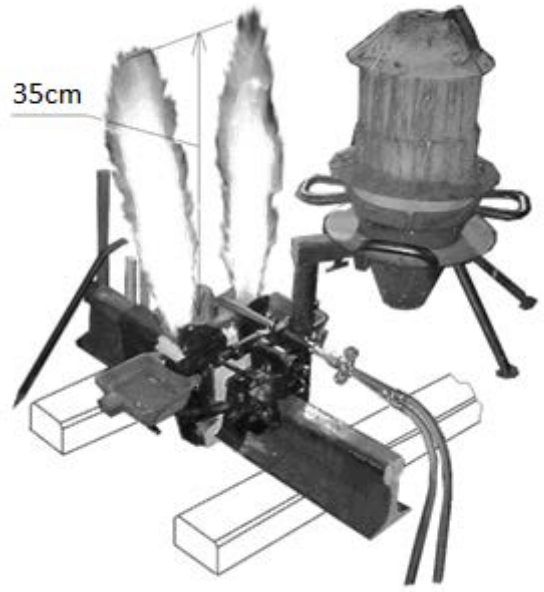
Dry the slag pans for a short period of time before positioning the pre-heating torch with torch saddle centrally on top of the mould and fix it by the set screw.

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.

The flame height shall be approx. 35 cm over the moulds.



The working pressures to be set at the regulators according to the data sheets develop the required flow pressures at the handle when using the prescribed devices according to the list of equipment (refer to section 7). Keep the working pressures for oxygen and for combustion gas constant over the whole period of pre-heating, if necessary by regulation, in particular with decreasing cylinder content and at the same time the increasing working oxygen pressure inside the hose, and in cold weather as well.

Inline check gauges are mandatory 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 data sheet). Check the time by a timer. The time runs as soon as the flames are fully developed over the mould risers.

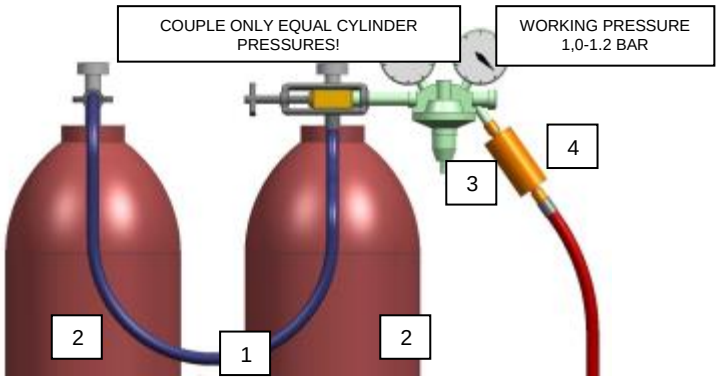
On completion of the pre-heating time inspect colour and if colour us achieved remove the torch saddle together with the torch.

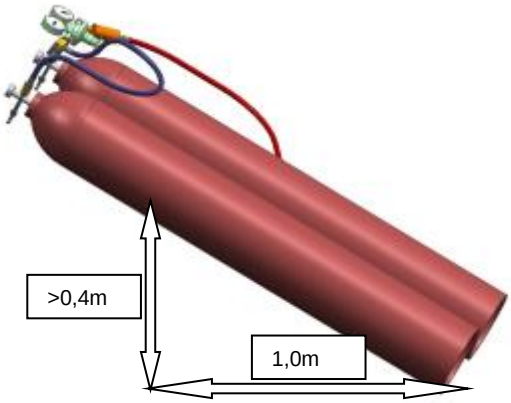
4.16 Particular features for flame cutting and pre-heating with acetylene/oxygen

Use the specific devices for this type of gas for flame cutting and pre-heating with acetylene/oxygen (refer to list of equipment in section 7.).

he usual rules of work shall be applicable here (according to data sheet 1.6), 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 Durring 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.

Plug insertion:

Press the plug into its seat in the head of the mould using tongs.

Crucible positioning:

Slew the long-life crucible tripod above the center of the plug.

or

Place the single-use crucible centrally onto the mould shoes into the guide.

Ignition of THERMIT® portion:

The ignitor is ignited (normally by the torch flame) and is then plugged – for two thirds of its length – centrally into the THERMIT® portion. Then attach the crucible cap; wear goggles.

If the single-use crucible is used for L70, plug the ignited ignitor (300 mm long) – deviating from this – through the opening of the already attached “crucible cap wide gap” into the 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. 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 single-use crucibles in a safe position on dry non-flammable ground.

In the case of crucible not tapping: Keep the crucible on the mould for single use crucible or above the mould for Long Life Crucible. Wait until the metal of the crucible inside is solidified, 30 minutes minimum. Carefully take down the crucible from the mould.

Carefully remove the mould shoes after the waiting time (4.5 minutes for standard gap welds) 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 4.5 minutes after the completion of the Thermit reaction and pour, the Elite rail clamp and mould protectors may be carefully removed
2. Immediately after removal of Elite 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.
4. After a MINIMUM of 5.5 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 or with a hot scrap chisel. Preferably use trimming shoe shape A only. If the trimming shoe shape B is used, do not bend the risers in red-hot condition in order to ensure an even area of fracture after later knocking off. Leave the risers at the rail foot and knock them off in direction of the rail by a hammer if completely cold.

4.22 Grinding for readiness-for-service / rough grinding

Roughly 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 in single-use crucible I should be removed from the site. For this purpose, fill the single-use crucible I first with ceramic waste and then with steel and slag residues. 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. For the purpose of 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 service.

5. 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, if possible.

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.

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 come into contact with Thermit Weld.

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

WI_8.5.1-334_TA_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 sufficient amounts of 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 the manufacture and repair of continuously welded tracks.

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 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.

Unless otherwise stipulated, a section of at least 60 m must be included in the neutralization procedure.

When carrying out the weld, regulate the hydraulic system and/or the heat supply to the rail in order 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 and 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 stock rail to the tongue rail shall be checked at the marks and corrected, if necessary. The details will be defined by the Railway Authority.

Sequence of operations:

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 and shrunk, 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 in the area of the heart. Parted mould shoes are available for these purposes.

Rail temperature:

The Railway Authority is responsible for specifying the neutral temperature range at which welding must take place. Any welding performed outside those specified temperatures will require destressing, the joints in welds, except tongue joints, shall be. In any event all welds should be made at nearly the same rail temperature.

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.

Two different methods are available for welding head hardened rails:

5.7.1 Z90-HC with post-heat treatment

Carry out the standard weld with Z90 – HC portion, followed by the hardness increasing post-heat treatment at the cooled down weld.

Due to the additional shrinkage effect by the later post-heat treatment, increase the peak at the running surface by 0.1 mm at both sides in this procedure as compared with the data sheet.

Carry out the following operations only if the weld has cooled down to ambient temperature:

For the post-heat treatment, fasten the clamping device at the rail head. Align the special torch type 250 410 centrally over the weld.

At temperature below 10 °C, couple two gas cylinders for gas tapping.

Set a flame core length of approx. 15 mm at the torch at working pressures of 5.0 bar oxygen and 1.5 bar propane. Then place the torch together with the torch saddle onto the clamping unit. The required torch height of 25 mm is achieved if the supporting pipe of the torch is at the running surface.

The running surface of the nearly finished ground weld has to be shock-heated for a period of 100 s (only for steel grade R350HT, the times for other steel grade are on request).

Then attach the covering hood onto the rail head and remove it after 2 minutes (only for steel grade R350HT, the times for other steel grades are on request). Check the time using a timer as a guide.

5.7.2 Portion grade Z 120/Z110

Execute the standard weld without additional measures. No covering is required for portion grade Z120 contrary to steel grade R320Cr! Thermit Australia designation of Z110 portion is to be utilised for R350HT rails.

5.7.3 Portion grade selection

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

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

6. 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. These may include: State Railway Authorities and their contracted organizations, community and connection railway administrations and their contracted organizations.

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. List of equipment

The following equipment is required for issue to a welding crew (recommended spare parts are indicated in brackets):

General tools:

1 flat chisel, long
1 hand hammer, 1.5 kg
1 sledgehammer 3 kg
- spare hammer shaft
2 combined goggles for welding/safety
1 wire brush, narrow
1 crowbar, 750 mm long
2 pairs of fire-resistant gloves
1 bucket for sand
1 bucket for water
1 rasp, half-round
1 machine saw blade
1 spatula

if required:

1 umbrella with plug-on tube
1 umbrella holder on request
1 set of rail head covers, (short and long)
1 temperature measuring instrument or pin
1 crucible removal tool

Rail alignment tools:

1 straight edge 1 m long
1 rail flame cutting gauge
2 supporting wedges, short (+ 4)
2 supporting wedges, long (+ 8)

if required:

1 gap measuring wedge
1 crown measuring wedge
2 sets of insulated rail gauge (1 set = 2 pieces) including spanner SW 41
4 half ribbed plates

Welding tools:

1 torch saddle
2 slag pans

if required:

1 portion container
1 set of tamping devices for supported joints
1 plate for sand collection

Pre-heating and flame cutting tools propane/oxygen:

Harris Oxygen/Propane unit includes all gas equipment to carry out THERMIT® welding.

Pre-heating and flame cutting tools acetylene/oxygen:

Harris Oxygen/Acetylene unit includes all gas equipment to carry out THERMIT® welding.

Rail joint trimming equipment:

Manual joint trimming:
- hot scrap chisel
- chisel shaft

Joint trimming by pneumatic tools:
- pneumatic chisel hammer
- compress air pressure reducer (Consider dimension of thread on cylinders!)
- compressed air hose, 10 or 20 m long with connections
- flat chisel for pneumatic hammer

Joint trimming by electric tools:
- generator 220 V, 4,4 kVA, 50 Hz
- tank 20 l for fuel
- chisel hammer,
- Power consumption 1,5 kW, impact energy min 25 J, beat frequency min 1890 min-1 with intake type SDS-max
- flat chisels (specific hard-faced cutting edge) for chisel hammer, with intake type SDS-max order number 256168
- extension lead 10 m

Joint trimming by trimmer:
- hydraulic trimmer (complete)

Grinding machine:
- grinding machine to grind the rail running surface and the rail head flanks

Measuring equipment/special equipment:
- rail thermometer
- alarm timer
- if required:
- rail heating device
- rail trolley
- rail covering hood for profile (information required) or insulation blankets
- RailStraight measuring device

Additional equipment for post heat-treatment when using HC welding portions:
- two-cylinder coupling for propane cylinders (Consider dimension of thread on cylinders!)
- torch type 250410
- torch saddle
- clamping device type 250406
- pressure drop shut-off device 12 kg/h, 1.5 bar
- rail head covering hood
- setting gauge SkV-Elite

For single-use crucible systems I and II (single-use crucible on mould shoes):
- clamping device, optional: universal clamping device for Vignol rail

pair of mould shoes SkV-Elite for suspended joints, profile...
if required:
pair of mould shoes SkV-Elite for supported joints, section ...
base plate for supported joints on request

Additional equipment L70:

set of equipment without mould shoes, without slag pans and with universal clamping device for Vignol rail
extension pipe for crucible tripod
slag pans design L70
pair of mould shoes L70 for suspended joints, profile...
crucible tripod E optional for single-use crucible high design
spatula
if required:
pair of mould shoes L70 for supported joints, profile...
base plate for supported joints on request

Weld Ignition System:

Traditional ignitor: classed as a dangerous good 1.4S Class UN0454 which is difficult to ship

Smartweld Spark: Wireless, handheld electronic system with audio ignition signal

For Long Life crucible system

Long Life Crucible
Thimble Drift
Thimble Applicator
Universal Rail Clamp
Crucible Stand
Crucible Cap
Crucible Extension Ring
Crucible Adaptor Ring

8. SAFESTART CAP Instructions

8.1 Product

This instruction refers to the SAFESTART CAP used in the Standard (Tin) Single Use Crucible and the ENVIROCRUCIBLE.

Figure 1 – Standard (Tin) Crucible

Figure 2 - ENVIROCRUCIBLE

8.2 Preparation:

Prepare crucible before pre-heating operation. Pour THERMIT portion into crucible and place cap (lid) on crucible.

8.3 Welding:

1. Upon completion of pre-heating operations and placement of pouring plug, position crucible in-between tabs on top of mould protectors.
2. Direct pre-heat flame 100-150mm above the Starter Mix at the centre of the SAFESTART CAP, (Figure 3). Ignition should take place in 1 to 2 seconds, (Figure 4).
3. Once the Starter Mix has ignited, the welder is to move out of the three metre exclusion zone. The THERMIT portion will ignite in 4 to 6 seconds, (Figure 5).

Figure 3 - Ignite Starter Mix

Figure 4 - Ignition of Starter Mix

Figure 5 - Ignition of THERMIT portion