TD08.6-16 **EXOTHERMIC CODE OF PRACTICE**

APPROVALS

	Name	Title	Signature	Date
Prepared by:	Malebo Tema	Quality Manager/Metallurgical		
Approved by:	Zachariah Khumalo	Production/Technical Manager		

Revision History

Revision #	Date	Short Description of change
4		**Section 1.16.1.4-** the welder can monitor the temperature and may increase the pre-heating time to reach a minimum 950°C inside the moulds.
5	11.08.2020	Template Changed to Goldschmidt Smart Rail Solutions
6	02.12.2021	Chemical analysis table was edited to include Z90 on the rail grade and Section 1.27.2.1 on the SKV M gap was changed from 30-35mm to 35-40mm

SAFETY FIRST

When **THERMIT** welds are carried out, the safety regulations of the relevant authorities **MUST** be observed.

Special attention must be paid to the following:

1. Igniters are pyrotechnics that initiate the alumina-thermic reaction. Igniters must always be stored separately from Thermit portions and never be kept in pockets of clothes. (Safety).
   MSDS attached as reference.
2. Protect welding portions, crucibles and moulds against moisture. Never let reacting welding portions or hot reaction products come into contact with water. Never use water for fire extinguishing purposes; if needed, cover with dry sand.
3. Observe safety-distances during the **THERMIT** reaction. Personnel must always adhere to the correct PPE i.e.

   - Safety-clothing and shoes to be worn during welding procedure
   - Safety goggles must be worn during welding and grinding work. Never use grinding equipment without safety guards. Protect surrounds from grinding sparks.
4. Hot slag pans must always be deposited in a safe position on dry and not flammable ground.
5. Make sure that the gas equipment is free from leaks and that the coupling nut at the burner is efficiently tightened. Before the burner is lit, first open the gas valve and then the oxygen valve. In case of flame flash-back which is noted by the shrill hissing sound, quickly close the gas valve and then the oxygen valve.
6. Before commencing any welding or grinding work, ensure that the correct firefighting equipment is in place and the site prepared to prevent a fire.

EXOTHERMIC WELDING OF RAILS

1.1 GENERAL

1.1.1 Personnel who have been trained and passed the test for Exo-thermic welding on the Transnet Railway Network may only undertake exothermic welding or any other network.

1.1.2 Welders may only be trained by an accredited institute. N.B The welder's certificate is valid for 2 years and must do a refresher course every 2 years.

1.1.3 Track welders must also be re-evaluated regularly by means of radiography and physical methods.

1.1.4 The equipment used for exothermic welding must be kept in a good condition and must be checked by Supervisors on a monthly basis. Make use of the Track Welding Equipment Checklist for this purpose (See Annexure "O").

1.1.5 All exothermic welding kits must be stored in a dry store and protected against moisture. Storing of Exothermic welding consumables must comply with the manufacturer's specifications and use according to manufacturing dates. A policy of first-in-first-out must be applied when issuing thermit-kits.

1.1.6 Castings of exothermic welds are not permissible in rainy condition.

1.1.7 A disc-cutter must be used to cut the prescribed welding-gap. The minimum distance from rail ends to the edge of nearest boltholes must be 25mm.

1.1.8 If for any reason, a Thermit weld was rejected, the weld must be removed completely, and must be replaced with a suitable closure rail of 4.2m.

1.1.9 Two rail-temperature readings must be taken:

- Place thermometer 2m from the rail end, after the rail end has been cut,
- **First temperature reading:** Before the rail ends are aligned
  Second temperature reading: After excess metal has been sheared.
- These readings must be recorded together with the joint data on the exothermic data field sheet
- Use two thermometers to verify the rail temperature. One from welding and track staff.

1.1.10 All joints inside turnouts, except for insulating joints and hinge joints, must be welded exothermic at rail temperatures higher than 5 degree Celsius. When the turnout is to be welded exothermically to the running line, specified temperature ranges is to be applied.

1.1.11 Rail joints, which are more than 20 m inside a tunnel, may be welded exothermically where the rail temperature is above 5 degree Celsius.

1.1.12 Fish plate joints on Mono- block crossings may not be exothermically welded. The crossing and rail ends must fit tightly to prevent any battering.

1.1.13 **Time required to exothermic weld rail ends:**

- A minimum time period of 45 minutes must be allocated to the Welder to perform exothermic welding,
- Namely:
  - Alignment of rail ends.
  - Mounting of Thermit welding equipment and consumables.
  - Casting of exothermic process.
  - Shearing and rough grinding of weld.

NB: Above-mentioned time does not include the preparation of the track, final grinding and cleaning of the weld.

1.1.14 All new exothermic welds that are subjected to an axle load of 26 tonnes and higher must be clamped by means of joggled plates, until joints are radiographic or ultrasonically tested and found to be defect free, joggled plates may then be remove.

1.1.15 Products and consumables used are compatible with the following rail profiles:

- UIC 60/60 E1
- S60
- SAR 57
- SAR 48
- SAR 40
- SAR 30
- Rail steel chemistries and metallurgies of Head Hardened, UIC grade 1100 (Chrome Manganese), UIC grade 900A and UIC grade 700.

1.1.16 Products and consumables are compatible to requirements of rail inclinations of 1:20 relative to the sleeper, track super-elevations of up to 100mm on track gauge of 1065mm, gradients of up to 1:30 and track radii as sharp as 90 metres or combinations of such instances.

1.2 INSPECTION AND DECISION MAKING

1.2.1 The Maintenance manager will determine workload and priorities. This will correspond with the Production manager's arrangement of work to be done.

1.2.2 The type of rail can be identified by the roll marks.

1.2.3 All dipped joints must be "cropped" and moved up before any exothermic casting can be performed.

NB: Casting of Exothermic welds where battered-end has been repaired by means of arc-welding are not prohibited

1.2.4 A minimum of 2m distance must be maintained between a flash-butt and an exothermic weld.

1.2.5 Permanent closure rail with a minimum length of 4,2m, without boltholes, must match existing track rail profile.

1.2.6 Measured rail height at the rail ends, by means of an outside calliper and steel ruler, a maximum and minimum height will determine which type of mould to be used. See clause 1.9

1.2.7 Composite Exothermic kits must be used to weld two rails of different profiles, and the rail height on these rails must not exceed 3mm in accordance with clause 1.28.2.2.

1.3 PROTECTION OF TRAINS AND SAFEGUARDING OF PERSONNEL

Refer to chapter 2 of the Track Welding Manual.

1.4 SAFE WORKING PROCEDURES

Refer to chapter 2 of the Track Welding Manual.

1.5 PREPARATION

1.5.1 PREPARATION BY TRACK PERSONNEL

1.5.1.1 Preparation work as described in the Manual for Track Maintenance (200) must be done before the welding process commences. This includes replacing of ballast, Sleepers, applying and fitted jumper cables before and removing of fishplates.

1.5.1.2 Insert of closure rail and insulating joints:

- The internal stresses in the rail have an influence on the rail gaps that have been cut in advance. Therefore, do not cut rail-welding gaps simultaneously at both ends of closure and insulating joints.
- Rail gaps must be marked off with a sharp Boilermakers chalk, because yellow and white crayons markings are not accurate (+/-10mm out of parameter), especially on the SKV-F process where only 2mm range is allowed.
- Cut rail gap as prescribed in table 1 plus 10mm extra, to fit closure rail of insulating joints easily.
- Once the first Thermit weld has been cast the second weld can now been set up.
- This process will eliminate the second rail gap from closing or opening beyond the prescribed Welding gap. This holds true especially in extreme weather conditions.

Table 1: Rail gap sizes

PROCESS	**MAXIMUM/ MINIMUM RAIL GAP**
SKV-F	24 – 26mm
SKV-M	35 – 40 mm
SKV-L	40 – 50 mm
SKV-ELITE	28 – 30 mm

- Temperature ranges as stipulated in Manual for Track Maintenance and Specification for Track Welding Clause 1.1.8 and 1.1.9 must be strictly adhered to at all time.
- These temperature readings must be logged on the exothermic field sheets for audit and inspection purposes.

1.5.1.3 Welded battered rail ends with defects, oval or cracked fish-bolt holes must be cropped and be replaced by a closure rail with a minimum length of 4,2m.

1.5.1.4 Rail ends that were previously cut with gas, must be cropped by at least 150mm using a disc-cutter, if the rail cannot be cropped and move, it must be replaced by a closure rail with a minimum length of 4,2m.

1.5.1.5 Where exothermic welds are cast in existing long-welded rails, 80 sleepers on both sides of the joint must be loosened to de-stress track.

1.5.1.6 Exothermic joints in track must be centred between two sleepers in order to be clamped with G-Clamps and joggle plates if necessary.

1.5.1.7 The track alignment must be brought to prescribed standard for a minimum distance of 5m on both sides of joint. After occupation has been granted and the Welder is ready, fasteners of three sleepers on both sides of weld must be loosened to make setting-up easier.

1.5.2 PREPARATION BY WELDING PERSONNEL

1.5.2.1 Before occupation, the Welder must identify the rail correctly so that he can apply the correct casting process (See clause 1.9.)

1.5.2.2 Clean rails with a steel cup knotted brush, chipping hammer and waste before jumper cables are fitted to ensure that rail ends are free from grease, oil, rust and foreign matter.

1.5.2.3 Fish-bolt holes must preferably be removed. If not possible, a minimum length of 25mm must be maintained from rail end to the edge of first fish bolthole.

1.5.2.4 Deformation of fish-bolt holes must be removed. Test holes with dye penetrant for any cracks. A steel plug that fits tightly must be placed into the first bolthole on either side of the rail ends.

1.5.2.5 After the gap is obtained, grind rail ends clean on each rail ends for 50mm to a shiny metal surface. (The purpose is to remove oxides from the rail surface).

1.5.2.6 Exothermic casting must not be allowed where welding to the rail crown was done previously, e.g. welding repair of battered rail ends, and wheel spin burns.

1.5.2.7 Overlap, which occurs on both sides of the rail crown, must be grinded over a distance of at least 0.5meter on either side of rail ends, to make fitting of moulds and shearing of welds easier. Copper bond residues must be removed by grinding to shiny metal surface.

1.5.2.8 All rails must be cut with a disc-cutting machine. Gas cutting is only permitted at kick-outs. Thereafter, the procedure as described in clause 1.12 must be followed.

1.5.2.9 Chrome-manganese rails must be cut with a disc cutting machine.

1.6 EXOTHERMIC WELDING EQUIPMENT

1.6.1 GENERAL

1.6.1.1 Tools and equipment must comply with loss-control requirements. (See Annexure D)

1.7 CRUCIBLES FOR THERMIT WELDING

1.7.1 USE OF THE LONG-LIFE CRUCIBLE

1.7.1.1 Assembling of long-life crucible:

- Sealing paste must be applied uniformly around the top of crucible rim
- The extension sleeve and crucible are clamped by means of a clamp ring
- After tightening the screw, lightly tapped around circumference of the ring with a hammer, and then retighten
- Smooth off any past, which has squeezed out at joint, inside the crucibles.
- The crucible is designed and manufactured to ensure the elimination of noxious gases and avoid splashing of molten steel and be safe to use.

1.7.1.2 Pre-heating of crucible:

- The crucible must be dried out at 150 degrees Celsius:
  - Before the first use daily.
  - Each time a new crucible is used.
  - When not in use for periods longer than an hour during a working shift.
  - Care must be taken to ensure uniform heat distribution, by rotating the flame inside the crucible.

1.7.1.3 Cleaning crucible after casting:

- After approximately 10 welds, when the volume of the crucible is excessively reduced by the accumulation of slag, all slag must be removed by using the thimble drift, try and break slag in a vertical line down to the thimble hole, this will ease removal of slag.
- Turn the crucible around, remove the residual thimble with thimble drift, and apply light hammer taps.
- Take care not to damage the thimble seat.

- When accumulation of slag in the upper part of crucible has become too thick, remove it carefully with a thimble drift.
- To avoid a run-out, renew the crucible when hot spots are visible on the crucible shell, and when the thickness of the refractory material after the removal of slag is inadequate/cracked.
- It is recommended that the crucible be placed inside a drum with sand to absorb shocks when transported.
- Care must be taken that the liner is not subjected to water. (Example Rain, vehicle-washing etc).

NB: The inside of the crucible lining must not be patched.

1.7.2 SINGLE USE CRUCIBLE (SUC)

1.7.2.1 Singe use crucible

- The base of the SUC incorporates a device for automatic tapping and is completed by a ceramic crucible cap, no additional equipment is necessary.
- It is not necessary to preheat the SUC before use as it is supplied as a hermetically sealed unit
- Do a visual inspection of the SUC prior to use to ensure no cracks or foreign matter lodged inside the crucible.
- Rail cover Plates should be place over the rails on either side of the joint to prevent molten metal and slag droplets from damaging the rails.
- The crucible is filled with the required Thermit portion.
- The exothermic powder (Thermit portion) must be sifted through with fingers when poured into the SUC.
- The SUC cover is then placed on top.
- After preheating the rails, the crucible is located centrally over and close to the upper part of the mould by placing it into the specially designed mould shoes with brackets.
- Ignition of the exothermic portion inside the SUC must be done within 20 to 30seconds after the flame is removed from the mould cavity.
- The ignitor is lit, placed into the powder ± 20 mm deep at an angle of 45 ° after which the cap is immediately replaced.
- 19 to 40 seconds after ignition molten metal will automatically pour onto the pouring plug and flow into the moulds.

- The SUC can be removed immediately.
- Debris can be placed into the tin container for easy removal from site.
- The crucible is designed and manufactured to ensure elimination of noxious gases and avoiding splashing of the liquid steel. The figure below is an illustration of such:

Figure 1: SUC with open lid for elimination of gases.

1.8 COMPOSITION OF AN EXOTHERMIC WELDING PORTION

Table 2: Exothermic welding portions with test results specifications.

Element %	Z80/Z90=R260	Z110=R320Cr	Z120=R350LHT	Working Range
Carbon	**0,4 – 0,75**	**0,5 – 1.00**	**0,5 – 1.00**	**± 0.12**
Manganese	**0,50 – 1,4**	**0,5 – 1,4**	**0,5 – 1,4**	**± 0.20**
Aluminium	**0.02-0,6**	**0.02-0,6**	**0.02-0,6**	**± 0.20**
Vanadium	**0.00-0.25**	**0.00-0.45**	**0.00-0.65**	
Chromium	**Min**	**0.00-0.08**	**0.0-0.80**	**± 0.20**
Hardness (BHN)	**280±20**	**330±20**	**350±20**	
Deflection at destruction(mm)				
48kg/m	**18mm**	**11mm**	**11mm**	
57kg/m	**18mm**	**11mm**	**11mm**	
60kg/m		**11mm**	**11mm**	
60kg/m E60 HT RAILS			**11mm**	
Breaking Load(Tons)				
48kg/m	**60 Tons Min**			
57kg/m	**65 Tons Min**	**SKV ELITE**		
60kg/m	**90 Tons Min**			
60kg/m	**90 Tons Min**			

1.9 TYPES OF EXOTHERMIC WELDING PROCESSES

- SKV-F PROCESS (0-3mm crown wear)

  Obtainable in 22, 30, 40, 48, 57 and 48 to 51kg/m (other sizes are on request)
- SKV-F PROCESS (0-3mm crown wear, 3-piece mould)

  Obtainable in 40, 48 and 57kg/m
- SKV-M PROCESS (0-3mm crown wear, 3-piece mould slab track in tunnels)

  Obtainable in 48, 57, S60, UIC60/60E1
- SKV-L PROCESS (0-3mm crown wear)

  Obtainable in 48, 57, S60, UIC60/60E1
- SKS PROCESS (CRANE RAIL)

  Obtainable in 64 and 88 kg/m (other sizes are on request)
- SKV-F PROCESS (COMPOSITE MOULDS)

  Obtainable in 40 to 48, 48 to 51, 48 to 57, 57 to S60 and 57 to UIC60/60E1
- SKV-E ELITE

  E60 ONLY
- SKV-F PROCESS (3-6mm crown wear, Step-Mould)

  Obtainable in 48 and 57kg/m
- SKV-M PROCESS (3-6mm crown wear) (Step-Mould)

  Obtainable in S-60, UIC60 and S-60 incl. to new UIC-60/60E1
- SKV-ELITE PROCESS (0-3mm crown wear)

1.10 HEAD HARDENED RAILS

Exothermic weld procedures for HH rails are the same as for UIC “A” type of rails with the following additional required processes.

Table 3: Head-hardened rails

RAILS	PORTION	COOLING TREATMENT

48kg/m UIC-A -48kg/m HH	Z80	No retarded cooling
48kg/m Cr-Mn – 48kg/m HH	Z110	Retarded cooling***
57kg/m UIC-A – 57kg/m HH	Z80	No retarded cooling
57kg/m UIC-A- 60kg/m Cr-Mn	Z80	Retarded Cooling***
57kg/m Cr-Mn – 57kg/m HH	Z110	Retarded cooling***
60kg/m Cr-Mn – 60kg/m HH	Z110	Retarded cooling***
UIC60 M HH – HH	Z120	No retarded cooling
UIC 60 L HH – HH	Z120	No retarded cooling
48 SKV-F HH – HH	Z120	No retarded cooling
48/51 SKV-F HH – HH	Z120	No retarded cooling
48 SKV-M HH – HH	Z120	No retarded cooling
48 SKV-L HH – HH	Z120	No retarded cooling
57 SKV-F HH – HH	Z120	No retarded cooling
57 SKV-M HH – HH	Z120	No retarded cooling
57 SKV-L HH – HH	Z120	No retarded cooling
60UIC M HT - HT	Z120	No retarded cooling

Note: *** Retarded cooling to be applied on the Cr-Mn rail side only.

1.11 COLOUR CODING OF PRODUCTS TO EASE IDENTIFICATION

1.11.1 GRADE 900 (UIC "A") Z80 CLEAR BAG FOR PORTION (F/L)

- 30kg/m SKV-F Brown Sticker
- 40kg/m SKV-F Purple Sticker
- 48kg/m SKV-F Blue Sticker
- 57kg/m SKV-F Red Sticker
- **48kg/m SKV-L 2x Blue Sticker**
- **57kg/m SKV-L 2x Red Sticker**

1.11.2 Grade 1100 (Cr-Mn) Z110 CLEAR BAG FOR PORTION (F/M/L)

- 48kg/m SKV-F Blue Yellow Sticker
- 57kg/m SKV-F Red Yellow Sticker
- 48kg/m SKV-M Blue Yellow Sticker M mark on sticker
- 57kg/m SKV-M Red Yellow Sticker M mark on sticker
- **48kg/m SKV-L 2x Blue 1x Yellow Sticker**
- **57kg/m SKV-L 2x Red 1x Yellow Sticker**
- **60kg/m SKV-M Green Yellow Sticker**
- **60kg/m SKV-L 2x Green 1x Yellow Sticker**

1.11.3 GRADE 1200 (HH) Z120 RED BAG FOR PORTION (F/M)

- 48kg/m SKV-F White Sticker
- 57kg/m SKV-F White Sticker
- **48kg/m SKV-L** White Sticker
- **57kg/m SKV-L** White Sticker
- **60kg/m SKV-M** White Sticker
- 48/51 SKV-F White Sticker
- **60kg/m Elite** White Sticker

NB: Red markings on box.

1.11.4 COMPOSITE WHITE BAG (F)

- 40/48kg/m SKV-F Purple Blue Sticker

- 48/57kg/m SKV-F Red Blue Sticker
- 57/60kg/m SKV-F Red Green Sticker
- 48/51kg/m SKV-F White Sticker

NB: Sticker is smaller.

Packing – A maximum number of five (5) Thermit kits may be stacked one upon the other without causing damage. The mass of the contents varies and is clearly indicated on the exterior sides of the Thermit kit box.

1.12 THE EXOTHERMIC WELDING PROCESS

1.12.1 PREPARATION OF THE JOINT

1.12.1.1 Mark off the required gap on rail by using a disc-cutting machine's distance gauge to determine the position of clamp for cutting.

1.12.1.2 Rail ends with boltholes, cut off an even quantity of metal from both sides, to make sure that the joint is centrally between the boltholes.

1.12.1.3 The effect of contraction and expansion must be taken into consideration during cutting of the gap width. This will lead to a big or small cast gap that can cause defects in exothermic welds **e.g. shrinkage cavity and lack of fusion.**

1.13 ALIGNMENT OF RAIL ENDS TO CAST EXOTHERMIC WELD

1.13.1 Use rail aligner or steel wedges to lift the rail ends after the HDPE pads have been removed.

NB: Due to the fact that rail joints at turn-outs sets are difficult to align, it is recommended that special care be taken while aligning rails to the turnout sets.

1.13.2 Use a 1-m straightedge and two 1mm shims for the SKV-F/SKV-Elite process and two 2mm shims for the SKV-M/L processes, to set up the rail ends to required height. Place the straightedge over the gap, with shims exactly the same distance from the ends of straightedge. Lift the rails by means of wedges or rail aligner, until rail ends at the gap just touches the edge of straightedge.

1.13.3 Place the straightedge centrally against the running edge of the crown rail to ensure that the two rails are aligned at the crown and rail flange.

NB: After the rail ends have been aligned, Rechecked rail crown and flange alignment to ensure it is correct.

1.13.4 The Welder must check the first weld cast every day after final grinding to ensure correct alignment. If alignment height is inadequate adjust shims underneath 1m straight edge to rectify.

1.14 MOUNTING AND SEALING OF MOULDS

1.14.1 The universal-mounting clamp must be positioned on the rail with universal gap gauge before being clamped.

1.14.2 The burner holder must be place on the universal-mounting clamp, centrally over the gap and set to the correct height of 35mm above the rail crown. The burner holder and burner are then removed as a unit.

1.14.3 Moulds are manufactured as per rail profile or profiles in the case of stepped moulds for worn rail profiles. Moulds have the ability to withstand temperatures reaching over 2000°C. Moulds must be

cleaned and examined for defects. Each half-mould is fitted against the side of rail, moulds may be rubbed gently against the side of the rail, if they do not fit correctly.

1.14.4 Moulds are strengthened by metal supports (mould shoes). The first half-mould and shoe must be placed centrally and vertically over the gap. The swing arm of the universal-mounting clamp must be placed in such a manner that the securing screw is in the centre of the mould shoe and the second half-mould and shoe positioned exactly in line with the other half-mould, which is already in position. Insert the cardboard card between the gap of the rail crown and the moulds, to prevent sealing sand from entering the gap. The clamping screws must be finger- tight, to prevent damage to the mould. Make sure that the pouring basin fits snugly into the moulds, especially where worn to new rails are welded.

1.14.5 Use the mould vertical alignment gauge to ensure that moulds are fitted vertically over the joint.

1.14.6 Pre-mixed luting-sand is used to seal the moulds. It comes ready for use; no water must be added to the Premix Luting-sand. The luting sand is sealed separately in a hermetically sealed container inside the Thermit kit. The sand must be kept in the original packaging at all times and opened for immediate use. The sealing sand does not allow any moisture into the weld and does not allow any deleterious metallurgies to form inside or on the surface of the weld.

1.14.7 Moulds must be properly sealed and compacted with a rammer, ensuring that no knocking takes place against the mould shoes and mould. If this does happen, the whole mould and mould shoe could move. This might lead to misalignment of the joint.

1.14.8 Sealing must be flush with the mould shoes. Luting-sand must be placed on the thread of the clamp to protect it from splatter. After sealing, the remaining sand must be removed and not used for the next exothermic joint.

1.14.9 The slag tray holders must be fitted to the mould-shoes and the slag trays placed on top of the slag tray holder.

1.14.10 Cover plates must be placed over the rails on both sides of the joint to prevent splatter damaging rails.

1.15 SETTING UP AND LOADING OF CRUCIBLE

1.15.1 The tripod and crucible must be placed on the universal-mounting clamp away from the mould assembly. The crucible must be swung over the centre of the pouring plug and must be adjusted to 35mm above the mould.

1.15.2 The crucible must, after the correct casting position has been obtained by adjustments, be swung away from the mould assembly to be loaded.

1.15.3 The exothermic composition includes an automatic thimble. The thimble must be placed firmly into the crucible outlet with the thimble applicator. Spread the sealing slag evenly around the thimble and remove the thimble applicator carefully. No slag must remain inside the aluminium tube, as this will delay tapping time or cause solidification.

1.15.4 The exothermic portion during the loading of the crucible must be mixed thoroughly by shaking the bag up and down so that the composition of the portion be properly distributed. The portion must then be sifted through the fingers during loading of a crucible and care taken that no portion particles falls into the moulds. The portion must be formed like a pyramid in the crucible, as this will aid the combustion process.

1.16 PREHATING (Annexure E Table 4)

1.16.1 GAS PREHEATING

1.16.1.1 Preheating of the joint is necessary to remove the moisture in the moulds and sealing sand as well as to heat the rail ends to ±950 degree Celsius which will ensure good fusion of the rail ends and molten metal.

1.16.1.2 The following gas pressures and preheating times are applicable to all 60 SKV-M and 60 SKV-L processes:

- Oxygen gas pressure - 200kPa
- Propane gas pressure - 60kPa
- Preheating time - 6 minutes
- Make use of an exothermic welding flow gauge meter to obtain the correct gas pressure. This meter must be mounted to the universal welding handle (Order No. 321-514, Harris)

1.16.1.3 Gas pressures and preheating times are applicable to all other processes as used on all other General Freight and Metro rail lines:

- Oxygen gas pressure - 200kPa
- Propane gas pressure - 60kPa
- Preheating time:
  - SKV-F/SKV-Elite - 6 minutes
  - SKV-M & SKV-L - 6 minutes
- Make use of an exothermic welding flow gauge meter to obtain the correct gas pressure. This meter must be mounted to the universal welding handle (Order No. 321-514, Harris)

1.16.1.4 Preheating time must always be monitored by a stopwatch. The welder must also monitor the temperature using the gun temperature gauge and may increase pre-heating time to obtain a minimum temperature of 950°C inside the moulds. (Please note that Weather conditions does influence the pre-heating temperature)

1.16.1.5 A carburising flame must be used in the preheating process. (This can be obtained by opening the LP-gas valve completely and adjusting the oxygen valve to get the correct flame). The correct flame

must stand out about 500mm above the riser apertures and must have an excess of LP-gas. Under no circumstances must an oxidising flame be used, as this will oxidise the rail ends and glaze the moulds, resulting in gas vapours being trapped into the moulds, leading to gas voids in the weld.

1.16.1.6 The flame must be kept long enough underneath the two slag trays to ensure that they are dry.

1.16.1.7 The pre-heating burner and burner holder must then be placed on to the clamp. Make sure the burner head is in the correct position above the gap (vertical and central)

1.16.1.8 When one of the oxygen/LP-gas cylinders becomes empty while preheating, the whole process must be stopped and the empty cylinder replaced. If the moulds haven't cracked, the whole preheating process must be repeated. If cracking of the moulds has occurred, they must be replaced.

1.16.1.9 When the preheating time has expired, burner must be removed and pouring plug positioned into the moulds. The crucible must then be placed in correct position centrally over pouring plug.

1.16.1.10 Gas pressures, type of flame and preheating times are very important to ensure a good quality joint.

1.17 PETROL/AIR PREHEATING OPERATING INSTRUCTIONS (Annexure F Table 5)

1.17.1 Operate as specified and instructed in the Manufactures Manual regarding safe working procedure. See Table 5.

- Preheating time SKV-F = 7 minutes and SKV-M/L = 8 minutes, time observed with a stopwatch

PETROL/AIR PREHEATING SYSTEM

Once the process has started, the preheating of the rail ends during the exothermic welding Welding process should never be interrupted. Should this occur, it is possible that the moulds will develop cracks with subsequent run-out. On the resumption of the pre- heating operation, the rail

end temperatures will be difficult to establish due to the time sequence delay. If any time interruption occurs, the process must be stopped and new moulds applied to the rail/gap area.

- Ensure that the petrol engine has sufficient fuel for the duration of the preheating operation. Check level of fuel tank (1) by removing petrol cap (2) (for number reference see attached photo/drawing of Thermax Model P4)

- Check that there is sufficient fuel in preheating unit's Petrol Tank (8) by unscrewing petrol cap (7). Do not fill beyond the bottom of the filler pipe within the tank. The tank capacity when full holds 12 litres.
- Connect the 5-merte burner hose (27) to the preheating unit at the hose connection at the end of Non-return Valve (18)
- Attach Combustion Burner (38) to burner holder (37) and position onto universal mounting clamp (36). Position Burner Assembly on rail head and adjust burner height to approximately 65 mm from the top of the rail. Lock wing nut to secure burner to burner holder. When mould are attached to the rail position burner centrally in the mould gap area.

THE PREHATING OPERATION CAN NOW COMMENCE

Start Engine (26). Move accelerating throttle to increase revolutions until a pressure of 35 kPa is attained on Pressure Gauge (6). Unscrew Pressure Relief Valve (5) from its housing,
Until air escapes. Re-screw Pressure Relief Valve (5) into housing, just until no more air escapes. Tighten locking screw on Pressure Relief Valve. This serves as a safety precaution if the Burner Hose should become crimped. Air will then flow out, via the Pressure Relief Valve.

Open Petrol Ball Valve (9b).
Open Cadac gas cylinder, light Blow Torch (39) and warm combustion chamber of Pre-heating Burner (38), for approximately 10 seconds.

Carefully open Petrol Needle Valve (9a) and at the same time position ignited Blow Torch (39) at Burner.

Adjust Petrol Needle Valve (9a) until good combustion is achieved. The flame colour should be orange in appearance. If the flame is blue-orange in colour, reduce petrol in the air stream by slightly closing the Petrol Needle Valve. If the Burner does not ignite, then there is insufficient petrol in the air stream. The performance of the burner is at its optimum when a regular purring noise is achieved. At this point the height of the flames escaping from the riser apertures in the mould should be between 200 – 350 mm in height.

The Burner Flame will become erratic in operation should any foreign particle be trapped in the Petrol Needle Valve. If this should occur, close Petrol needle Valve (9a) and remove Burner from Moulds. Open Petrol needle Valve (9a) quickly and away from any naked flame and then close immediately. The preheating operation can then be resumed and timed as from the beginning.

If fluctuations in the flame operation still persist, the Fuel Filter Cartridge (10) situated in the main fuel line between petrol tank (8) and Needle Valve (9a) should be removed and cleaned.

The Petrol/Air Combustion Burner needs back pressure to burn and will not ignite outside the mould gap cavity.

Should the Pressure Gauge (6) indicate a drop-in pressure during the preheating operation, open the small pressure relief valve on top of the pressure gauge, to relieve any build-up of pressure within the pressure gauge itself.

PREHEATING TIME

When using the 35-mm gap SKV-M exothermic welding process the duration of the preheating time for UIC 60 and S60 rails must be 6 minutes. Preheating time is commenced after the burner flame is stabilised and burning correctly.

The duration of the Preheating time for rail 40 to 48kg/m rails should be 6 minutes, regardless of gap size. Preheating time is commenced after the Burner Flame is stabilised and burning correctly.

The fuel consumption required for this preheating time is approximately 1,5 litres of petrol.

COMPLETION OF PPREHEATING

When the preheating operation has been completed, immediately close Petrol Ball Valve (9b), reduce engine speed and then switch engine off with Engine Stop Switch (3)

1.18 CASTING PROCESS

1.18.1 After the preheating time has expired, the moulds and sealing sand will be dried out and rail ends heated to ±950 degree Celsius.

1.18.2 The igniter must be lit, placed 20mm deep at an angle of 45degree in the exothermic portion and the lid be replaced. At ±19 to 35 seconds after ignition, the molten metal will automatically flow onto the pouring plug and into the mould. Pre-determine times must be followed for different sizes of gaps after casting when slag trays, crucible tripod, swinging arms, mould shoes and clamp must be removed.

1.18.3 The rail flange and rib solidify first. Crown will solidify last because of thicker metal; solidification takes place from the outside to the inside of the weld. All impurities will be trapped on top of the excess metal and riser-gate stubs, because these places solidify last.

1.19 SHEARING OF THE EXOTHERMIC WELD (Annexure E + F)

1.19.1 Remove all loose sand from the rail crown before shearing of the welded joint.

1.19.2 Care must be taken not to disturb the remaining of the moulds. Damaged moulds will lead to quick cooling, which result in a defect in the exothermic weld. (E.g. Shrinkage Cavity).

1.19.3 Excess metal must be sheared away using an approved double-bladed hydraulic shearing machine.

1.19.4 After shearing the exothermic weld, the following must be observed:

- Where Cast metal did not bond/tear on excess metal, shearing was done while metal had not solidified fully.
- Allow extra time before shearing the next weld, this will enable hot metal to solidify. Especially in various weather conditions and different shearing machines models used.

1.19.5 Bend risers downward by means of two Tommy bars. Do not hit it with a hammer.

1.20 FINAL FINISHING

1.20.1 ROUGH GRINDING

1.20.1.1 At least 1mm-layer of cast metal must remain on crown after rough grinding the weld, to allow for contraction during cooling. This will ensure that the weld is not hollow after cooling.

1.20.1.2 Only after the weld has been rough grinded and cooled down to 300 degree Celsius, a train may be allowed to pass over it at a maximum speed of 30km/h, provided that steel support plates (150mm x 150mm) of suitable thickness have been place between rail and sleepers.

1.20.1.3 As soon as the train has passed, and the rail temperature still exceeds 200 degree Celsius, the sleepers must be loosened.

1.20.1.4 After the weld has cooled down to ambient temperature, the steel support plates and wedges must be removed. The HDPE pads must be replaced and all the sleepers fastened and tamped.

1.20.1.5 The start and end temperature, as well as the portion number must be written with a chalk on rib at the filed side of the rail for each weld.

1.21 RECTIFICATION

1.21.1 The weld must be rejected when it has cooled down to the ambient temperature and the alignment at the top of the rail is more that 2mm low or 1mm high if tested with a 1-m straight –edge. A maximum of 1mm may be grind off from the rail crown.

1.22 FINAL GRINDING

1.22.1 The joint must be grind so that the top part and the running side of the crown are within the specified tolerances and that the profile of the rail is maintained.

1.23 MARKING OF EXOTHERMIC JOINTS

1.23.1 The following details must be stamped with stencils of 6mm on field side of rail crown at the weld area:

- An example of a welder's code is SD210904, and has the following meaning:
  - Company name, e.g. C = Company, C = Contractor, etc.
  - The Depot will allocate the code letter of the Track welder (E.g. D)
  - The day, month and last two digits of the year. (DDMMYY)
  - Joint number e.g. Start with number 1, 2, etc, at the start of book year 1 of April.

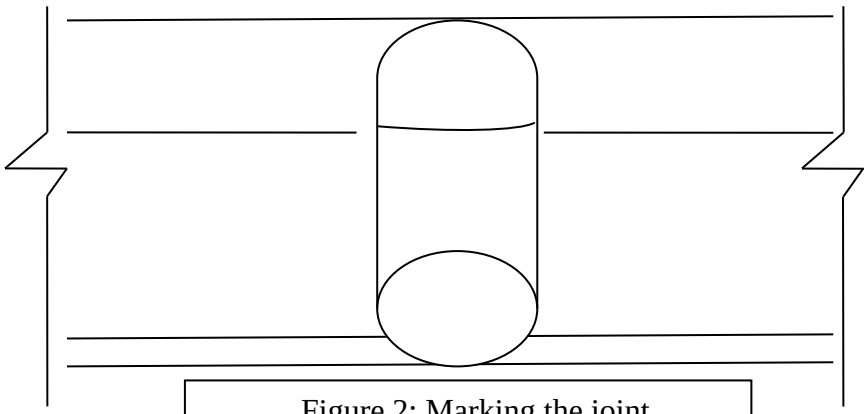


Figure 2: Marking the joint.

1.23.2 Welds must also be numbered for control purposes. These numbers must start at one at the beginning of every financial year. The Regional Engineer must determine how the numbers for his district must be allocated. The Welder must allocate a number to every joint and this number must then be

written against the rail rib and stamped on the joint for record purposes. Use Exothermic Welding Field sheet (Annexure N), for inspections and record purposes.

1.24 INSPECTION OF EXOTHERMIC WELD AFTER FINAL GRINDING.

1.24.1 General Testing

- All welded joints shall be checked for surface or internal weld defects by visual inspection and non-destructive inspection and the results recorded.
- All welds will be Ultrasonic tested & X – Rayed. (Refer Procedures CON026P Ultrasonic Testing & CON058P Radiographic X Ray Test)
- All Radiographic X Rays will undergo evaluation by an independent competent authority for compliance
- All welds will be signed off, PASS or FAIL, by the Engineering Manager once all tests has been completed & results evaluated. (Form QC041F)
- All welds & records will be inspected by Quality Control to ensure compliance to this procedure.

1.24.2 Hardness Testing

- Testing according EN specification – EN 14730-1: 2017 (I) – Refer to page 34

1.24.3 Slow Bend Testing

- Testing according EN specification – EN 14730-1: 2017 (E) – Refer to page 28

1.25 STANDARDS AND TOLERANCES

1.25.1 All exothermic welds must be final ground and cleaned within 24 hours after joint has been cast.

1.25.2 All loose mould material must be removed with a suitable blunt tool from the weld collar as soon as possible after the weld has cooled down to ambient temperature.

1.25.3 The joint must be sound, without cracks, slag, sand inclusions, under-cuts and porosity, as well as foreign matter. A mirror must be used for inspection purposes, especially underneath the foot.

1.25.4 Weld collar alignment must be as follows:

- **VERTICAL ALIGNMENT**

  The alignment of collar, measured from the edge of foot to the bottom of railhead on both sides of weld must be within 2mm of vertical.

- **SQUARE ALIGNMENT JOINT TO RAIL:**

  The squareness of the weld is checked by measuring the alignment of the weld collar on the underside of foot. The edge of weld collar on one side of foot must be less than 3mm out of alignment of opposite foot edge.

- **MOULD/JOINT MISALIGNMENT:**

  The two mould halves must be aligned within 3mm of each other at the joint on underside of rail foot.

1.25.5 A filler gauge of 0,2mm must not enter anywhere between the running surface of the rail and a 1-m straightedge, which is placed centrally over the joint. Only a gradual curvature from the ends to the centre of the straightedge is allowed.

1.25.6 A filler gauge of 0,3mm must not enter anywhere between the running side of the rail and a 1-m straightedge, which has been placed centrally over the joint. (The field side must be ground within the permissible tolerances in case the rails have to be turned around at some later stage.)

1.26 EXOTHERMIC PROCESSES WITH UNIQUE STANDARDS AND PARAMETERS

1.26.1 Summary of exothermic welding parameters preheating with Oxy/LP gas Table 4 and Petrol Preheating Table 5

1.27 EXOTHERMIC WELDING OF RAILS: 24 to 26mm GAS (SKV-F) and 28 to 30mm GAS (SKV- ELITE)

1.27.1 GENERAL

1.27.1.1 Apart from the explanation underneath, the procedure from 1.11 up to and including 11.26 must be strictly followed.

1.27.1.2 Chrome-Manganese rails must be treated as indicated on Table 3.

1.27.2 PREPARATION OF THE JOINT

1.27.2.1 A gap of at least 24-26mm for SKV-F/ 28-30mm SKV-Elite/35-40mm SKV-M and 40-50mm SKV-L is required to ensure adequate fusion between the exothermic metal and rails

1.27.2.2 Check rail ends for cracks by using dye penetrant.

1.27.2.3 The rail ends must be lifted 1mm, as measured at the ends of a 1-m straightedge placed centrally over the joint.

1.27.3 TREATMENT OF THE WELD

1.27.3.1 See Clause 1.26, Table 4 and 5 for parameters.

1.27.3.2 Loose sand on the rail crown must be removed from the crown of the rail.

1.27.3.3 Remove excess metal by means of a hydraulic shearing machine. Bend risers vertically away from weld.

1.27.3.4 For Chrome-Manganese rails the following must be strictly adhered to:

- Immediately after shearing, but not later than 8 minutes after casting, the joint must be covered completely with approved insulating material for 30 minutes.

1.27.3.5 Retarded cooling, see clause 1.10 Table 3, where applicable.

1.27.3.6 After weld has reached ambient temperature, bend risers vertically towards the weld.

1.27.3.7 All loose moulds material must be removed from weld collar. Clean weld by means of chisel, ball peen hammer, wire brush and mirror.

1.28 EXOTHERMIC WELDING OF RAILS: 35 – 40mm GAP (SKV-M) and 40 – 50mm GAP (SKV-L)

1.28.1 GENERAL

1.28.1.1 Apart from the explanation underneath, the procedure from 1.11 up to and including 1.26 must be strictly followed.

1.28.1.2 Chrome- Manganese rails must be treated as indicated on clause 1.10 table 3.

1.28.1.3 The 40-50mm Gap (SKV-L) must be used in cases where an existing exothermic (SKV-F) weld has to be removed, or where rail gaps are bigger as those prescribed for SKV-F weld. (The old weld must be removed completely). Check for cracks by using dye penetrant.

1.28.2 PREPARATION OF THE JOINT

1.28.2.1 A gap of at least 35-40mm for SKV-M or 40-50mm SKV-L is required to ensure adequate fusion between the exothermic metal and rails.

1.28.2.2 The rail ends must be lifted 2mm, as measured at the ends of a 1-m straightedge placed centrally over the joint.

1.28.3 TREATMENT OF THE WELD

1.28.3.1 See Clause 1.26, Table 4 and 5 for parameters.

1.28.3.2 Loose sand on the rail crown must be removed from the crown of the rail.

1.28.3.3 Remove excess metal by means of a hydraulic shearing machine. Bend risers vertically away from weld.

1.28.3.4 For Chrome-Manganese rails, the following must be strictly adhered to:

- Immediately after shearing, but not later than 11 minutes after casting, the joint must be covered completely with approved insulating material for 30 minutes.

1.28.3.5 Retarded cooling, see clause 1.10 Table 3, where applicable.

1.28.3.6 All loose moulds material must be removed from weld collar. Clean weld by means of chisel, ball peen hammer, wire brush and mirror.

1.28.3.7 Remove the risers by bending it in a longitudinal direction of the rail when the joint has reached ambient temperature.

1.29 EXOTHERMIC WELDING OF COMPOSITE JOINTS 24-26mm GAP (SKV-F)

1.29.1 GENERAL

1.29.1.1 Apart from the explanation underneath, the procedure from 1.11 up to and including 1.26 must be strictly followed.

1.29.1.2 Chrome-Manganese rails must be treated as indicated on clause 1.10 table 3.

1.29.1.3 Different profiles 40kg/m to 48kg/m rails, 48kg/m to 57kg/m rails, or 57kg/m to 60kg/m rails are welded, it is a Junction Joint and uses an exothermic composite mould kit.

1.29.1.4 If a 40kg/m rail has to be welded to a 57kg/m rail, a 48kg/m-closure rail and appropriate composite kits must be used to weld 48kg/m rail.

1.29.1.5 If junction rails are manufactured outside the track, they must be made in left-hand and right-hand sets as required.

1.29.2 PREPARATION OF THE JOINT

1.29.2.1 A gap of at least 24-26mm for SKV-F is required to ensure adequate fusion between the exothermic metal and rails.

1.29.2.2 Check rail ends for cracks by using dye penetrant.

1.29.2.3 The top and running side of the crown must be aligned with the aid of a 1-m straightedge. A deviation in the alignment will however occur at the bases.

1.29.2.4 The rail ends must be lifted 1mm, as measured at the ends of a 1-m straightedge placed centrally over the joint.

1.29.2.5 Where different rail profiles are welded, see table 6 for maximum and minimum heights and measurements outside these parameters, a suitable closure rail must be used.

Table 6: Height differences

Joints profiles	Max height difference	Min height difference
40/48	26	20
48/57	18	12
57/60 (both 165mm)	3	3
57/UIC 60 or S60	10	4

1.29.2.6 Where these tolerances are not met, suitable closure rail must be used.

1.29.3 TREATMENT OF THE WELD

1.29.3.1 See Clause 1.26, Table 4 and 5 for parameters.

1.29.3.2 Loose sand on the rail crown must be removed from the crown of the rail.

1.29.3.3 Remove excess metal by means of a hydraulic shearing machine. Bend risers vertically away from weld.

1.29.3.4 For Chrome-Manganese rails the following must be strictly adhered to:

- Immediately after shearing, but not later than 8 minutes after casting, the joint must be covered completely with approved insulating material for 30 minutes.

1.29.3.5 Retarded cooling, see clause 1.10 Table 3, where applicable.

1.29.3.6 All loose moulds material must be removed from weld collar. Clean weld by means of chisel, ball peen hammer, wire brush and mirror.

1.29.3.7 Remove the risers by bending it in a longitudinal direction of the rail when the joint has reached ambient temperature.

1.30 EXOTHERMIC WELDING OF TURNOUTS SETS 24-26mm GAP (SKV-F) 28-30mm Elite

1.30.1 GENERAL

1.30.1.1 Apart from the explanation underneath, the procedure from 1.11 up to and including 11.26 must be strictly followed.

1.30.1.2 Chrome-Manganese rails must be treated as indicated on clause 1.10 table 3

1.30.1.3 Exothermic composite moulds kits 48kg/m to 51kg/m rails must be used when welding stock and switch rails.

1.30.2 PREPARATION OF THE JOINT

1.30.2.1 A gap of at least 24-26mm for SKV-F/28mm-30mmElite is required to ensure adequate fusion between the exothermic metal and rails.

1.30.2.2 Check rail ends for cracks by using dye penetrant.

1.30.2.3 When vertical and tilted rails at turnout sets are welded together, the crown of rails and flange must align. For this purpose, rail alignment device must be used.

1.30.2.4 Where tilted rails are welded to flat rails at turnout sets, see Track Manual.

1.30.2.5 The rail ends must be lifted 1mm, as measured at the ends of a 1-m straightedge placed centrally over the joint.

1.30.3 TREATMENT OF THE WELD

1.30.3.1 See Clause 1.26, Table 4 and 5 for parameters.

1.30.3.2 Loose sand on the rail crown must be removed from the crown of the rail.

1.30.3.3 Remove excess metal by means of a hydraulic shearing machine. Bend risers vertically away from weld.

1.30.3.4 For Chrome-Manganese rails, the following must be strictly adhered to:

- Immediately after shearing, but not later than 8 minutes after casting, the joint must be covered completely with approved insulating material for 30 minutes.

1.30.3.5 Retarded cooling, see clause 1.10 Table 3, where applicable.

1.30.3.6 All loose moulds material must be removed from weld collar. Clean weld by means of chisel, ball peen hammer, wire brush and mirror.

1.30.3.7 Remove the risers by bending it in a longitudinal direction of the rail when the joint has reached ambient temperature.

1.30.4 GRINDING

1.30.4.1 A MC2 grinding machine and angle grinder must be used where grinding of the running surface and the field side cannot be done with a MP12 grinding machine.

1.31 EXOTHERMIC WELDING ON CONCRETE SLABS

1.31.1 GENERAL

1.31.1.1 Apart for the explanation underneath, the procedure from 1.1 up to and including 1.26 must be strictly followed.

1.31.1.2 Chrome-Manganese rails must be treated as indicated on clause 1.10 table 3.

1.31.1.3 Welding of rails on concrete slabs mainly occurs in tunnels. Special jigs are necessary to lift the rail ±80mm from the concrete slab, to fit exothermic mould kits.

1.31.2 EQUPMENT AND CONSUMABLES

1.31.2.1 The following equipment consisting of 3-piece mould system to be used:

- One pair special mould shoe and one bottom tray.
- One pair special refractory mould and one bottom slab.
- Fifteen special jigs, which have been manufactured from 75mm x 75mm x 8mm angle iron, as well as two round iron bars of 16-mm diameter which are welded to the angle iron and fit into the holes of the “Pandrol” chair.

1.31.3 PREPARATION OF THE JOINT

1.31.3.1 The 15 special jigs are spaced evenly over a distance of 20 m on both sides of the rail ends to lift the track ±80 mm.

1.31.3.2 Fit the bottom tray to base of the rail.

1.31.3.3 Position the two half-moulds over the gap and fix the refractory tile to the bottom of the moulds. Ensure that the tile and the mould joints fit very well before sealing starts.

1.31.3.4 Position the refractory tile and seal the opening between the tile and the bottom tray with sealing sand. The flat side of the refractory tile must under no circumstances be placed against the rail. It will cause contracting cracks and insufficient fusion underneath the base. The collar formation of the bottom slab must face upwards.

1.31.3.5 Position the mould shoes. Make it finger-tight only and seal the openings between the mould shoes and the rail.

1.31.3.6 Ensure that all openings between the mould shoes, refractory tile and rail are properly sealed.

1.31.4 TREATMENT OF THE WELD

1.31.4.1 See Clause 1.26, Table 4 and 5 for parameters.

1.31.4.2 Loose sand on the rail crown must be removed from the crown of the rail.

1.31.4.3 Remove excess metal by means of a hydraulic shearing machine. Bend risers vertically away from weld.

1.31.4.4 For Chrome-Manganese rails the following must be strictly adhered to:

- Immediately after shearing, but not later than 8 minutes after casting, the joint must be covered completely with approved insulating material for 30 minutes.

1.31.4.5 Retarded cooling, see clause 1.10 Table 3, where applicable.

1.31.4.6 All loose moulds material must be remove from weld collar. Clean weld by means of chisel, ball peen hammer, wire brush and mirror.

1.31.4.7 Remove the risers by bending it in a longitudinal direction of the rail when the joint has reached ambient temperature.

1.32 EXOTHERMIC WELDING OF CRANE RAILS WITH 24-26mm GAPS (SKS)

1.32.1 Exothermic kits for crane rails are available on special request from the supplier.

IDENTIFICATION OF RAIL TYPES FOR WELDING PURPOSES								
No.	ROLL MARKS							
	H.C.O.B							
1	◄—<	NOM MASS					19--	SAS
2	◄—<	NOM MASS	~~2 M C C~~			9	19--	SAR

3	◄—	NOM MASS			z	9	19--	SAS
4	◄—	NOM MASS				9	19--	SAR
5	◄—	NOM MASS	~~2 M C C~~		z	9	19--	SAS
6	◄—	NOM MASS	~~2 M C C~~		Z	9	19--	SAS
7	◄—	NOM MASS			Z	9	19--	SAR
8	◄—	NOM MASS			Z	9	19--	SAS
	U I C A							
9	◄—	NOM MASS				9	19--	SAR
10	◄—	NOM MASS			z	9	19--	SAS
	U I C B							
11	◄—	NOM MASS				9	19--	SAR
	U I C C							
12	◄—	NOM MASS	2 M C C			9	19--	SAS
13	◄—	NOM MASS	2 M C C			9	19--	SAR
14	◄—	NOM MASS				9	19--	SAS
	Cr – Mn							
15	◄—	NOM MASS			9	19--	SAR	
16	◄—	NOM MASS		KRUPP		19--	SAR	
	***HEAD HARDENED/ KROON VERHARD**							
17	DO	96	IV	UIC 60				
18	THYSSEN			UIC 60	HH	350		
19	THYSSEN			UIC 60	HHLA	350		
20	HY	96	X	UIC 60				
21	HY	96	X	UIC 60				
22	UIC 60	LDVT	IIIIIIIIII					
23	UIC 60	LD	NKK	THH	TH34**			
24	UIC 60	LD	NKK	THH	TH37**			
25	E60	CORUS HT	CO					

Siemens-Martin (basic) process

☐ Electric process

☐ Steel refined by Oxygen-bloom process

PARTICULARS FOR THE THERMIT WELDING OF HEAD HARDENED RAILS.

1. A retarded cooling rate, as is necessary when welding Cr/Mn rails to Cr/Mn rails is not allowed to be applied when welding Head Hardened rails to Head Hardened Rails

2. When welding any Head Hardened Rails to worn Cr/Mn rails, 4 – 6 mm stepped composite 35 – 40 mm gap S60 to UIC 60 moulds must be used in conjunction with a Z110 portion. In this instance, the weld and the chrome manganese rail side must be covered by an insulating blanket or an approved muffler box for a distance not less than 200 mm.

3. When welding Head Hardened rail to Head Hardened rail, UIC 60 M moulds must be used in conjunction with a Z120 portion.

4. Flames cutting of Cr/Mn and Head Hardened rails are strictly prohibited.

RECOMMENDED GAS PREHEATING EQUIPMENT

Maximum hose lengths: 15 metres.

Oxygen: Harris 92 – 700 multi stage oxygen regulator (Part No. 232017)
Harris 85 – 10 RH (Ultra high pressure) flash back arrestor.
(Part No. 237087)
Harris 361-1 flashback arrestor for oxygen. (Part No. 237-155)

Propane: Harris 30 – 500 regulator (Part No. 232 361)
Harris 85 – 10 LPG flashback arrestor. (Part No. 237-086)
Harris 361-1 flashback arrestor for LPG. (Part No. 237-154)

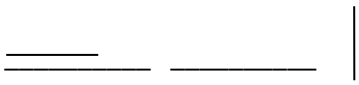
Test Gauge: Exothermic Test Gauge Assembly (Part No. 321 – 514)

PROCESS E: THERMIT WELDING OF HEAD HARDENED RAILS

Section 1-9 and 11 to 15 applies to Head Hardened rails.

Roll marks on Head Hardened rails.

a) Voest Alpine Grade 350 HT
350 HT DO 96 x UIC60



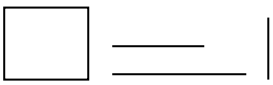
b) NKK Grade 350 LHT
NKK 34 TH

c) NKK Micro-alloy-
NKK 37 ATH

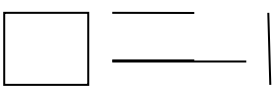
d) Thyssen Grade 350 HT
Thyssen 96 UIC 60 HH 530

e) Thyssen Grade 350 LHT
Thyssen 96 UIC 60 HHLA 350

f) Sogerail Grade 350 LHT
HY 96 x UIC 60



g) Sogerail Micro-alloy
HY 96 x UIC 60



h) Nippon – Micro alloy
NSC or Nippon UIC 60 LDVT
Rollmarks on Chrome- Manganese S60 rails

9 19 – SAR

ANNEXURE

BYLAE B

MINIMUM CUT DISTANCE FROM WELDED JOINTS AND MINIMUM DISTANCE BETWEEN RAILS JOINT		
MINIMUM CUT DISTANCE FROM WELDED JOINTS		IF WELD IS DEFECT CUT RAIL NOT CLOSER THATN 150 mm FROM TEH CENTRE OF AN EXIXTING WELDED JOINT. THE CUT MAY BE MADE THROUGH THE WELD. .

		CUT RAIL NOT CLOSER THAN 35 mm FROM TEH CENTRE OF ANEXISTING FISHPLATE HOLE
MINIMUM DISTANCE BETWEEN RIAL JOINTS		MIN. DISTANCE BETWEEN THERMIT WELD/FISHPLATE JOINT AND THERMIT WELD/FISHPLATE JOINT MUST BE AT LEAST 4.2mm
		MINIMUM DISTANCE BETWEEN THERMIT WELD/FISHPLATE JOINT AND FLASHBUTT WLED MUST BE AT LEAST 2m

ANNEXURE C

EXOTHERMIC CASTING INFO

CLIENT:_____ **CONTACT NO:**_____

Welders Name_____ Code:_____

Joint No.	Km Point	Station/Place	Rail Type	Type (F-M-L/elite	Portion Batch No.	Temp (B A)	Date	Remarks

ANNEXURE D EXOTHERMIC WELDING EQUIPMENTS & TOOLS

Name:
ID Number:
Company:
Date:

Gas Equipment

Cylinder Spindle key	Total Authorized	Available	Condition	Remarks
Oxygen Cylinder	2			
LP Gas Cylinder	1			
Acetylene Cylinder	1			
Oxygen Gauge	1			
LP Gas Gauge	1			
Acetylene Gauge	1			
Oxygen Hose Blue / Black Rubber 15m	15m			
LP Gas Hose Neoprene Orange 15m	15m			
Acetylene Hose Orange rubber 15m	15m			
Flash Back Arrestor Oxy.	1			
Flash Back Arrestor LP Gas / Acet.	1			
Torch flash back arrestor Oxy.	1			
Universal handle	1			
Mixer Lpg / Acet / Oxy	1			
Burner 32 holes 3 rows	1			
Exothermic test gauge	1			
Multi-purpose spanner	1			
Cylinder Spindle key	1			
Flint lighter	1			

Nozzle cleaner	1			

Exothermic Equipment

Type of Equipment	Total Authorized	Available	Condition	Remarks
Universal mounting clamp	1			
Burner Holder screw type	1			
Burner Holder Conventional	1			
Slag Trays	1 Pr.			
Slag tray holder	1 Pr.			
Gap Gauge	1			
Universal Gap Gauge	1 or 28-30mmElite			
Mould Gauge	1			
Set Rammers (Lutting Tool)	2			
Steel wedges large	6			
Steel wedges small	6			
Rail top cover plates	2			
Crucible cover	1			
Crucible clamping ring	1			
Crucible extension sleeve	1			
Crucible tri-pod	1			
Crucible thimble applicator	1			
Thimble drift	1			
Hot set	2			

Mould shoes pair

22 Kg	1			
30 Kg	1			
40 SKV-F	1			

48 SKV-F	1			
57 SKV-F	1			
48/57 SKV-F junction	1			
57/60 SKV-F junction	1			
48 SKV-M	1			
57 and S60 SKV-M	1			
48 SKV-L	1			
57 and S60 SKV-L	1			
40/48 SKV-F junction	1			
60 SKv Elite Single Use Crucible	1			

General Tools

Numeric stencils 6mm	1 Set			
Alphabetical stencils 6mm code	Code letter			
Hammer 1 Kg Ball type	1			
Hammer 2 Kg	1			
Hammer 7 Kg	1			

Tommy bar 1000mm	1			
Pinch Bar (Tommy bar) 1800*25mm	1			
Steel brush	1			
Cols flash chisel 200*19mm	1			
Straight edge 1m	1			
3m Tape	1			
Stop watch	1			
Thermometer	1			
Mirror	1			
Pipe type igniter for P\Air	1			
Burner and pipe complete for P\Air	1			
Shifting spanner 300mm	1			
Pliers fencing	1			
Toolbox steel army type	1			
Jumper cables 2.5m	1			
Funnel	2			

Safety Equipment

	Total Authorized	Available	Condition	Remarks
Safety Goggles	1			
Grinding Goggles	1			
leather gloves - Long Green (Spare)	1			
Overall - 2 piece blue	1			
Safety boots	1			
Leather Aprons	1			
Spats (Pair)	1			
Face shield clear	1			
Reflective Vest	1			
Welders cap	1			

Veld Fire Equipment

Water cans - Clearly marked water	2*20Lt			
Fire Extinguisher - powder	2			
Fire fighters (Beaters)	4			
Venfire forestry knapsack	1			

Machines

Petrol air pre-heating unit	1			
Gensets	1			
Mc 2 Rail Grinder - Electric	1			
Mp 12 rail grinder - electric	1			
Rail sharing machine	1			
Angle grinded - 230mm industrial	1			
Baby grinder - 115mm	1			
Disc cutter	1			
Rail trolleys	1			

Assessor

Name:

Date

Signature

Operator

Name:	
ID Number	
Signature	

ANNEXURE E

PARAMETERS FOR EXOTHERMIC WELDING PROCESSES

PRE-HEATING WITH OCY\LP GAS

Table 4

Description	SKV-F Weld	SKV-F Cr-Mn 48kg\m - and 57kg\m	SKV-M Weld	SKV-L Weld	SKV-M 60 kg\m	SKV-L 60kg\m
Gap	24 - 26mm		35 - 40mm	40 - 50mm	35 - 40mm	40 - 50mm
Burner Type (Burner Head)	32 Holes					
Burner Height	35mm					
Pre-heat time: 48kg\m 57kg\m	6 minutes				6 minutes	
Gas pressures (Flow Pressure) At exothermic test gauge Assembly	200 kPa Oxygen 60 kPa propane				200 kPa Oxygen 60 kPa propane	
Flame Length	500mm					

Remove tri-pod, crucible and slag pans	2 minutes		3 minutes	3 minutes
Remove universal clamp and mould shoes	3 minutes		4 minutes	4 minutes
Shearing after "X" minutes from pour	5 - 6 minutes SKV-F		SKV-M or L 6 - 7 minutes	
Treatment of weld	No retarded cooling	Cera blanket to be on 8 minutes after pour only for Cr-Mn rails	No retarded cooling	Cera blanket to be on 11 minutes after pour only for Cr-Mn rails

NOTE: **For H.H. rail parameters remain the same – except for no retarded cooling**

For composite welds, the rail parameters remain the same for SKV-F

SKV- ELITE 28 – 30 mm GAP

ANNEXURE F

PARAMETERS FOR EXOTHERMIC WELDING PROCESSES

PRE-HEATING WITH PETROL / AIR PRE-HEATING UNIT P4

Table 5

Description	SKV-F Weld	SKV-F Cr-Mn 48kg\m - and 57kg\m	SKV-M Weld	SKV-L Weld	SKV-M 60 kg\m	SKV-L 60kg\m
Gap	24 - 26mm		35 - 40mm	40 - 50mm	35 - 40mm	40 - 50mm
Burner Type (Special Type)	Petrol Air Burner					
Burner Height	65mm					
Pre-heat time: 48kg\m 57kg\m	7 minutes				8 minutes	
Pressure on gauge	Pump Sutobilt: 30kPa Grat Pump: 25kPa				Pump Sutobilt: 30kPa Grat Pump: 25kPa	
Flame Length	500mm					
Remove tri-pod, crucible and slag pans	2 minutes		3 minutes		3 minutes	
Remove universal clamp and mould shoes	3 minutes		4 minutes		4 minutes	

Shearing after "X" minutes from pour	5 - 6 minutes		SKV-M or L 6 - 7 minutes	
Treatment of weld	No retarded cooling	Cera blanket to be on 8 minutes after pour only for Cr-Mn rails	No retarded cooling	Cera blanket to be on 11 minutes after pour only for Cr-Mn rails

NOTE: **For H.H. rail parameters remain the same – except for no retarded cooling**

For composite welds, the rail parameters remain the same for SKV-F

SKV-ELITE - NA