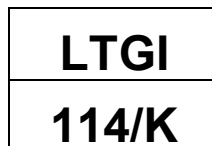


AB LTG Infra

APPROVED by
Head for Technical Maintenance, AB LTG Infra
_____, 2025
Decision No. SPR-L2 (INFRA)_____



RULES FOR THERMITE WELDING OF RAILS AND SWITCH ELEMENTS

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1. GENERAL PROVISIONS

1.1. The purpose of the Rules for Thermal Welding of Rails and Switch Elements (hereinafter – the Rules) is to establish a set of technical and organisational measures for the thermal welding of rails and switch elements on tracks operated by AB LTG Infra (hereinafter – the Company) in accordance with the established technical requirements.

1.2. The Rules have been drawn up in accordance with the normative technical documents which are part of the Company's system of normative technical documents for the Infrastructure subsystem and which set out the requirements for the repair and maintenance of railway track.

1.3. The Rules are intended for all persons carrying out thermite welding of rails and switch elements using the SKV-ELITE standard methods.

1.4. Thermite welding methods not described in these Rules are subject to the approval of the Company in accordance with the procedures laid down in these Rules.

1.5. The Rules constitute a part of the Infrastructure Subsystem of the Company's system of normative technical documents.

2. REFERENCES

The Rules contain references to the current versions of the following legal acts, normative technical and other documents:

2.1. Regulations for the Technical Use of Railways, approved by Order No. 297 of the Minister of Transport and Communications of the Republic of Lithuania of 20 September 1996.

2.2. Railway Traffic Signalling Rules ADV/002, approved by Order No 483 of the Minister of Transport and Communications of the Republic of Lithuania on 30 December 1997.

2.3. Railway Traffic Rules ADV/003, approved by Order No. 452 of the Minister of Transport and Communications of the Republic of Lithuania on 30 December 1999.

2.4. LTGI 71/K Rail Defect Classification, approved by Order No. CS(LGI)-210 of the Director General of 1 June 2021.

2.5. Instructions for the safe operation of rolling stock during works on railway tracks and track structures LTGI 78/K, approved by Decision SPR-L2(INFRA)-300/2024 of the Head for Technical Maintenance of AB LTG Infra of 23 July 2024.

2.6. Requirements for the Condition of the Track, Track Structures and Equipment and Submission of Documents for Acceptance of Repair Works LTGI 138/K, approved by Decision SPR-L2 (INFRA)-135/2024 of the Head for Technical Maintenance of AB LTG Infra dated 4 April 2024.

2.7. Rules for the Maintenance and Repair of the Trackless Road LTGI 145/K, approved by Order PO(LGI)-262 of Head for Technical Maintenance of AB LTG Infra of 19 October 2021.

2.8. Requirements for Inspection of Welded Rail Joints LTGI 219/K, approved by Order JS (LGI)-503 of the Director General of AB LTG Infra of 4 November 2020.

2.9. Railway applications LST EN 14730-1. Railway track. Thermite welding of rails. Part 1. Approval of the welding procedure.

2.10. Railway applications LST EN 14730-2. Railway track. Thermite welding of rails. Part

2. Qualification of thermite welders, approval of contractors, and acceptance of welded joints.

2.11. General rules for the installation of electrical equipment. Approved by Order No. 1-22 of the Minister of Energy of the Republic of Lithuania of 3 February 2012.

2.12. Rules for the Safety of the Operation of Electrical Equipment. Approved by Order No. 1-100 of the Minister of Energy of the Republic of Lithuania of 30 March 2010

2.13. Law of the Republic of Lithuania on the Carriage of Dangerous Goods by Road, Rail and Inland Waterways. Adopted by the Seimas of the Republic of Lithuania on 24 May 2011, No. XI-1401.

2.14. Safety Requirements for Sintered Abrasive Products. LST EN 12413

2.15. Rules for the Maintenance of Switches and Track Crossings LTGI 113/K, approved by Order PO(INFRA)-112/2022 of the Head for Technical Maintenance of AB LTG Infra of 1 April 2022.

2.16. General Fire Safety Rules. Approved by Order No. 64 of 18 February 2005 of the Director of the Fire and Rescue Department under the Ministry of the Interior.

2.17. Railway Transport Code of the Republic of Lithuania. Approved by Law No. IX-2152 of 22 April 2004.

2.18. Rules 27/K for the Use of Rails and Acceptance of New Rails, approved by Order No. J-189 of the Director General of AB Lietuvos geležinkeliai of 4 April 2003.

2.19. Rules for the Maintenance of Fasteners (Rails, Splices and Buttresses) LTGI 364/K, approved by Order No PO(LGI)-271 of the Head for Technical Maintenance of AB LTG Infra of 26 October 2021.

2.20. 335/SS Rules for the Organisation of Infrastructure Maintenance and Repair Works at Railway Stations and Intermediate Stations without Interruption of Railway Traffic, approved by Decision No. SPR-L1(INFRA)-13/2024 of the Director General of AB LTG Infra dated 22 January 2024;

2.21. Technology Card 14/DTK Thermite Welding of Rail Joints approved Decision SPR-L2(INFRA)-460/2024 of the Head of Performance Regulation on 29 October 2024;

2.22. LTGI 6/AE Safety Rules for the Operation of Electrified Overhead Contact Line and Automatic Interlocking Power Supply Equipment, approved by the Head for Technical Maintenance of AB LTG Infra on 8 January 2024, Decision No. SPR-L2(INFRA)-3/2024;

2.23. LTGI 403/K Rules for the Performance of Works for the Installation of Roadway Turnouts LTGI 403/K approved by the Head for Technical Maintenance of AB LTG Infra by Decision No. SPR-L2(INFRA)- 534/2024 dated 6 December 2024.

2.24. Description of Safety and Health Technological Cards 273/SS for Maintenance and Repair of Road, Road Structures, Earth Slipway Maintenance and Repair Works, approved by Order No. J-489 of the Director General of AB Lietuvos geležinkeliai dated 17 May 2013.

3. TERMS AND DEFINITIONS

3.1. Terms used in the Rules:

Term	Definition
Destructive testing	A method of inspection of a thermite seam that changes the chemical, physical and geometric characteristics of the seam. The thermite joints are not fit for further service after destructive inspection
ATS stopper	A special tool to open the crucible after a thermite reaction has taken place
Responsible welder	A responsible welder designated by the head of the structural unit or welding contractor as a welder in charge and authorised to carry out thermite welding on railway tracks operated by the Company
Rail temperature	Rail installation and operating temperature, measured directly on the running surface of the rail head using a special thermometer with a valid metrological calibration
Reusable crucible	The container in which the chemical reaction of the thermite portion takes place. Can be used more than once
Diagnostics	AB LTG Infra Technical Maintenance Diagnostics activities
Riser	The upper portion of molten metal poured into the ceramic mould
Long rail	Rail longer than 120 m in length, manufactured at that length or produced by welding shorter rails together
Rail neutral temperature	The temperature at which the long rail was joined with fishplates or welded to another long rail or rail and fastened to the sleepers
Track MS	Track Maintenance Supervisor or a person responsible for the organisation and supervision of railway track maintenance operations
Runner bar	A portion of solidified metal and slag in the gating channels of ceramic moulds, formed during thermite rail welding
Non-destructive testing	A method of testing a thermite seam after which the chemical, physical and geometrical characteristics of the seam remain unchanged
Optimum temperature	Temperatures within tolerances that ensure the strength of rail joints and rails, the stability of the track, and provide favourable conditions for maintenance and repair work. Optimum temperature in Lithuania: $t_{opt} = (30 \pm 5) ^\circ\text{C}$
Movable end of a long rail	Up to 60 m long end of the long rail, which can move along the road axis as temperatures change
Check	Independent monitoring to assess how the employee's performance meets the requirements of applicable standards, requirements and other normative documents
Surface defect	Any defect visible on the surface of the seam after finishing
Forced rail temperature adjustment	A process in which long rails are stressed using special rail jacks or heated until the calculated length is achieved
Metal flow distributor	A special plug for controlling the flow of molten metal in the mould
Thermite weld collar	A solidified metal part of the thermite weld that connects the ends of welded rails

Welding Contractor	A company ensuring an approved thermite welding procedure in accordance with LST EN 14730-1, which is approved by the railway infrastructure manager to supply welding materials and equipment for thermite welding
Welder	A person holding a valid thermite welder's certificate issued by the manufacturer of thermite welding materials
Thermite welding of rails	Welding method for intermediate casting rails
Thermite matches	Matches used to ignite the thermite portion inside the crucible
Thermite portion	A pre-measured mixture of iron oxide, aluminum powder and other additives, packaged in specified quantities
Fishplating	Strengthening a defective section of a rail using fishplates
Disposable crucible (Euro-type crucible)	The container in which the chemical reaction of the thermite portion takes place. Can be used only once
Public railway infrastructure	Railway infrastructure for meeting the needs of the public and those of economic entities – for the carriage of passengers, baggage and/or freight, and/or for travel to and from sites where construction, repair and/or maintenance works on railway infrastructure facilities are carried out. [2.17]
Public Railway Infrastructure Manager	AB LTG Infra, which is responsible for the maintenance, operation, renewal and development of the public railway infrastructure in accordance with the procedure established by the Railway Transport Code of the Republic of Lithuania. [2.17]

4. GENERAL REQUIREMENTS

4.1. The rail and switch elements (rails to rails, rails to frame rails, crosses, etc.) are connected to each other using fishplates. When the rails are connected in this way, a gap (clearance) is left between them [2.19]. As the wheels roll through this gap, the ends of the rails are subjected to dynamic loads that lead to the development of defects. In order to minimise the occurrence and development of defects resulting from these loads, aluminum thermite rail welding (hereinafter – thermite rail welding) is used.

4.1.1. After thermite rail welding, train traffic in the interstation section (on the line) is permitted at the prescribed speed in accordance with the requirements of [2.5].

4.1.2. Thermite rail welding is carried out in accordance with, and using, the company's equipment, the thermite portion and the refractory welding seam forming materials (Annex No. 1).

4.1.2.1. The ELEKTRO-THERMIT technology is suitable for welding both new and used rails, irrespective of the melting category of steel [2.18].

4.1.3. The methods of thermite rail welding in the infrastructure managed by AB LTG Infra comply with the requirements of references [2.9] and [2.10] and these Rules.

4.1.4. When applying thermite rail welding, it is permitted:

- to weld rails with different vertical wear;
- to repair welds by cutting out the defective weld and re-welding the rails.

4.1.5. For each type of rail, the appropriate ceramic mould and thermite portion are used.

4.1.6. When applying thermite rail welding, within 15 mm on each side from the edge of the rail weld, a reduction in rail head hardness of no more than 20% is permitted.

5. STORAGE, WAREHOUSING AND TRANSPORT OF EQUIPMENT, TOOLS, MATERIALS USED

5.1. Storage requirements

The components for thermite rail welding (thermite portions, thermite matches, ceramic moulds, metal flow distributors, disposable and reusable crucibles) must be stored indoors under appropriate microclimatic conditions at a temperature of not less than plus 5 °C and a humidity of not more than 80 %.

5.1.1. Thermite portions, crucibles, ATS plugs, thermite matches and ceramic moulds must be protected from moisture.

5.1.1.1. Thermite portions and thermite matches must be stored in rooms with non-combustible floors.

5.1.1.2. Thermite portions **must not be** stored with flammable liquids and/or gases.

5.1.1.3. Thermite portions are stored in specialised sealed metal drums at a distance of at least 0.2 m from the support structures of the storage facility.

5.1.1.4. Barrels containing thermite portions **must not be** stacked on top of each other.

5.1.1.5. Thermite portions are packed in airtight, moisture-proof pouches (hereinafter – the packs). Once the packs of thermite portions have been opened, the thermite portions must be used on the same day. The storage of thermite portions in opened packs **is prohibited**.

5.1.1.6. Thermite portions that have been stored without complying with the above conditions, even after drying, are considered as wet and **may not be** used.

5.1.2. Thermite matches are stored in transport boxes.

5.1.2.1. **It is forbidden to** store thermite matches within 2 m of thermite portions.

5.1.3. Ceramic moulds that have been affected by moisture (as shown by the discolouration of the surface of ceramic moulds from red to grey-white) can only be used after additional drying and only on tracks where the rolling stock speed does not exceed 40 km/h.

5.2. Requirements for storage of materials

5.2.1. In warehouses, it is recommended to provide aisles of at least 0.8 m width every 6 m.

5.2.2. The distance between luminaires and sealed metallic structures containing thermite portions must be at least 0.5 m.

5.2.3. The use of gas and electrical appliances and unauthorised electrical installations **is prohibited** in the warehouse.

5.2.4. At the end of the work, the electrical equipment in the warehouse must be de-energised. Automatic fuses to protect electrical circuit against excessive current surge or short circuits must be located on the outside of the storage area on a wall or support and enclosed in a lockable cabinet or recess.

5.2.5. Depending on the area of the warehouse and the quantity of thermite portions to be stored, the necessary quantity of powder extinguishers and dry sand is determined on a case-by-case basis, in accordance with the applicable fire regulations.

5.2.6. Dry sand boxes must be supplied with a shovel.

5.2.7. Temperature and humidity measuring instruments must be metrologically verified in the rooms in which the thermite rail welding components are stored.

5.2.8. Welding components can only be accepted for storage at positive ambient temperatures.

5.2.9. Equipment and tools (except gas cylinders and equipment with internal combustion engines) can be stored in the warehouse together with the welding materials.

5.2.10. Storage conditions for equipment and tools must comply with the manufacturer's requirements.

5.3. Transport requirements

5.3.1. Gas cylinders, welding equipment and other work tools must be transported in a vehicle or container in such a way as to ensure their stability and safety.

5.3.2. Gases are classified as Class 2 dangerous goods. Compressed propane and oxygen gas cylinders must be transported in a truck in accordance with the Law of the Republic of Lithuania on the Carriage of Dangerous Goods by Road, Rail and Inland Waterways [2.13].

5.3.3. The door of a rigid body or container of a vehicle must bear a notice at least 25 mm high: "ATTENTION! NOT VENTILATED. OPEN WITH CAUTION".

5.3.4. Thermite portions must be additionally placed in strong, airtight, moisture-proof transport containers (e.g. airtight drums) during transport.

5.3.5. Thermite matches must be stored in transport boxes during transport.

5.3.6. Gas cylinders, equipment and tools may be transported by all modes of transport, provided that the requirements of these Rules and the Law of the Republic of Lithuania on the Carriage of Dangerous Goods by Road, Rail and Inland Waterways [2.13] are met.

6. PREPARATORY WORKS FOR THERMITE WELDING

6.1. Requirements for tracks and rails

6.1.1. Before thermal rail welding begins, the following must be determined:

6.1.1.1. the length of rail required to properly restore the integrity of the rail seam;

6.1.1.2. the suitability group of the rail to be used on the track and to be welded, in accordance with the requirements of reference [2.18] (the suitability groups of the rails must be the same).

6.1.2. When it is necessary to thermite weld rails with a height difference of more than 3 mm (e.g. UIC60 and R65), special transition ceramic moulds are used (see p. 6.2.2).

6.1.3. The difference in lateral wear on the working edge of the rails to be welded and the rails in service may not exceed 1 mm.

6.1.4. The length of thermally welded rails when laying new long rails must be:

6.1.4.1. On category I tracks, at least 10.0 m;

6.1.4.2. On category II tracks, at least 6.0 m;

6.1.4.3. On other tracks, at least 3.0 m.

6.1.5. For thermite-welded renewal of an in-service jointless track with rails of type UIC60 (60E1) and heavier, the distance between two joints of thermite-welded or thermite-electro-contact-welded rails must be:

6.1.5.1. On category I tracks, at least 6.0 m;

6.1.5.2. On category II tracks, at least 3.0 m;

6.1.5.3. On other tracks, at least 1.5 m.

6.1.6. For thermite-welded renewal of an in-service jointless track with rails of type R50 and lighter, the distance between two joints of thermite-welded or thermite-welded and electro-contact-welded rails shall be:

6.1.6.1. On category I tracks, at least 10.0 m;

6.1.6.2. On category II tracks, at least 6.0 m;

6.1.6.3. On other tracks, at least 3.0 m.

6.1.7. **It is forbidden to** carry out thermite welding works when:

6.1.7.1. rail ends are damaged (crumpling, metal spalling, internal defects);

6.1.7.2. holes are drilled in the rails in non-standard shapes for bolts;

6.1.7.3. the distance from the end of the rail to the edge of the nearest hole is less than 38 mm on all categories of tracks, R50 and lighter types.

6.1.7.4. the distance from the end of the rail to the edge of the nearest hole is less than 60 mm on all categories of tracks, UIC60 (60E1) and heavier types.

6.1.8. For thermite rail welding of type R50 and lighter, if the distance between the edge of the first hole and the rail flange is between 38 mm and 80 mm, the speed of train traffic is limited to 25 km/h.

6.1.9. For thermite welding of UIC60 (60E1) and heavier rails, if the distance between the edge of the first hole and the rail flange is between 60 mm and 80 mm, the speed of train traffic is limited to 25 km/h.

NOTE: When the distance from the rail flange to the edge of the nearest hole is greater than 80 mm, such rails can be welded on all categories of tracks.

6.2. Preparation of welding tools and materials

6.2.1. The workplace must be protected from precipitation.

6.2.2. Preparation of the required quantity of welding tools and materials:

6.2.2.1. thermite portion(s) (selected according to the welding method used);

6.2.2.2. a ceramic mould (consisting of two half-moulds);

6.2.2.3. sealing sand (at least 8 kg);

6.2.2.4. thermite match (the length of the match depends on the height of the crucible used);

6.2.2.5. disposable or reusable crucible (ATS plug for reusable crucible).

6.2.3. The thermite portion is selected according to the specified rail hardness (see Annexes No. 4 and 5).

6.2.4. An example of the labelling of a thermite portion pack is given in Table 1.

Table 1. Labelling of thermite portion packs

Packaging marks	Meaning of the marking
65 120 SKV-ELITE	Track type (R65). Temporary resistance ¹⁾ (1,200 N/mm ²). Welding method. This welding method is applied using a multiple crucible.
60 90 SKV-ELITE E	Track type (UIC60). Temporary resistance ¹⁾ (900 N/mm ²). Welding method. This welding method is carried out using a disposable crucible (Euro-type crucible I).

¹⁾ The property of a metal to resist deformation or breakage (irreversible change of shape) under static or dynamic loading.

6.2.5. The batch number (German: branch) and portion number (German: portion) are indicated on the packaging of each thermite portion. The batch and portion numbers must be entered

on Form K-79 *Thermite Welded Rail Acceptance Certificate* (hereinafter – the Form K-79 Certificate).

This information is recorded in the Form K-79 Certificate (Annex No. 7).

6.2.6. When welding rails of different hardness, the thermite portion(s) is selected according to the thermite portion used for the lower hardness rails (see Annexes No. 4 and 5).

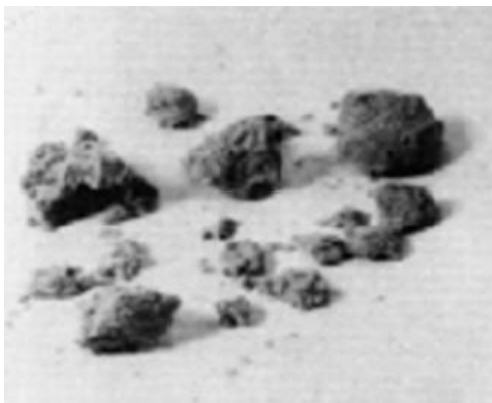
6.2.7. Ceramic moulds are selected according to the welding method, the type of rail to be welded and the size of the gap between the ends of the rail.

6.2.8. Requirements for sealing sand:

6.2.8.1. the sealing sand must be uniformly moist (moisture content of the sand must be between 6% and 8%);

6.2.8.2. the day before use, the dry sealing sand must be moistened with water;

6.2.8.3. before using the sealing sand, the moisture content of the sand must be measured with a metrologically tested instrument and tested for its suitability for use. The test is carried out by dropping a compressed sandball from a height of 1 m. If the sandball has broken up into several large pieces when it falls, the sand is suitable for further use; if it has not broken up, the sand is not be suitable for further use (see Figure 1).



a - at proper moisture content



b - at improper moisture content

Figure 1. Determining the moisture content of the sealing sand

6.2.9. Thermite matches must be selected before welding. Matches are available in two sizes:

6.2.9.1. short – 15 cm;

6.2.9.2. long – 30 cm.

6.2.10. The use of friable and/or wet thermite matches **is prohibited**.

6.2.11. The following types of crucibles can be used for thermite rail welding:

6.2.11.1. disposable crucibles (Euro-type Crucible I, Euro-type Crucible I high-profile crucible, and thermite-filled crucible – Euro-type crucible II filled with a thermite portion) (see Figure 2);

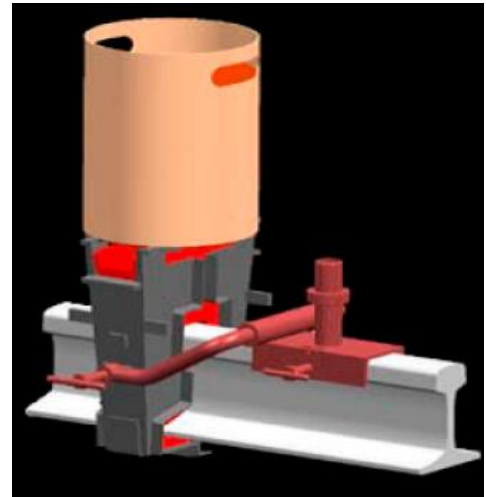
6.2.11.2. reusable crucibles (see Figure 3).



a) (Euro-type Crucible I)
disposable crucible



b) (Euro-type Crucible I)
disposable high-profile
crucible



c) (Euro-type Crucible II)
disposable crucible filled with a thermite
portion

Figure 2. Disposable crucibles



Figure 3. Reusable crucible

6.2.12. The disposable Euro-type Crucible I is used for thermite welding by the SKV-ELITE method.

6.2.12.1. Short and long thermite matches are used to ignite the thermite portion of a disposable Euro-type Crucible I.

6.2.13. The disposable high-profile crucible Euro-type Crucible I is used for thermite welding by the SKV L-50 and/or SKV L-75 methods.

6.2.13.1. Using the disposable high-profile Euro-type Crucible I, long thermite matches are needed.

6.2.14. Thermite portions marked with SkV Elite E are used to fill in all disposable crucibles.

6.2.15. The disposable Euro-type Crucible II with a filled thermite portion is used for thermite welding by the SkV Elite method.

6.2.16. The Euro-type Crucible II with the termite portion inside must be shaken well before use.

6.2.17. Short or long termite matches are used to ignite a disposable Euro-type Crucible II with a termite portion inside.

6.2.18. The reusable crucible is used for termite welding by the SKV Elite method.

6.2.19. The high-profile reusable crucible is used for termite welding by the SKV L-50 and/or SKV L-75 methods.

6.3. Preparation of rail ends for termite welding

6.3.1. On both sides of the weld joint, rail fastening clips are loosened from the sleepers:

6.3.1.1. from at least three sleepers using the SKV Elite and SKV L-50 welding methods;

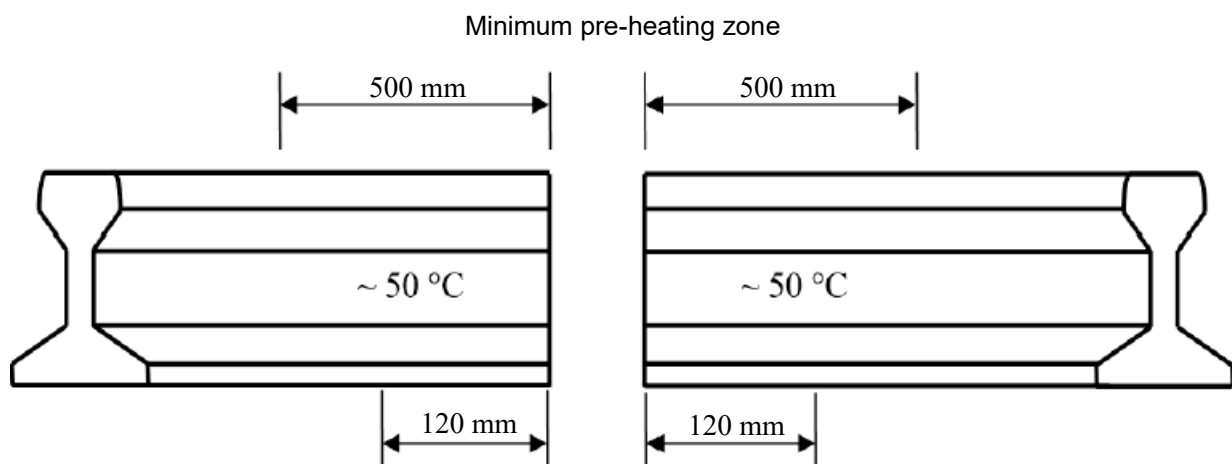
6.3.1.2. from at least four sleepers using the SKV L-75 welding method.

6.3.2. Rubber/plastic elements are removed from the first sleepers to be loosened from both sides of the welded joint to prevent damage (burning) during the pre-heating of the rail ends. Welded connectors are also cut off without damaging the rail, using hand-held cutting/grinding tools.

6.3.3. The pre-heating of the rail ends with a gas burner is carried out as follows:

6.3.3.1. the injection properties of the burner will be checked during the propane injection test;

6.3.3.2. the entire termite rail welding area and a distance of at least 500 mm from the end of the rail end are pre-heated with a gas burner to +50 °C (see Figure 4).



Minimum cleaning distance for markings and impurities

Figure 4. Rail pre-heating zone

6.3.4. After rail end pre-heating, using hand grinding tools, raised rail marking signs (markings) are removed within a 120 mm zone from the rail ends. After removing the markings, it is necessary to clean the 120 mm area from the rail ends of impurities using a metal brush (see Figure 4).

6.4. Rail end gap adjustment

6.4.1. The size of the gap between the rails to be welded will depend on the thermite welding method used. The gap size equivalents for welding methods are given in Table 2.

Table 2. Gap size equivalents for welding methods

Welding method	Gap size between the ends of rails to be welded, mm
SKV ELITE	29 ± 1
SKV L-50	45 ± 5
SKV L-75	70 ± 5

6.4.2. The required gap is obtained by cutting the rail ends mechanically (abrasive disc).

6.4.3. Where the clamping force does not allow the cutting of the rail ends with an abrasive disc, the cutting is carried out with a gaseous detergent in accordance with paragraph 6.4.2.

6.4.4. Requirements for the cutting of rail ends with a gas-powered cutter:

6.4.4.1. the rail ends are cleaned of petroleum products at the cutting point;

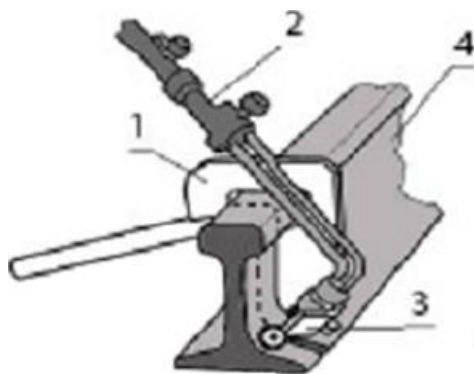
6.4.4.2. wooden sleepers are protected from the effects of flames;

6.4.4.3. a burner conveyor (3) is attached to the gaseous detergent, as shown in Figure 5;

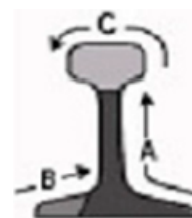
6.4.4.4. a supporting template is fixed to the rail in order to set the required rail end gap;

6.4.4.5. the gas-powered cutter is supported by the supporting template and the rail is cut in the sequence shown in Figure 5;

6.4.4.6. the slag and oxide film are removed with abrasive tools so that the height of the irregularities does not exceed 3 mm.



1 – supporting template; 2 – gas cutter;
3 – specially designed device; 4 – rail



Cutting sequence: A – sole + neck; B – sole on the other side of the rail; C – rail head

Figure 5. Cutting rail ends with a gas cutter

6.4.5. When using standard metal holders for ceramic moulds, the cut line of the rail joint is not less than 80 mm from the side face of the sleeper.

6.5. Rail end alignment

6.5.1. Horizontal and vertical alignment of the rail ends is carried out prior to thermite welding:

6.5.1.1. vertical alignment of the rail ends is done by wedging them between the bottom of the rail sole and the sleeper;

6.5.1.2. lateral horizontal alignment of the rail ends by means of support wedges driven between the edges of the rail sole and the edges of the pad;

6.5.1.3. after rail end alignment, the step between the edges of the rail sole may not exceed 1 mm.

6.5.2. Taking into account the gap widths and the factors given in Table 4, the rail ends are raised to the height specified in Table 3 before thermite welding of the rails.

Table 3. Rail end lifting height in relation to the rail end gap

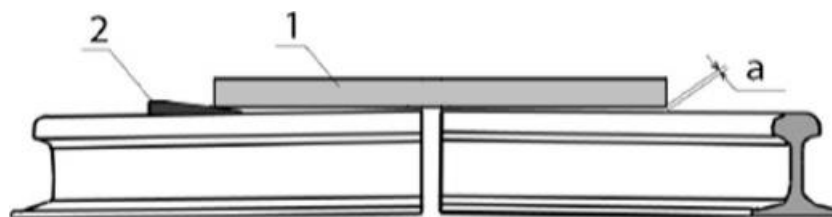
Welding method	Distance between the rail ends to be welded (gap), mm	Rail end lifting height, mm
SKV ELITE	28 to 29	1.2
	29 to 30	1.8
SKV L-50	40 to 45	1.8
	45 to 50	2.2
SKV L-75	65 to 70	2.0
	70 to 75	2.4

Table 4. Rail end lifting height depending on factors

Factors influencing the rail end lifting height	Rail end lifting height depending on the welding method, mm		
	SKV ELITE	SKV L-50	SKV L-75
Intact track (washouts, defective sleepers)	1.8	2.2	2.4
Washed-out track	1.2	1.8	2.0
New rails	1.2	1.8	2.0
Used rails	1.8	2.2	2.4
It is planned to remove the support wedges without waiting for the temperature to drop to 100 °C	1.8	2.2	2.4

NOTE: If the rail end lifting height has different values for different factors, the rail ends are triggered to the higher value.

6.5.3. The rail end alignment and uplift are measured with a 1 m metal straightedge and a 0.5 m measuring wedge on both sides of the joint. The measurement method is shown in Figure 6.



1 – 1 m long metal straightedge; 2 – wedge for measuring the uplift; a – uplift height.

Figure 6. Rail end alignment and lifting

6.6. On-site preparation of welding equipment and ceramic moulds

6.6.1. After aligning and lifting the rail ends, a universal holder is attached to the rail using the SKV ELITE template, as shown in Figure 7.

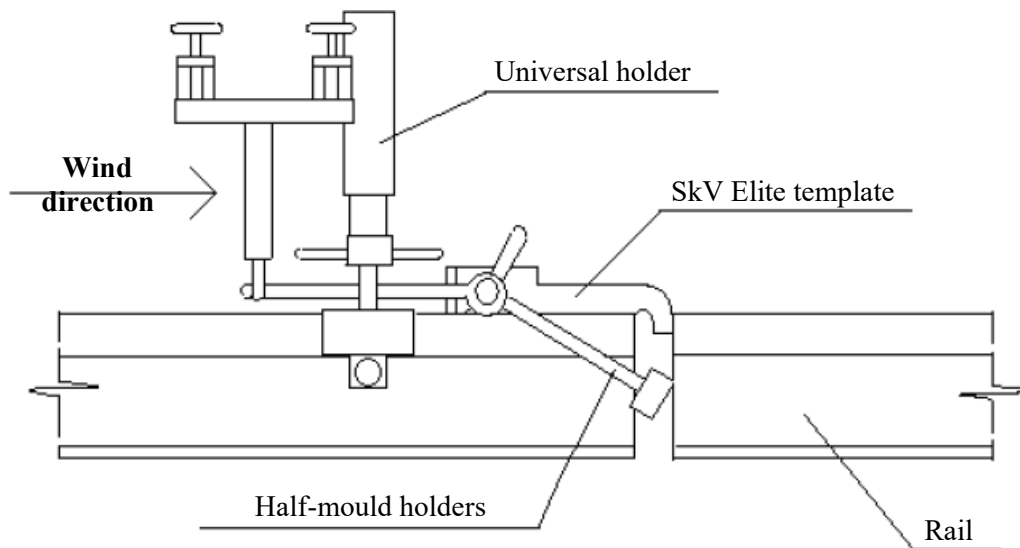


Figure 7. Attaching the universal holder

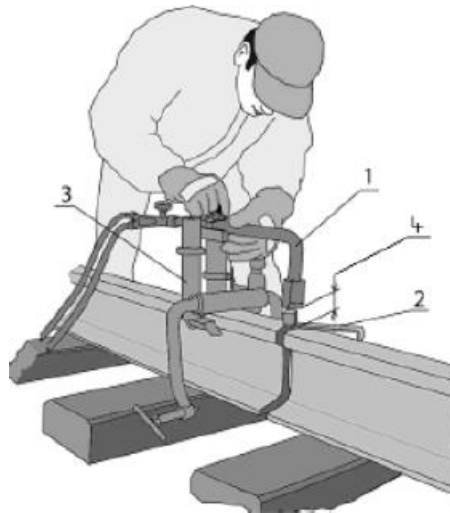
6.6.2. The universal holder is mounted in such a way that the flame from the ceramic moulds is directed in the opposite direction to the wind during the pre-heating of the rail.

6.6.3. Before building the ceramic mould using the SKV ELITE template, it is necessary to adjust the height of the burner above the top of the rail head and to attach the burner to the universal holder. Depending on the welding method, the distance between the lower part of the burner head and the upper part of the rail head is determined in accordance with the requirements given in Table 5 and Annex No. 6.

Table 5. Requirements for adjusting the distance between the burner and the rail

Welding method	Distance between the lower part of the burner head and the upper part of the rail head, mm
SKV ELITE	30 to 35
SKV L-50	30 to 45
SKV L-75	40 to 65

6.6.4. The burner head is positioned over the opening of the ceramic moulds as shown in Figure 8.



1 – pre-heating burner; 2 – SKV ELITE template; 3 – universal holder; 4 – burner distance above the top of the rail head.

Figure 8. Position of the burner above the rail gap

6.6.5. The line of symmetry of the burner head coincides with the axes of symmetry of the rail and the gap.

6.6.6. Once the burner is in the correct position, the ceramic moulds are prepared:

6.6.6.1. the half-moulds are removed from their packaging and inspected to ensure that they are undamaged and/or not wetted. The use of damaged and/or wet half-moulds **is prohibited**;

6.6.6.2. One half-mould is secured with mould holders from the outside of the track so that the centre of the gap coincides with the vertical axis of the ceramic mould (see Figure 9);

6.6.6.3. the gap is covered with a piece of cardboard supplied with the moulds;

6.6.6.4. the other half-mould is placed on the inside of the track. When constructing the second half-mould, it is necessary to make sure that the two half-moulds are in close contact with each other around the perimeter of the joint and do not form a 'step';

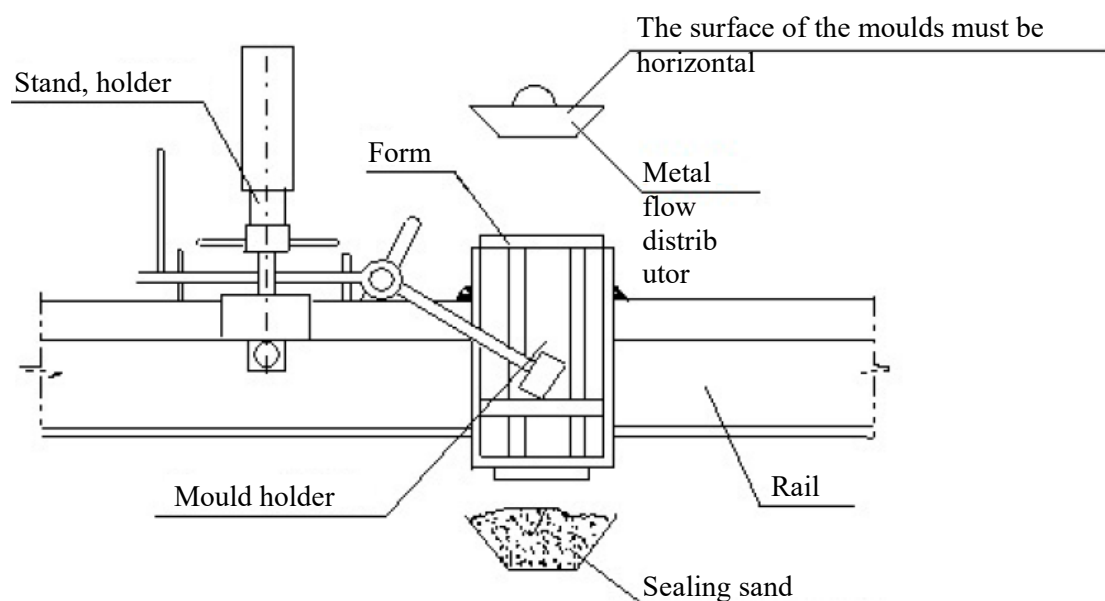


Figure 9. Scheme of the installation and sealing of ceramic moulds at the welding site

6.6.6.5. a file is used to sand off parts of the half-moulds that are in contact with the rail and interfere with the correct positioning of the ceramic moulds. **It is forbidden to** leave a 'step' between the half-moulds and a gap between the ceramic mould and the underside of the rail sole;

NOTE: Often a step is formed when rails of different heights are welded.

6.6.6.6. when thermite welding is applied to the outer rail of a curve in the track, where there is an elevation of the outer rail, the metal flow distributor is ground at an angle to distribute the liquid metal evenly in the ceramic moulds. The metal flow distributor must fit freely in the opening of the ceramic mould;

6.6.6.7. a tin container is placed in the sleeping space;

6.6.6.8. a protective piece of cardboard is placed on top of the opening of the ceramic mould;

6.6.6.9. the gaps between the rails and the ceramic moulds and the metal holders of the ceramic moulds are sealed with sand or sealing paste so that the sealing sand does not get inside the ceramic moulds (if dirt has got inside the ceramic moulds it is necessary to disassemble the ceramic moulds, remove the dirt, and reassemble the ceramic moulds);

NOTE: The sealing paste is only used with specially adapted ceramic moulds.

6.6.6.10. If rails with different wear are welded, gaps may form between the ceramic moulds and the rails (often at the more worn rail); these gaps are sealed with pieces of cardboard to prevent sealing sand from entering the ceramic moulds. The inserted pieces of cardboard must not protrude beyond the ceramic moulds;

6.6.6.11. monitor the metal outlets of all types of crucibles, which must be located above the centre of the metal flow distributor;

6.6.6.12. the rail head is covered with a special protective sheet;

6.6.6.13. special baths are fitted to collect the slag.

6.6.7. Before thermite welding of rails with a reusable crucible, or when the time between welds exceeds 1 h, the inside of the reusable crucible is heated with a low flame until the temperature of the shell of the reusable crucible reaches 100 °C.

6.6.8. When welding with a reusable crucible, a new ATS plug is used each time. The insertion of the ATS plug into the interior of the reusable crucible is done with the piston of the ATS plug (see Figure 10). The ATS plug must be inserted tightly into the opening of the crucible stopper.

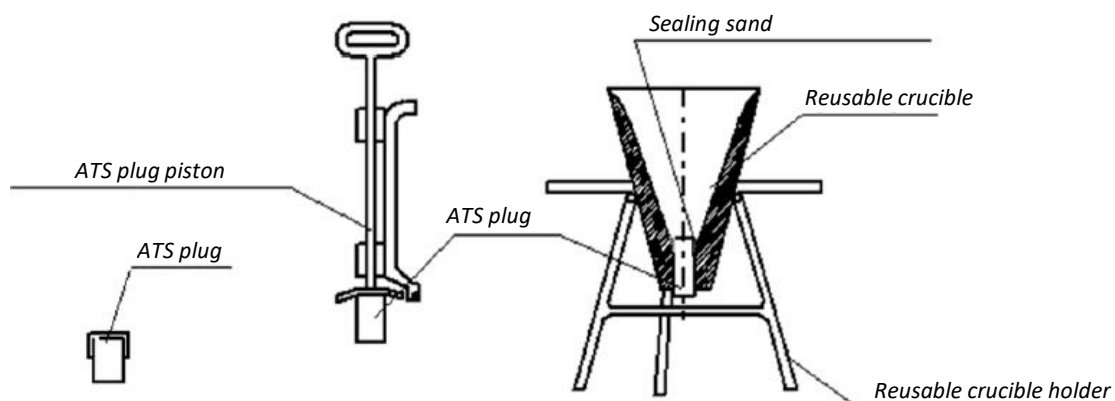


Figure 10. Diagram of ATS plug installation and sealing sand filling

6.6.9. The sealing of the ATS plug with sand is carried out without removing the piston of the ATS plug by evenly pouring the sealing sand around the ATS plug.

6.6.10. After the ATS plug has been completely filled with sealing sand, the piston of the ATS plug is withdrawn.

6.6.11. Sealing sand **must not be allowed** to enter the inside of the ATS plug protection tube.

6.6.12. **It is forbidden** to fill a reusable crucible over the prepared ceramic moulds.

6.6.13. After each welding, the walls of the multiple crucible orifice must be cleaned of slag and ATS plug residues with the crucible opening cleaning tool shown in Figure 11.

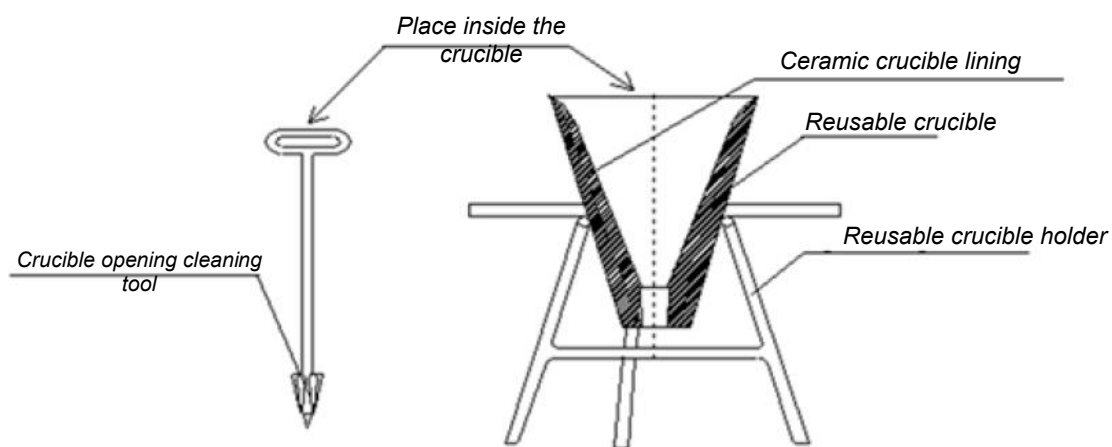


Figure 11. Preparation of a reusable crucible

6.6.14. When the capacity of the reusable crucible is reduced (after approximately 15 welds), the slag layer is removed with wedges without damaging the ceramic inner layer of the reusable crucible.

6.6.14.1. Slag residues that cannot be removed are allowed to remain.

6.6.15. The use of disposable and reusable crucibles that are damaged and/or wet, uncleaned and have sand inside **are prohibited**.

6.6.16. Thermite matches are ignited by the flame of a gas burner.

6.6.17. The burning thermite match is inserted into the thermite portion about 2/3 of the length of the match. **It is forbidden** to throw thermite matches into the thermite portion.

7. THERMITE RAIL WELDING

7.1. General conditions for thermite rail welding works

7.1.1. Thermite rail welding is carried out during a traffic break in accordance with the requirements of references [2.1], [2.2], [2.3], [2.5], [2.21] and [2.22].

7.1.2. Thermite rail welding is carried out at rail temperatures between +5°C and +30°C.

7.1.2.1. Jointless track rehabilitation is allowed for track temperatures between +5°C and -5°C, but it is subject to authorisation by the Company in accordance with the procedures laid down by the Company.

7.1.2.2. When laying new long rails, the requirements of paragraph 7.1.2.1 are not applicable. The requirements of paragraph 7.1.2 must be followed.

7.1.3. For the purpose of ensuring strength and stability of the jointless track, thermally welded rails are fixed in accordance with the requirements of reference [2.7] and Annex No. 8 to these Rules.

7.1.4. During the welding of long rails, the temperature of the rails can drop suddenly due to a change in meteorological conditions (e.g. rain, snow, etc.). For this purpose, compensatory rail heating or stretching using a hydraulic rail stretching device as required in reference [2.7] must be used.

7.1.5. Long rails are welded by thermite only after the track has been laid in plan and profile and stabilized.

7.2. Pre-heating of rails

7.2.1. Before lighting the burner, the valve on the oxygen cylinder is unscrewed to the spring, followed by the valve on the propane gas cylinder after 3 seconds.

7.2.2. A special spark igniter with an extended handle is used to ignite the flame of the burner.

7.2.3. The length of the flame core of the burner should be determined between 15 mm and 20 mm by turning the valve of the propane gas cylinder.

7.2.4. The position of the burner should be adjusted in the middle of the opening of the ceramic moulds using the universal adjustment clips.

7.2.5. The flame height of the burner is checked. The height of the burner flame above the duct opening must be 50 cm as shown in Figure 12.

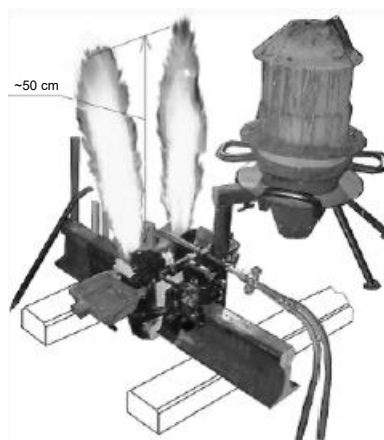


Figure 12. Pre-heating of rails

7.2.6. During the pre-heating of the rails and ceramic moulds (hereinafter – the pre-heating), the gauge readings are monitored and they must be:

7.2.6.1. propane 0 – 1.5 bar;

7.2.6.2. oxygen – 5.0 bar.

7.2.7. When a suitable flame has developed (see p. 7.2.5), the duration of pre-heating is measured using a stopwatch.

NOTE: The stopwatch used must undergo metrological verification.

7.2.8. The requirements for the determination of the pre-heating time are given in Table 6 and Annex No. 6.

Table 6. Setting the pre-heating time

Rail type	Pre-heating time
R50 and lighter type rails	1 min 30 s
UIC60 (60E1) and heavier rail types	2.0 min

NOTE: At ambient temperatures below plus 10 °C, the pre-heating time must be increased by 30 seconds.

7.2.9. When welding different types of rails, the pre-heating time is determined by the heavier rail profile.

7.2.10. During pre-heating, flame penetration between the rail and ceramic moulds must be avoided. If a flame breakthrough is observed, the flame breakthrough is sealed with sealing sand.

7.2.11. After preheating, a ceramic mould plug is inserted into the opening of the ceramic mould.

7.3. Thermite rail welding methods

7.3.1. At the end of thermite welding, a slag layer forms on the liquid metal surface.

7.3.2. After the molten metal has flowed out of the crucible and the time interval specific to the welding method has elapsed, the actions specified in Table 7 and Annex No. 6 are carried out.

Table 7. Determination of the time interval after which the scheduled actions are to be carried out

Actions	Time taken to perform the action, depending on the welding method		
	SKV ELITE	SKV L-50	SKV L-75
Removal of metal holders for ceramic moulds	after 3 min 30 s	after 5 min	after 7 min
Removing the lower part of ceramic moulds	-	-	after 8 min
Removing the top of ceramic moulds	after 4 min 30 s	after 8 min	after 10 min
Cutting off the upper part of the ceramic moulds and the resulting metal using special scissors	after 5 min ¹⁾	after 8-9 min ²⁾	after 11 min ^{2),3)}

1 NOTE: When applying the SKV Elite welding method, where disposable Euro-type Crucibles and a 120 thermite portion are used for the welding of the hardened rails, the start time for the part of ceramic moulds and the resulting metal to be cut off can be increased to 1 min.

2 NOTE: When applying the SKV L-50 and SKV L-75 welding methods, when disposable Euro-type Crucibles and a 120 thermite portion are used for the welding of hardened rails, the start time for the part of ceramic moulds and the resulting metal cut-off can be increased to 30 s.

3 NOTE: When applying the SKV L-75 welding method, the upper part of the ceramic moulds and the resulting metal are cut off with special scissors:

where reusable crucibles are used and an ambient temperature is below plus 15 °C, after 11 minutes for a 65 mm gap and after 11 minutes 30 seconds for a 75 mm gap;

where reusable crucibles are used and an ambient temperature is above plus 15 °C, after 11 minutes 30 seconds for a 65 mm gap and after 12 minutes for a 75 mm gap.

7.4. Preliminary preparation of the welding area

7.4.1. At the end of the time period specified in Table 7, cuts should be made in the ceramic moulds around the circumference of the ceramic moulds using a hand saw.

7.4.2. When hammering, use the side of the blacksmith's chisel to bend the upper part of ceramic moulds to see if the metal has set.

NOTE: If the metal is still liquid, the top of the ceramic moulds must be put back in place.

7.4.3. The time for removing the riser is determined visually. The riser is removed when the white-yellow surface of the metal formed darkens and bubbles appear.

7.4.4. After the removal of the upper part of ceramic moulds, it is necessary to equip the welding site with specialised metal shears U-ML or equivalent in terms of technical characteristics and start the shearing process:

7.4.4.1. cut off the protruding metal parts (flakes) on the rail head using a hydraulic device;

7.4.4.2. remove the riser from the rail head, leaving 2 mm to 3 mm high bumps.

NOTE: In the event of failure of the hydraulic device or in other unforeseen cases, it is allowed to remove metal residues from the rail head using a blacksmith's pick.

7.4.5. With a B-type knife, the upper part of the stagnant metal and the runner bar are cut off and the surface of the rail head must be smooth after cutting (Figure 13).

7.4.6. An A-type knife cuts off the upper part of the stagnant metal and the connection of runner bars to the rail head. While the metal is hot, use a blacksmith's pick to bend the runner bars sideways away from the rail head up to 5 cm (Figure 13).

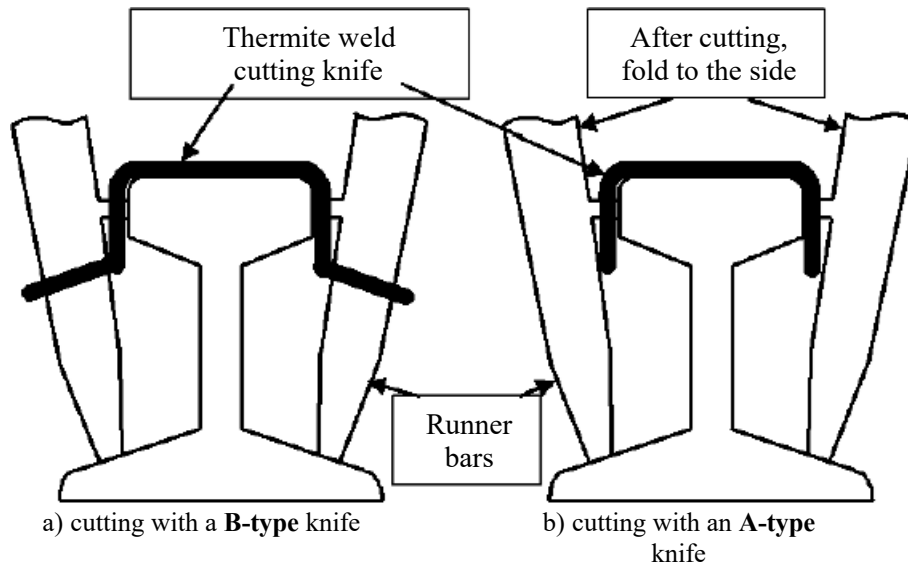


Figure 13. Cutting off the runner bars

7.4.7. After cutting off the runner bars, the welded areas must be roughly polished without touching the main rail metal, leaving a metal layer of 0.5 mm to 1.0 mm on the running surface and 0.1 mm to 0.3 mm on the working and non-working side rail surfaces.

NOTE: After rough grinding and wedging, rolling stock may be allowed to run at speeds up to 15 km/h.

7.5. Final machining of the welding area

7.5.1. When the metal has cooled below 200 °C, use the blunt end of the blacksmith's chisel to carefully remove any sand and metallic residues from the welded area and from under the rail pad. **It is forbidden** to leave residues of sand and ceramic moulds at the welding site.

7.5.2. Once the runner bars have cooled below 100 °C, they must be carefully removed with a blacksmith's pick. After the removal of the runner bars, the weld collar must not have any metal protrusion of more than 0.5 mm that would interfere with the application of the milled fishplates. If necessary, the metal protrusions must be ground to the rail profile.

7.5.3. Welding material residues (sand, ceramic mould residues, etc.) must not be left on or near the track and must be collected and disposed of.

7.5.4. The final treatment of the running surface must be carried out after the rail has cooled below 100 °C. **It is forbidden** to heat the welded areas more than 100 °C with grinding wheels during the final treatment.

7.5.5. In the final grinding of the welded area, **it is forbidden** to remove more than 0.5 mm of metal in a single pass of the grinding machine to prevent overheating, which causes the metal surface to lose its hardening properties. A sign of overheating is a change in the colour of the surface of the metal from grey-white to blue. If signs of overheating appear, grinding is stopped, the metal is allowed to cool for up to 10 minutes and then grinding is resumed.

7.5.6. Once the final treatment of the running surface is complete, the trays, gaskets and other fasteners are put in place. Track alignment is corrected and the ballast prism is restored. After thermite welding, specially prepared edgeless trays are replaced by standard trays.

7.5.7. The final treatment of thermally welded rails must comply with the following requirements:

7.5.7.1. in a one-metre section, the number of depressions and elevation bumps may not exceed:

7.5.7.1.1. on the running surface of the rail head between minus 0.2 mm and plus 0.3 mm;

7.5.7.1.2. on the working side of the rail head, between minus 0.3 mm and 0.0 mm;

7.5.7.2. the height of the roughness of the non-working edge of the rail head should not interfere with the ultrasonic inspection of the rails.

7.5.8. The unevenness of the running surface of the rail head must be smoothed evenly on both sides of the weld with a slope of not more than 0.5 mm over a length of one metre.

NOTE: Irregularities of the rail head running surface are measured with a 1 m metal straightedge and a set of measuring wedges, with an accuracy of 0.1 mm.

7.5.9. After final grinding, but without ultrasonic defectoscope inspection of the welded joint, rolling stock may be allowed to run at speeds not exceeding 25 km/h.

7.5.10. After thermite rail welding and after checking the joint with a defectoscope, it is necessary to compact the ballast in the joint area before the trains are allowed to run at the specified speed. The ballast must be compacted under at least three sleepers on either side of the thermite welded joint.

8. THERMITE WELDING OF SWITCH ELEMENTS

8.1. General requirements

8.1.1. On Category I and II tracks, the junctions between switch elements and adjacent tracks are welded within six months after the switch or switch element has been installed on the track and the volume of freight passing over the switch should not exceed 10 million tonnes (gross).

8.1.2. The welding of track joints of the tracks connecting to the switch is carried out in accordance with the approved jointless track construction design.

8.1.3. The provisions of these Rules apply only to switches constructed in accordance with the requirements of reference [2.10].

8.2. Requirements for the installation of switches

8.2.1. Switch elements must be manufactured without end (first) bolt holes at the rail ends.

8.2.2. Welding of switch elements may only be permitted in switches installed in accordance with the requirements given in references [2.6], [2.15] and [2.23].

8.2.3. The rail joints of switch elements must be welded at the rail temperature (see 8.3.2) at which the stability of the jointless track with the spurs welded into it is guaranteed. The switch may not be located at the moving end of the long rail and switches must be located in the middle part of the jointless track.

8.2.4. Only after the switch has been properly positioned in the plan and profile and the switch has been stabilised, can thermite welding be carried out.

8.3. Welding of switch elements

8.3.1. The sequence of welding rail joints of switch elements and adjacent tracks depends on the type of switch crossing (see Annex No. 10). Thermite welding of switch crossings or crossings not specified in these Rules must be coordinated separately in accordance with the procedures established by the Company.

8.3.2. Individual switches are welded in the following manner:

8.3.2.1. switches with an angle of 1/11 and less (e.g. 1/18) for rail temperatures between plus 5 °C and plus 30 °C;

8.3.2.2. switches with an angle of 1/9 and higher (e.g. 1/6) for rail temperatures between plus 10 °C and plus 28 °C;

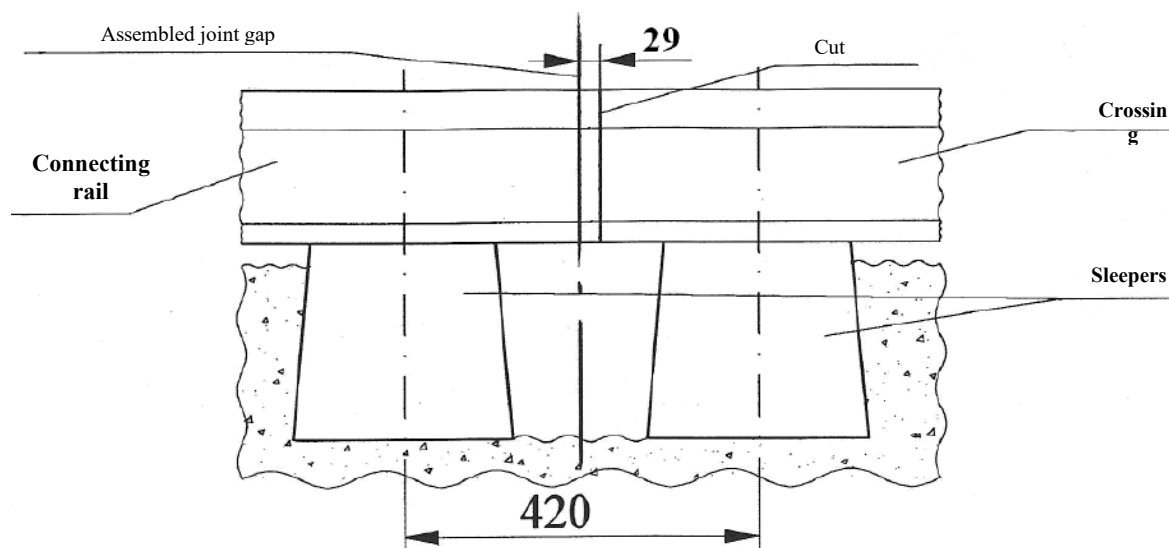
8.3.2.3. grouping of switches is welded at rail temperatures between plus 15 °C and plus 28 °C.

8.3.3. Switch blades are welded only after the switches have been welded into groups or into the jointless track. Switch blades are always welded last.

8.3.4. Before and after welding the switch blade, it is necessary to check the locking of the switch.

8.3.5. Switches with welded switch blades are equipped with anti-creep locks designed to control relative movement between the stock rail and the switch blade.

8.3.6. When thermite welding of switch elements is carried out, it is necessary to make an incision in the course of the element to be installed so that when the defective switch element is replaced by a new one, the used switch element is removed together with the welds (see Figure 14).



420 – size for information

Figure 14. Thermite welding of a switch element**9. PROCEDURE FOR THE ACCEPTANCE OF THERMITE WELDING WORKS**

9.1. The following steps are taken when accepting thermite welds on rails and switch elements:

- 9.1.1. inspection of the welding site;
- 9.1.2. inspection of the weld;
- 9.1.3. checking with measuring tools;
- 9.1.4. ultrasonic defectoscope inspection;
- 9.1.5. recording the results of the inspection on a K-79 form (see Annex No. 7), to be signed on the day the thermite welding of the rails is carried out;
- 9.1.6. marking of the termite joint (see p. 10.5)
- 9.1.7. recording of work results in the K-80 Welders' Work Log Form (hereinafter – the K-80 Form Log) (see Annex No. 9).

9.2. When inspecting the welding site, it must be ensured that the track has been finalised: the rails have been secured to sleepers or sleepers, ceramic moulds, slag and metal residues have been removed for disposal, and the ballast under the sleepers is compacted.

9.3. When inspecting the weld area, it is necessary to make sure that:

- 9.3.1. the surface of the weld collar is thoroughly cleaned of sand and ceramic mould residues;
- 9.3.2. the surface of the weld collar is undamaged by the blacksmith's chisel;
- 9.3.3. quality removal (polishing) of metal protrusions on the runner bars.

9.4. Using a 1 m metal straightedge and a set of measuring wedges, carry out the inspection of the geometric parameters of the weld and verify that the measured irregularities correspond to the actual values and do not exceed the limits specified in p. 7.5.7; the results are to be recorded in the K-79 Form Certificate.

9.5. Nondestructive Testing (NDT) operators perform ultrasonic testing of the welded joint at a thermite joint temperature of plus 50 °C or less. Ultrasonic testing of the welded joint is carried out in accordance with the [2.8] regulations.

9.6. The ultrasonic inspection data are recorded on the K-79 Form Certificate by the NDT operator, who also certifies by his signature that the weld irregularities and internal and surface defects are as measured.

9.7. The details of the welding materials and the welding method are entered and signed by the responsible welder on the K-79 Form Certificate. The responsible thermite welder is responsible for the quality of the thermite welding and grinding performed.

9.8. The track MS will supervise the track after welding and, taking into account the inspection data provided by the NDT operator, will determine the safe speed of trains during thermite welding of the rail and will sign the K-79 Form Certificate. In the case of works carried out by a welding contractor, the person carrying out technical supervision will sign the K-79 Form Certificate.

9.9. In the event of a defect being detected during the inspection, the provisions of [2.4] will apply.

9.10. When a defective thermite-welded joint can be reinforced with fishplates, fishplating is carried out in accordance with the *Thermite Joint Fishplating Procedure* set out in Annex No. 11.

9.11. Work results will be recorded by the responsible thermite welder by in the K-80 Form Log and will be submitted for signature to the track MS and to the NDT operator of AB LTG Infra, who will certify by their signature that the data in the K-80 Form Log correspond to the data in the K-79 Form Certificate. The K-80 Form Log must be kept throughout the lifetime of the thermite junction.

9.12. The K-79 Form Certificate is approved by the head of the structural unit or welding contractor whose employees welded the rails.

9.13. The approved K-79 Form certificates are forwarded to the Company's structural unit where the thermite welding was carried out. The certificate must be kept for the lifetime of the thermite junction.

10. STAFF QUALIFICATION REQUIREMENTS

10.1. The qualifications and competences of welders must comply with the requirements of the [2.10] standard. The welder must hold a qualification certificate issued by the training institution.

10.2. Thermite training for welders shall be provided by the welders' employer. The training must be carried out in accordance with the procedures specified in standard [2.10].

10.3. Welders performing welding on public railway infrastructure or on the Company-operated tracks must have a K-141 Form permit issued by Diagnostics (Annex No. 2), containing the welder's name, code, expiry date, company and other information.

10.4. The K-141 Form permit to perform thermite rail welding shall be issued after the employer of the welder submits a qualification certificate issued by a welding training institution and the welder passes theoretical and practical knowledge assessments

10.5. The K-141 Form permit shall be valid for up to 5 years.

10.6. Controls over the issuance of permits, periodic knowledge testing, qualifications and performance of work shall be carried out in accordance with the procedures laid down by the Company in Form K-141.

10.7. Employees holding a K-141 Form permit for thermite welding shall be recorded on the K-78 Form list (Annex No. 3).

10.8. Thermite welding of rails shall be carried out by at least two welders holding K-141 permits.

10.9. The welding area (thermite joints) shall be marked (e.g. with a non-washable paint or marker that will last for at least 36 months):

- 10.9.1. The marking of the joint shall be carried out at a distance of approximately 20 to 25 cm from the weld collar.
- 10.9.2. The marking shall include the date of welding and the unique welder code.
- 10.9.3. The height of the marking symbols shall not exceed 6 cm.
- 10.10. The welder who carries out the thermite welding work shall provide the welding area (thermite joints) with a location marking (Annex No. 10) so that all welds are traceable.
- 10.11. The welder shall be responsible for the quality of the welding and grinding work and shall draw up a report in Form K-79 as specified in Annex No. 7.
- 10.12. The track MS shall be responsible for the loosening and/or fixing of the rails (long rails) and for the adjustment of the joint gaps in the section where the rail is thermite welded. If the work is carried out by a welding contractor, the contractor's work supervisor shall be responsible for the loosening and/or fixing of the rails (longitudinal rails) and for the adjustment of the gaps in the section where the rails are thermite welded.
- 10.13. Non-destructive testing of thermite welded rails shall be carried out by the Company's structural unit responsible for carrying out the non-destructive testing.
- 10.14. The employee who carried out the non-destructive testing shall sign the K-79 Form Certificate and shall be responsible for the results of the ultrasonic testing of the thermite joint. He must record the code of the welder who carried out the welding in his database.
- 10.15. The Company's representative(s) have the right to carry out unannounced audits, including inspections of welding equipment, materials, welding procedures, and welders' work safety.
- 10.16. In case of non-compliance (violations) with the requirements of welding technology, safety at work and/or these Rules, the Company reserves the right to revoke and cancel the validity of the issued K-141 Form thermite welding permits during the audit (inspection).
- 10.17. Thermite welding of rails **shall not be** performed unless the requirements of these Rules are met or a permit under Form K-141 is issued.

11. SAFETY OF WORKERS

- 11.1. The requirements of references [2.16] and [2.24] shall be strictly complied with for thermite welding of rails.
- 11.2. Before thermite welding of rails, workers must be instructed and familiarised with the instructions for use of the equipment and the safety data sheets for the chemicals.
- 11.3. Welders must use the following personal protective equipment when performing thermite welding of rails: flame-resistant gloves, welder's goggles for gas welding, welder's boots, welder's work clothes, safety hats, and signal vests.
- 11.4. Employees working with grinding equipment must wear the following personal protective equipment: work gloves, work boots, hearing and eye protection, work clothes, and safety helmets.
- 11.5. Employees working with grinding/cutting equipment must observe the direction of sparks and ensure that they do not fall on combustible materials.

11.6. Grinding discs shall comply with the quality and safety requirements in reference [2.14].

11.7. Before starting work, workers must make sure that the cutting and grinding discs are not mechanically damaged and/or cracked. It is **forbidden** to work with cracked or otherwise damaged cutting and grinding discs.

11.8. Work on mobile electrical installations shall be carried out by personnel trained and certified in accordance with references [2.11] and [2.12].

11.9. When carrying out thermite welding, oxygen and propane gas cylinders shall be kept at least 5 m from an open flame. These requirements shall not apply to welding equipment with which thermite welding of rails is being carried out at the time.

11.10. Propane gas cylinders must be protected from direct sunlight (shade, etc.).

11.11. Propane gas cylinders must only be stored in an upright position.

11.12. **It is forbidden to** have more than one oxygen or propane gas cylinder in the workplace. Additional propane gas cylinders can be stored in specially equipped vehicles.

11.13. The oxygen cylinder reducer and valve must be protected from oil and/or grease; reducer gauges must have a valid metrological check.

11.14. Propane gas cylinders must be transported using specially adapted trolleys or stretchers. **It is forbidden** to carry gas cylinders on the shoulders or by hand without a stretcher.

11.15. Before starting welding work, it is necessary to check the suitability and tightness of the oxygen and propane gas equipment, and to check that the torch locknut is securely tightened.

11.16. Before lighting the burner, the valve on the oxygen cylinder is unscrewed first, followed by the valve on the propane gas cylinder.

11.17. When the work is finished, the valve on the propane gas cylinder is closed first, followed by the oxygen cylinder.

11.18. In the event of a flashback, when a whistling sound is heard, the oxygen cylinder valve must be closed immediately, followed by the propane gas cylinder valve.

11.19. Actions which may cause fire and/or explosion **shall not be** carried out during the preparation of rails for welding and during the welding of rails:

11.19.1. pour a portion of thermite into a wet (not dried) crucible;

11.19.2. pour the melted thermite portion into a moist ceramic mould;

11.19.3. place the wet (not dried) metal flow distributor in a ceramic mould;

11.19.4. carry thermite matches in the pockets of your work clothes;

11.19.5. throw hot liquid slag into water, snow or other wet areas after removing it from the casting seam;

11.19.6. place hot slag baths on wet, flammable and unstable surfaces.

11.20. The hydrogen in the thermite portion may increase the intensity of combustion due to the interaction of aluminum with water, and **it is therefore forbidden** to extinguish a burning thermite portion with water foam and carbon dioxide extinguishers, water and water foam mixtures. Fire extinguishing powder and/or dry sand shall be used to extinguish the burning portion of thermite.

11.21. The heat, sparks or flames from the combustion reaction can cause a fire and/or explosion if there are flammable materials around (rubbish, wood, paper, fabrics, plastics, flammable liquids etc.). All combustible materials within a radius of 2 m around the welding area must be removed or covered with a non-combustible material.

11.22. Before igniting a thermite portion, the welder must warn other workers on the work site to keep at least 3 m away from the installed crucible.

11.23. When the welder ignites a thermite portion, a sudden chemical reaction occurs in the crucible and the welder must move as quickly as possible at least 3 m away from the crucible.

12. KNOWLEDGE ASSESSMENT OF THERMITE WELDERS, CONTROL OF WELDING OPERATIONS AND ISSUING OF PERMITS

12.1. Submission of applications

12.1.1. During the welding season, the Diagnostics function shall carry out the thermite inspection and the issuance of K-141 Form permits (Annex No. 2) for welders.

12.1.2. Welders who hold a valid thermite welder certificate and wish to obtain or renew a K-141 Form permit shall submit an application to the Diagnostics function for assessment of thermite welder's knowledge. The application shall include the name and employer of the thermite welder applying for a K-141 Form permit to perform thermite welding of rails on the public railway infrastructure.

12.1.2.1. The application shall be accompanied by the following annexes:

12.1.2.1.1. a copy of a valid thermite welder's certificate issued by the manufacturer of thermite materials and welding equipment;

12.1.2.1.2. a copy of the Certificate of Safe Conduct on Railway Tracks and their Facilities Protection Zones issued in accordance with the Company's procedures;

12.1.2.1.3. a photograph (3 x 4 format) of a thermite welder seeking to obtain and/or renew a K-141 Form permit.

12.1.2.2. The application and its annexes must be submitted by e-mail monitoringas@ltginfra.lt.

12.2. Knowledge assessment

12.2.1. The assessment of thermite welders' compliance shall include theoretical and practical knowledge testing and assessment. The assessment shall be carried out by a representative of the Diagnostics function. Persons attending the knowledge assessment must present proof of identity (driving licence, passport or identity card).

12.2.2. **Theoretical knowledge test** shall be provided in the national language (Lithuanian) in the form of a test.

NOTE: For people who do not speak the national language, a translation service shall be provided by the welding contractor. Translators must be impartial, reliable and independent.

12.2.2.1. The Diagnostics function shall prepare the test material no later than 24 hours before the start of the theoretical knowledge test.

12.2.2.2. The theoretical test shall take 45 minutes to complete. At the end of the allotted time, the theoretical test shall be terminated.

12.2.2.3. An answer to the question shall be considered to be incorrect if the thermite welder has not marked all the correct answers and/or has marked at least one incorrect answer.

12.2.2.4. The test results shall be considered positive if at least 16 correct answers are given within the time allowed for solving the test.

12.2.2.5. The use of literature, mobile phones or other means of receiving and transmitting information, talking to or interfering with other persons shall be prohibited during the knowledge assessment.

NOTE: If, in answering the questions, the thermite welder uses literature, mobile phones or other means of receiving and transmitting information or talks to other persons in a way that disturbs them, the commission appointed by the Company shall terminate the assessment of the theoretical knowledge of the person who has violated the procedure and give a negative evaluation of his/her result.

12.2.2.6. Thermite welders must write neatly and legibly, and must write the final answer only with a dark blue pen, and must not use proofreading tools. If the thermite welder decides that he has marked an answer incorrectly, he shall have the right to cross out the written answer neatly and to write the answer he thinks is correct and to sign next to it.

12.2.2.7. A positive result in the theoretical skills assessment shall be valid until a positive result in the practical skills assessment is received, but not longer than 15 working days.

12.2.2.8. After the theoretical knowledge assessment, the thermite welder can check the mistakes made.

12.2.2.9. Failure to pass the theoretical knowledge test may result in a repeated test of the theoretical knowledge no earlier than 5 working days later.

12.2.2.10. A pass in the theoretical knowledge test shall entitle one to take the practical skills test.

12.2.3. **Assessment of practical welding skills** (hereinafter – the assessment) shall be carried out in the territory of Lithuania, after agreeing on the place of work with the Diagnostics representative performing the knowledge assessment.

12.2.3.1. The welding contractor shall provide the working tools (welding materials, welding equipment, etc.) required for the assessment.

12.2.3.2. The test shall assess the welder's ability to perform thermite welding by a predetermined method in accordance with the requirements of these Rules within a period of time not exceeding 60 minutes.

NOTE: The time allowed for welding may be increased at the discretion of the Diagnostics function employee carrying out the skills test, depending on the welding conditions. At the end of the allotted time, the practical skills assessment shall be terminated.

12.2.3.3. The test shall be graded as pass or fail.

12.2.3.4. Welding actions that are judged to be inadequate shall be divided into critical and non-critical. Each incorrect action shall be treated as one error. The number of errors shall determine the final assessment result.

12.2.3.5. The Diagnostics function representative shall monitor the thermite welder's actions, record the number of errors, make observations, assess practical skills and abilities and record the results of the inspection in the Basic Thermite Welding Technology Parameters Inspection Record (Annex No. 13).

12.2.3.6. The test shall be marked negative and considered failed if more than 5 errors are made.

12.2.3.7. The test shall be terminated and assessed negatively when the welder, during the inspection:

12.2.3.7.1. attempts to influence (by himself or herself or on behalf of another person) the Diagnostics function representative appointed to carry out the assessment for the purpose of improving the result of the assessment;

12.2.3.7.2. receive instructions or advice from third parties;

12.2.3.7.3. perform acts that endanger human health or equipment.

12.2.3.8. The assessment shall be considered positive when the thermite welder has not made the errors in p. 12.2.3.6 and has not carried out the actions specified in p. 12.2.3.7, 12.2.3.8.

NOTE: The assessment shall not be evaluated when it is interrupted earlier than the specified time due to reasons beyond the welder's control (sickness, adverse weather conditions, etc.)

12.2.3.9. At the end of the assessment, the thermite welder may consult the results of the assessment.

12.3. Inspection of the contractor's company

12.3.1. The Company's representative(s) shall lawfully inspect contractors' welding equipment, materials, welding techniques and the safety requirements of welders.

12.3.2. The inspection shall be carried out by a representative(s) appointed by the Company.

12.3.3. The inspection shall be carried out at least once a year.

12.3.4. During the inspection, the following shall be checked:

12.3.4.1. compliance of material storage facilities with the requirements;

12.3.4.2. shelf life of materials;

12.3.4.3. compliance with labelling of premises and materials;

12.3.4.4. presence of tools and the validity of their metrological checks;

12.3.4.5. presence of regulatory documents and compliance with documentation;

12.3.4.6. validity of staff certificates and K-141 Form permits issued.

12.3.5. The inspection shall be followed by a Thermite Welding Inspection Report for the Company (Annex No. 14).

12.3.6. The inspection shall be considered negative when:

- 12.3.6.1. one critical error is made; (0 points)
- 12.3.6.2. two or more non-critical errors are made; (1-2 points)
- 12.3.6.3. more than two comments are given;
- 12.3.6.4. an overall evaluation score is less than 21 (out of 30 points).

12.4. Inspection of the performance of thermite welding works

- 12.4.1. The inspection shall be carried out by an employee(s) of the Company.
- 12.4.2. During the inspection, the following shall be checked:
 - 12.4.2.1. thermite welder's qualifications (validity of the welder's certificate and K-141 Form permit); validity of the thermite welder's certificate and K-141 Form permit;
 - 12.4.2.2. preparation of the welding workplace (preparation of the surface of the rails, proper loosening of sleepers, preparation of materials and equipment);
 - 12.4.2.3. execution of the welding process (compliance with temperature and flame maintenance requirements, cooling times, use of personal protective equipment);
 - 12.4.2.4. post-weld works (removal of excess metal, roughing and finishing of the weld, tidying up the work area);
 - 12.4.2.5. completing documentation (logs and certificates);
 - 12.4.2.6. condition of the weld (visible surface defects, presence of non-fusion or pores).
- 12.4.3. After the inspection of the thermite welder, an inspection report for workers performing thermite welding shall be drawn up (Annex No. 15).
- 12.4.4. The inspection shall be considered negative when:
 - 12.4.4.1. one critical error is made; (0 points)
 - 12.4.4.2. three or more non-critical errors are made; (1-2 points)
 - 12.4.4.3. more than three comments are given;
 - 12.4.4.4. an overall evaluation score is less than 32 (out of 45 points).

12.5. Issuance, revocation and extension of permits

- 12.5.1. Thermite welders who successfully pass the inspection shall be issued a welder's code and a K-141 Form permit by the Diagnostic function representative.
- 12.5.2. The K-141 Form permit shall be issued for a period of 5 years, but no longer than the validity of the thermite welder's certificate issued by the manufacturer of the thermite materials and welding equipment.
- 12.5.3. In the event of a thermite welder changing employers or in the event of the loss of a K-141 Form permit, the Diagnostics function must be notified.
 - 12.5.3.1. Welders who change employers during the term shall be given a new welder's code and a new K-141 Form permit.
 - 12.5.3.2. A new K-141 Form permit shall be issued to a thermite welder who loses his K-141 Form permit.

12.5.4. The Diagnostics function representative may suspend the validity of the K-141

Form permit when:

12.5.4.1. the results of an inspection of the contractor's business are negative

12.5.4.2. during the inspection of the works, serious breaches of the thermite welding technology are found;

12.5.4.3. the requirements of these Rules are not complied with;

12.5.4.4. obsolete and/or inappropriate materials are used for the works;

12.5.4.5. no and/or expired metrological verifications of the equipment.

12.5.5. In the event of a technology violation that results in the revocation of the thermite welder's K-141 Form permit, the K-141 Form permit shall be returned to the Diagnostics function and the thermite welder shall be required to retake the knowledge assessment test.

13.FINAL PROVISIONS

13.1. The owner of the Rules is the Head for Technical Maintenance, Regulation of Operations, and Technology and Parameter Management.

13.2. The requirements of the Rules shall be reviewed every three years and updated as necessary.

13.3. The Rules shall apply to the extent that they do not conflict with the laws of the Republic of Lithuania and/or other applicable legal acts.

LIST OF EQUIPMENT USED FOR THERMITE WELDING

1.1 Table 18. List of equipment required by welders

Item No.	Name	Quantity, pcs.
1. Ordinary tools		
1.1.	flat long chisel	1
1.2.	1.5 kg manual hammer	1
1.3.	universal welder's goggles	2
1.4.	narrow metal brush	1
1.5.	750 mm long crowbar	1
1.6.	oil reservoir	1
1.7.	bucket for sand	1
1.8.	half-round file	1
1.9.	rain tent	1
1.10.	rail head protection long sheet	1
1.11.	rail head protection short sheet	1
1.12.	wrench for 13/17 crucible screws	1
2. Rail joining – smoothing tools		
2.1.	one-metre metal straightedge	1
2.2.	folding ruler	1
2.3.	gas cutting rail template	1
2.4.	support wedges, short	4
2.5.	support wedges, long	8
2.6.	gap measuring wedge	1
2.7.	wedge for measuring bumps	2
2.8.	rail straightening tool set with insulation (1 set, 2 pieces) including spanner No 41	1
3. Welding equipment		
3.1.	clamping mechanism	1
3.2.	burner holder	1
3.3.	crucible holder	1
3.4.	special slag baths	2
3.5.	narrow putty knife	1
3.6.	ATS plug piston	1
If necessary:		
3.8.	thermite portion container	1
3.9.	tamping set for hard joints	1
3.10.	tin container	1
4. Initial pre-heating and gas cutting tools		
4.1.	handle for pre-heating burner/cutting insert	1
4.2.	cutting insert kit with guide trolley, spare heating nozzle and cutting nozzles	1
4.3.	propane reducer	1
4.4.	oxygen reducer	1
4.5.	oxygen/propane hose set 20 m with connection elements	1
4.6.	protective orange bugle for propane reducer	1

Item No.	Name	Quantity, pcs.
4.7.	protective blue bugle for oxygen reducer	1
4.8.	gas lighter	1
4.9.	spanner 30/32	1
4.10.	burner key	1
5. Rail joint machining tools		
Manual joint machining:		
5.1.	hot-work blacksmith's chisel (without handle)	1
5.2.	blacksmith's chisel handle	1
Pneumatic joint processing (pneumatic or electric joint processing tools available):		
5.3.	pneumatic hammer – chisel	1
5.4.	compressed air reducer	1
5.5.	compressed air hose set with connectors, 10 m to 20 m length	1
5.6.	flat pneumatic hammer chisels	1
Power tooling (pneumatic or power tools are available):		
5.7.	mobile electricity station	1
5.8.	fuel container	1
5.9.	electric hammer-chisel 250 V, 1,1 kVA, 3 X 200 Hz	1
5.10.	10 m extension, NSH 4x2.5 mm ² fork HF and connection box HF	1
5.11.	flat electric hammer chisels	2
Machining joints with cut-off tools:		
5.12.	U-ML hydraulic cutting unit	1
5.13.	universal grinding machine	1
6. Measuring instruments		
6.1.	thermometer attached to the rail	1
6.2.	Stopwatch (or other device for measuring the time of track heating)	1
If necessary:		
6.3.	track measurement trolley	1
7. SKV additional devices		
7.1.	SKV Elite template	1
7.2.	slag baths	2
7.3.	pair of Form Stability Sheets for floating joints, R65, UIC60, R50	1
7.4.	preheating burner insert No 55.502	1
If necessary:		
7.5.	a couple of shapes, stability sheets for solid joints (R65, UIC60, R50)	1
	Alternative:	
7.6.	permanent crucible and sealing paste	1
7.7.	crucible sleeve 2920	1
7.8.	clamping ring 29	1

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Item No.	Name	Quantity, pcs.
7.9.	crucible shell ET1 with tensioning screws	1
7.10.	crucible washer with a ring welded to the nozzle of the crucible	1
7.11.	spare tensioning screws for M10 crucible	6
7.12.	crucible cover ET1	1
8. SKV or SkV L-75 additional tools		
8.1.	SKV appliance set without form-holding metal sheets, or SKV L-75 (without slag collection vessels)	1
8.2.	extension tube for clamping mechanism	1
8.3.	slag collection vessels SKV L-75	2
8.4.	mould stability sheets L-65	1
8.5.	crucible tip 2930	1
If necessary:		
8.6.	a pair of moulds supporting the metal sheet support joints, with the profile type corresponding to the SKV L-50 or SKV L-75 device	1
8.7.	bottom metal sheet for support joints (SKV L-50 and SKV L-75)	1

LTGI K/114 Rules for Thermite Welding
of Rails and Switch Elements
Annex No. 2 (p. 10.3, p. 10.4, p.
10.5, p. 10.6, p. 10.7, p. 10.16, p.
10.17)

**PERMIT TO CARRY OUT THERMITE WELDING OF RAILS ON PUBLIC RAILWAY
INFRASTRUCTURE OR ON COMPANY-OPERATED TRACKS**

AB LTG INFRA		Form K-141
PERMIT FOR THERMITE RAIL WELDING NO. _____		
Photo	_____	
	(Welder's first name and surname, code)	
	Workplace	
	Certificate No.	
Thermite rail welding on the Public Railway Infrastructure or on the tracks operated by the Company by the welding method is hereby authorised		
Rail cutting methods		
(First name and surname of the person issuing the permit, signature)		
Period of validity of the permit		

Back side of Form K-141	
ATTENTION!	
<ul style="list-style-type: none"> - This permit shall not entitle the holder to carry out thermite welding works not covered by the permit on the Public Railway Infrastructure - or on the tracks operated by the Company. - In the event of a violation of the thermite welding technology, the permit shall be suspended immediately and the permit shall be returned to the Company. - This permit is the property of AB LTG Infra, so if you find it, please notify the Company's representative or deliver it to the nearest structural unit. 	






LIST OF WELDERS QUALIFIED TO CARRY OUT THERMITE WELDING

Form K-78

LIST OF PERSONNEL AUTHORISED TO CARRY OUT THERMITE WELDING			I HEREBY APPROVE		
			_____ (first name and surname, position)		_____ (signature, date)
Item No.	Name (code) of the structural unit or company	Thermite welder's		To a thermite welder	
		first name and surname	certificate validity period (until)	welding permitted (until)	code assigned (letters)
1	2	3	4	5	6
Prepared by _____ (first name and surname, position) (signature, date)					

TYPES OF RAILS USED ON AB LTG INFRA TRACKS AND THEIR WEIGHT

4.1 Table 18. Rail ballast according to LST EN 13674

Rail steel grade	Bitterness interval, HBW	Temporary resistance, N/mm ²	Heat treatment	Rail marking (marking)	Marking of the thermite portion used
R260	260 to 300	880 to 1030 (<i>treated as 900</i>)	not available		Z90 Alternative: Z100 on special order
R260Mn	260 to 300	880 to 1030 (<i>treated as 900</i>)	not available		Z90
R350HT	350 to 390	880 to 1180 (<i>treated as 1200</i>)	Hardened head		Z110 Alternative Z90 HC with post-weld heat treatment
R370Cr HT	From 370 to 410	1280	Hardened head		Z130 Alternative: Z90 HC with post-weld heat treatment
R400HT	400 to 440	1280	Hardened head		Z140, using only a disposable crucible

1 NOTE: 1997 and 1998 The hardened UIC60 (60E1) rails obtained from British Steel have a hardness of 280 HBW, which corresponds to a temporary resistance of 900 N/mm².

2 NOTE: The UIC60 (60E1) type rails with hardened head received from British Steel in 1999 have a hardness of 350 HBW, corresponding to a temporary resistance of 1200 N/mm².

3 NOTE: Since 2000, CORRUS (France) and DO (Austria) UIC60 (60E1) rails of type UIC60 (60E1) have a hardened head (rail steel grade 350 HT).

4 NOTE: Previously manufactured UIC60 (60E1) and R65 rails were available in either hardened or unhardened form.

5 NOTE: UIC60 (60E1) and R65 fully hardened rails are marked with a ring 15 to 20 mm in diameter.

6 NOTE: Some rail manufacturers mark the type of hardening (e.g. Azovstal marked A) only with coloured paint. In this case, the hardness of the rails has to be determined with a hardness tester.

Newly welded hardened and unhardened rails must have a strength not less than that specified in Table 4.2 when tested by static transverse bending by breaking the specimens through the head.

4.2 Table 18. Slow bend tests

Rail type	Minimum breaking load, kN
R50	915
UIC60 (60E1)	1210
R65	1395

SUMMARY OF THERMITE PORTIONS USED FOR RAIL WELDING

Gap, mm	Welded rails		Basic thermite portions						Additional thermite portions			
	type	temporary resistance, N/mm ²	50/Z 90 SkV	50/Z 120 SkV	60/Z 90 SkV (65/Z 90 SkV)	60/Z 120 SkV (65/Z 120 SkV)	65/Z 90 SkV (60/Z 90 SkV)	65/Z 120 SkV (60/Z 120 SkV)	412/Z 90 SkV	412/Z 120 SkV	712/Z 90 SkV	712/Z 120 SkV
(29±1)	R50	900	+									
		1200		+								
		900 with 1200	+									
	R65	900						+				
		1200							+			
		900 with 1200						+				
	UIC60 (60E1)	900				+						
		1200					+					
		900 with 1200					+					
	UIC60 (60E1) with R50	900				+						
		1200					+					
		900 with 1200					+					
UIC60 (60E1) with R65	900				+							
	1200					+						
	900 with 1200				+							
(45±5)	R50	900	+						+			
		1200		+						+		
		900 with 1200	+						+			
	R65	900						+	+			
		1200							+		+	
		900 with 1200						+	+			
	UIC60 (60E1)	900				+			+			
		1200					+			+		
		900 with 1200				+			+			
	R65 with R50	900						+	+			
1200								+		+		
900 with 1200							+	+				
(70±5)	R50	900	+								+	
		1200		+								+
		900 with 1200	+								+	
	R65	900						+			+	
		1200							+			+
		900 with 1200						+			+	
	UIC60 (60E1)	900				+					+	
		1200					+					+
900 with 1200					+					+		

TECHNICAL SPECIFICATIONS FOR WELDING METHODS**6.1 Table. Note of technical specifications for welding methods**

Indicator	Unit of measurement	Welding method		
		SKV ELITE	SKV L-50	SKV L-75
Distance between rails to be welded (gap)	mm	29 ± 1	45 ± 5	70 ± 5
Rail end lifting height	mm	Between 1.2 and 1.8	Between 1.8 and 2.2	Between 2.0 and 2.4
Rail end heating length	m	The thermite welding area of the rails and at least 0.5 m beyond it, heated to plus 50 °C by a gas burner		
Length of rail end wiping with metal brush	m	Clean dirt in the 0.12 m zone across the entire cross-section of the rail ends with a metal brush		
Distance between burner and top of rail head	mm	30 to 35	From 30 to 45	From 40 to 65
The thermite portion to be used	type	Main portion	Main portion + additional portion	Main portion + additional portion
Gas pressure	bar	Propane 1.5 Oxygen 5.0		
Preheating time for rails and ceramic moulds	min	R50 and lighter rail types 1 min 30 sec. For UIC60 (60E1) and heavier rail types 2 min. At ambient temperatures below plus 10 °C, the pre-heating time is increased by 30 seconds.		
Distance between the lower part of the reusable crucible and the ceramic moulds	mm	Not more than 30		
Start of removal of ceramic mould holders	min	After 3 min 30 s	After 5 min	After 7 min
Start of removal of the lower part of ceramic moulds	min	-	-	After 8 min
Start of removal of the upper part of ceramic moulds	min	After 4 min 30 s	After 8 min	After 10 min
Shearing off the upper part of the ceramic moulds and the resulting metal with scissors	min	After 5 min ¹⁾	After 8-9 min ²⁾	After 11 min ^{2) 3)}
Roughness of the rail head after grinding	mm	Running surface of the rail head from - 0.2 to + 0.3 Working edges of the rail head from - 0.3 to 0.0		

End of Annex No. 6

¹⁾ When applying the SKV ELITE welding method, when disposable Euro-type crucibles and a 120 thermite portion are used for the welding of hardened rails, the start time for cutting off the part of ceramic moulds and the resulting metal may be increased to 1 min.

²⁾ When applying the SKV L-50 and SKV L-75 welding methods, when disposable Euro-type crucibles and a 120 thermite portion are used for the welding of hardened rails, the start time for the part of ceramic moulds and the start time for the shearing of the resulting metal may be increased to 30 s.

³⁾ When applying the SKV L-75 welding method, the upper part of the ceramic moulds and the resulting metal are cut off with special scissors:

a) where reusable crucibles are used and an ambient temperature is below plus 15 °C, after 11 minutes for a 65 mm gap and after 11 minutes 30 seconds for a 75 mm gap;

b) where reusable crucibles are used and an ambient temperature is above plus 15 °C, after 11 minutes 30 seconds for a 65 mm gap and after 12 minutes for a 75 mm gap.

ACCEPTANCE CERTIFICATE FOR THERMITE-WELDED RAILS

(Name of the structural unit/Contractor's company)*

Form K-79

ACCEPTANCE CERTIFICATE FOR THERMITE-WELDED RAILS	I HEREBY APPROVE	
_____ (date)	_____ (No.)	_____ (first name and surname, position)
		_____ (signature, date)

This is to certify that the thermite welding of the _____ rail joint was carried out in the following
location:
(rail type)

(Line, road, kilometre, picket, metre, seam / Station, road, kilometre, picket, metre, seam / Station, road, distance, seam / Station,
switch no., welded seam no.)

Thermite welding is carried out at _____ the gap of mm using _____ ceramic forms and
(gap size) (year of manufacture)
_____ thermite portion: _____, _____
(year of manufacture) (marking code) (batch no., German: Batch) (portion No., German: Portion)

Welding conditions: dry/wet*, _____ °C, _____ °C.
(air temperature) (rail t°)

The rail welding works were supervised by _____ responsible thermite welder
(name of the structural unit/Contractor's company)*

_____, _____
(first name and surname) (welder's code)

Welded spot inspection by the NDT operator _____
(code, first name and surname)
defectoscope _____ Bumps in the joint _____
(type) (code) (head running surface) (working edges of the head)

The roadworks team was led by: chief foreman/foreman * _____
(first name and surname) (signature)

Ultrasonic test result: no defect/defect code/comments* _____

Responsible thermite welder

(signature, first name and surname)

NDT operator

(signature, first name and surname)

CM/Maintenance Supervisor*

(signature, first name and surname)

* Delete what is not required.

NOTE: The certificate is drawn up separately for each joint (weld).

FORCED ADJUSTEMENT OF THE LONG RAIL TEMPERATURE TO THE OPTIMUM RAIL NEUTRAL TEMPERATURE

1. If it is necessary to thermite weld the long rails at a temperature more than 5 °C below the optimum neutral temperature, a forced adjustment of the long rail temperature must be used before welding.

2. Before starting the works, the required extension of the long rail end must first be calculated, which will later be necessary when stretching or heating the long rail to the calculated length and the optimal neutral temperature.

3. During forced temperature adjustment, the long rails are laid on roller supports or pairs of sliding plates and tensioned using special hydraulic jacks or heated.

4. The extension of the long rails is calculated according to formula (1):

$$\Delta l = \alpha \cdot L \cdot \Delta t; \quad (1)$$

where:

Δl is the extension of long rails expressed in millimetres (mm);

α is the coefficient of extension of rail metal equal to 0.0000115;

L is the length of long rails in millimetres (mm);

Δt is the difference between the initial neutral or laying temperature of the rails and the optimum neutral temperature, °C.

5. When thermite welding of typical lengths of long rails is carried out, the extension of long rails is selected from Table 8.1.

8.1 Table. Extension of long rails (Δl mm) by stress equalisation

Temperature difference (Δt), °C	Length of long rails L , m					
	180	300	600	900	1,200	1,500
5	10.4	17	35	52	69	86
10	20.7	35	69	104	139	173
15	31.3	52	104	155	207	259
20	41.4	69	138	207	276	345
25	51.8	86	173	259	345	431

CALCULATION EXAMPLE:

Given:

- length of the long rail $L = 180$ m
- optimum temperature $t_{\text{opt}} = 30^\circ\text{C}$
- temperature of the rails to be welded $t = 5^\circ\text{C}$
- temperature difference $\Delta t = 30 - 5 = 25^\circ\text{C}$

– coefficient of extension of rail metal $\alpha = 0.0000115$

Calculations:

$$\Delta l = \alpha \cdot L \cdot \Delta t = 0.0000115 \cdot 180 \cdot 25 = 0.05175 \text{ m} = 51.75 \text{ mm}$$

extension required

$$\Delta l = 51.75 \text{ mm}$$

6. To check the uniformity of the extension of the long rail, a check marking is made with a marker perpendicular to the rail, through the sole of the rail and a ribbed pad or diverter under the sole of the rail, at intervals of 50 m from the stationary end of the long rail to the moving end. The offset of each marking is determined according to formula (1), where L will be 50 m, 100 m, 150 m, etc. To check the extension of the entire long rail, a check marking shall be made at the first sleeper near the end of the long rail.

7. One end of the long rail is thermite welded and the weld is allowed to cool below 500 °C. The other end of the long rail is then stretched using special hydraulic jacks or heated to the calculated length. The required tensile force N_t is calculated according to the formula (2).

$$N_t = \alpha \cdot E \cdot F \cdot \Delta t; \quad (2)$$

where:

E is the modulus of elasticity of the rail metal, equal to $2.1 \cdot 10^7 \text{ N/cm}^2$;

F is the cross-sectional area of the rail in square centimetres ($F=82.56 \text{ cm}^2$ for type R65, $F=76.66 \text{ cm}^2$ for type UIC60 (60E1), $F=65.93 \text{ cm}^2$ for type R50);

$$N_t = 0.0000115 \cdot 2.1 \cdot 10^7 \cdot 82.56 \cdot 25 = 500 \text{ kN}.$$

8. The longitudinal gauge is properly stretched when the calculated marks agree with all the reference marks. The stretched end of the long rail is fixed starting from the free end. The sliding end of the long rail, the length of which is calculated according to the formula (3).

$$l_{ps} = \left(\frac{N_r}{r} \right) + 1; \quad (3)$$

where:

r is the resistance to longitudinal displacement of one metre of rail ($r=12 \text{ kN/m}$);

$l_{ps} = (500 \div 12) + 1 = 42.7 \text{ m}$, to be attached to each sleeper and the remainder to every fifth sleeper.

9. After the long rail has been attached to the sleepers, the long rails can be thermite welded.

10. When welding, the reference marking should be observed to maintain the calculated length of the long rail. Do not allow stresses to build up at the welding points until the rail has cooled to 500 °C.

11. On completion of the welding, the entire welded long rail and the two moving ends of the adjacent long rails in each direction are released from the thermite welds from the clamps holding the rail, followed by the insertion of rollers or slippery plates underneath the rail, the beating of the rail with a special device or a wooden hammer, and the final fixing.

THERMITE WELDERS' WORK LOG

(left side)

Form K-80

Date of completion of thermite welding	Acceptance certificate No.	Thermal welder's code (letters)	Marking of the welded joint site	Air temperature, °C	Welded rails		Rail gap, mm	Thermite mix		
					temperature, °C	type		code	batches	portions
1	2	3	4	5	6	7	8	9	10	11

(right side)

Form K-80

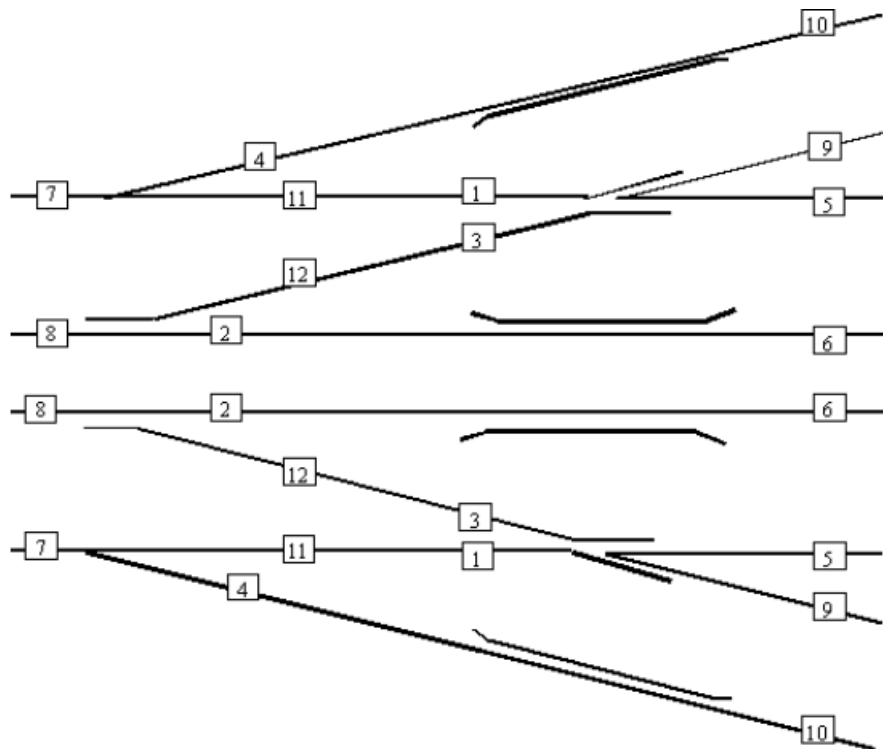
Thermite welder's first name and surname, signature	Non-destructive Testing Operator's first name and surname, signature	KM/Maintenance Supervisor's first name and surname, signature	Responsible welder's first name and surname, signature
12	13	14	15

LTGI K/114 Rules for Thermite Welding
of Rails and Switch Elements
Annex No. 10 (p. 8.3.1 and 10.10)

MARKING OF THE LOCATION OF THERMITE JOINTS

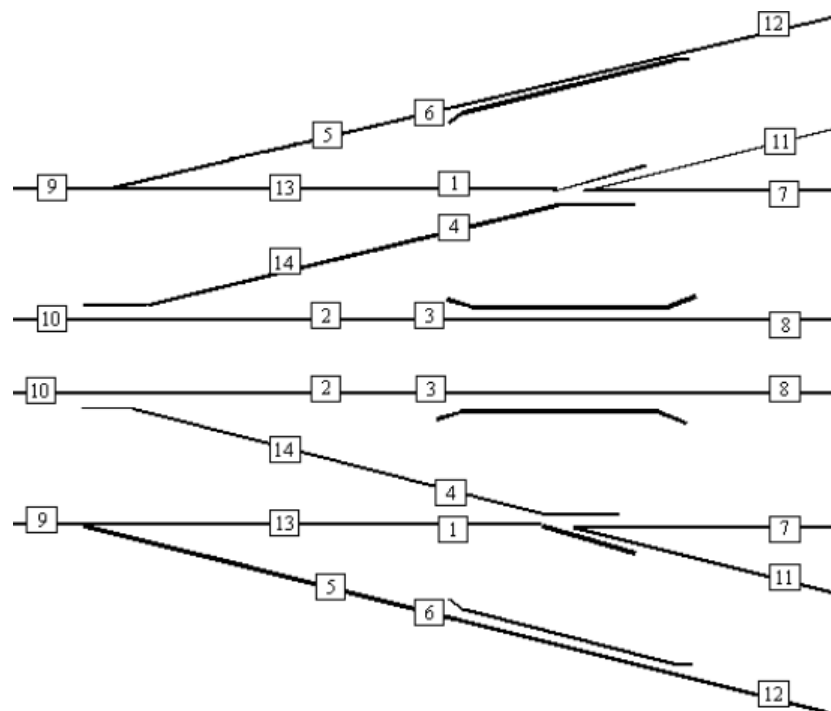
Primary location condition	Secondary location condition	Examples of welded areas
On the main track – the following data are provided: 1. the name of the line; 2. direction of travel (L/N); 3. kilometre (km); 4. picket (pk).	Not at a switch or crossing – the following data are provided: 5. distance from the start of the picket (m); 6. weld seam.	Vilnius-Klaipeda, L, 320 km, 8 pk, 63 m, D
On a secondary track – the following data are provided: 1. station name, 2. number of the track	With kilometre and picket signs – the following data are provided: 3. kilometre (km); 4. picket (pk); 5. metres (m) from the start of the picket; 6. weld seam.	Šiauliai, track 5, 35 km, 2 pk, 20 m, K Kalnėnai, track 2, 14 km, 1 pk, 35 m, D
	In the absence of kilometre and picket signs – the following data are provided: 3. the distance (m) and the number of the switch (IP) from which the measurement started; 4. weld seam.	Tauragė, track 3, 113 m from IP7, D Pauostis, track 102/104, 114 m from IP104, K Pauostis, track 1', 182 m from IP12, K
At the switch – the following data are provided: 1. Name of station or block point	2. switch (IP) or crossing (BS) number 3. welded joint number (s)	Vilnius, IP11, 6s BP249, IP101, 3s

The sequence and marking of thermite welding of switch element joints depend on the type of switch crossing frog (Figure 10.1).



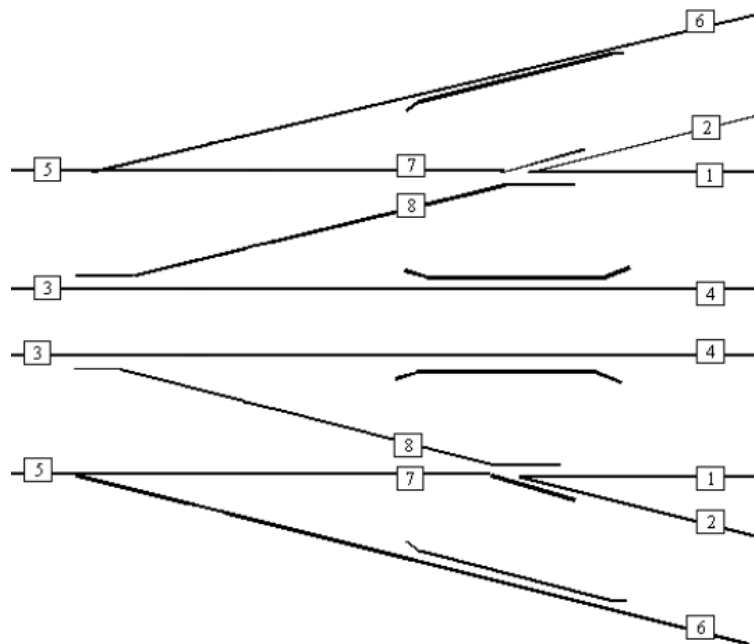
10.1 Fig. Procedure for the welding sequence and marking of thermite-welded joints in 1/9 and 1/11 turnout crossing frogs

NOTE: For convenience during welding, the joints with the following numbers: 5, 6, 7, 8, can be welded in any sequence.



10.2 Fig. Procedure for the welding sequence and marking of thermite-welded joints in a 1/18 turnout crossing frog

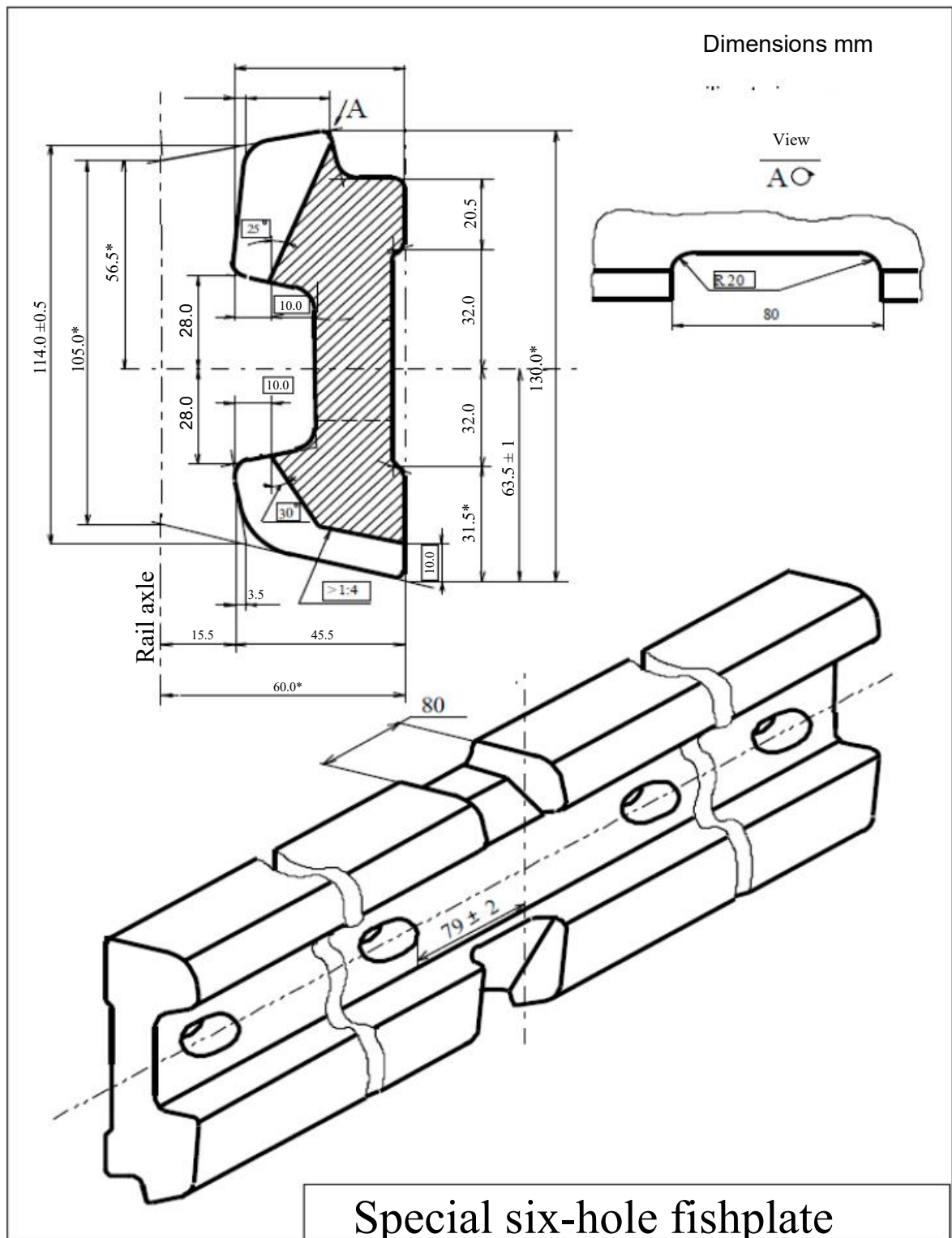
NOTE: For convenience during welding, the joints with the following numbers: 5, 6, 7, 8, can be welded in any sequence.



10.3 Fig. Procedure for the welding sequence and marking of thermite-welded joints in a 1/6 turnout crossing frog

PROCEDURE FOR FISHPLATING THERMITE WELD JOINTS

1. The procedure lays down requirements for reinforcing defective thermite joints with fishplates.
2. If a defect is found by the NDT operator during the inspection of thermite joints, a K-36 Form *Defective Rail Report* (hereinafter – K-36 Form Report) shall be completed and handed to the works supervisor and reported to the employee responsible for the defective rail record.
3. The K-36 Form report specifies the permissible speed of trains and contains a proposal (recommendation) for rail fishplating or removal.
4. The works supervisor shall, upon receipt of a K-36 Form report from the NDT operator, restrict the speed of trains to the speed specified in the K-36 Form report and organise the repair of the defective rail in accordance with the prescribed procedure (the contractor's works supervisor shall inform the track MS upon receipt of a K-36 Form report from the NDT operator of the necessity to restrict the speed of trains).
5. Where the K-36 Form report indicates that a defective rail is proposed to be fishplated, the works supervisor or the track MS shall decide to replace or fishplate the rail in accordance with the [2.4] regulations.
6. Defective thermite joints can be reinforced with six-hole, four-bolt fishplates so that the middle part of the fishplate overlaps the defect. Once the rail has been secured as specified, the rolling stock shall be passed at the specified speed.
 - 6.1. When reinforcing a thermite joint with a defect, the holes shall not be drilled for the two internal bolts to prevent the defect from developing towards them.
 - 6.2. After the end of the thermite joint fishplating works, the track MS informs the employee of the Diagnostics function responsible for the defective track inventory.
7. The reinforced thermite joint shall be subject to traffic safety measures of hazard level D3 and further operation of this rail shall be carried out in accordance with the requirements of [2.4].
8. In the event of a transverse fracture of the thermite welding, the welding area must be replaced (repaired). If the fractured area can be reinforced prior to replacement/repair, train speeds shall be limited to 25 km/h over the reinforced joint of rail type R65 and 15 km/h over the reinforced joint of rail type UIC60 (60E1) and lighter.
9. In all cases, if there is a crack in any of the milled dressings, it shall be considered to be highly defective and must be replaced. Trains shall be allowed to run at a maximum speed of 15 km/h until the fishplate is replaced at this joint.



11.1 Fig. General view of the fishplate

THE MOST COMMON DEFECTS IN THERMITE WELDS**12.1 Table.** List of defects in thermite welds and their repair methods

Defect description	Cause of the defect	Prevention
Gas holes, bubbles, pinholes in the cast weld	<ol style="list-style-type: none"> 1. A very active reaction in the crucible, with liquid metal escaping over the edges of the crucible. 2. Wet mould. 3. Reduced track gap size. 	<ol style="list-style-type: none"> 1. Check the granulation of the thermite portion and the quality of packaging. 2. Dry the mould. 3. Reduce the moisture content of the mould sealing sand, check the quality of the ceramic mould sealing. 4. Determine the required track gap size.
Overheating of metal, melting of rail sole	<ol style="list-style-type: none"> 1. Increased heating time. 2. Incorrect burner setting. 3. Reduced track gap size. 	<ol style="list-style-type: none"> 1. Select the correct heating time. 2. Determine the required track gap size.
Lack of fusion. The casting metal did not stick to the rail. The surface of unwelded areas is dark in colour and the sole of the rail shows inclusions of between 0.5 mm and 3.5 mm	<ol style="list-style-type: none"> 1. Insufficient pre-heating of the rail ends. 2. Slag deposition on welding surfaces due to the previous discharge of metal from a crucible that has not been preheated. 3. Contamination of welding surfaces. 	<ol style="list-style-type: none"> 1. Check the burner operation and, if necessary, increase the pre-heating time of the rail ends. 2. Check the cleanliness of the purge channels before the mould is fitted. 3. Check the quality of the crucible. 4. Feed the crucible before adding the thermite portion. 5. Clean welding surfaces before welding. 6. Ensure the rail ends are in the correct pre-heating mode.
Hot casting metal cracks and depressions in the weld head	<ol style="list-style-type: none"> 1. Rapid cooling of liquid metal due to insufficient pre-heating of the rail ends. 	<ol style="list-style-type: none"> 1. Increase the pre-heating time of the rail ends.
Increased metal embrittlement of the cast weld	<ol style="list-style-type: none"> 1. Increased aluminum content in the thermite portion or uneven distribution of aluminum in the thermite portion. 2. Overheating of the metal during pre-heating of the rail ends. 	<ol style="list-style-type: none"> 1. Make claims against the manufacturer of welding materials. 2. Ensure adequate mixing of the fractions of the thermite portion. 3. Change the pre-heating mode.

Annex No. 12 continued

Defect description	Cause of the defect	Prevention
Slag inclusions. The slag did not have time to detach from the metal and come to the surface. Slag inclusions on the surface of the weld collar are greenish in colour	<ol style="list-style-type: none"> 1. Introduction of an unburnt thermite portion into the mould. 2. The thermite portion contains coarse fractions. 3. Moist thermite portion. 4. Rapid crystallization of metal in the lower rail cross-section due to reduced rail gap size. 	<ol style="list-style-type: none"> 1. Stir the thermite portion to distribute the fractions evenly. 2. Ensure compliance with the storage requirements for the specified thermite portions. 3. Determine the required track gap size. 4. Use moulding materials with higher fire resistance.
Lack of metal in the cast weld	<ol style="list-style-type: none"> 1. Low-quality thermite portion. 2. Increased rail gap size. 3. Partial leakage of metal through leaks between the rail and the ceramic moulds. 4. Violations of the storage conditions for the thermite portion. 	<ol style="list-style-type: none"> 1. Use the thermite portion for the existing rail type. 2. Determine the required track gap size. 3. Quality installation of ceramic half-moulds. 4. Ensure the quality of the sealing of ceramic moulds. 5. Ensure compliance with the storage requirements for the specified thermite portions.
Other defects: 1. angles at the welded joint, displacement of rail heads on the rolling surface, displacement over working edges. 2. Undercuts and grinding irregularities.	<ol style="list-style-type: none"> 1. Improperly aligned and raised track ends. 2. Grinding machine failure. 	<ol style="list-style-type: none"> 1. Carefully shape the rail gap before welding. 2. Repair the grinding machine, replace the grinding disc.

**INSPECTION REPORT ON THE MAIN PARAMETERS OF THE THERMITE WELDING
TECHNOLOGY**

Welding crew _____ inspection _____ date: _____
 (name of welding company) (welding location)

		yes	No
1. Occupational safety	1.1. Compliance with the occupational safety rules meets the requirements	<input type="checkbox"/>	<input type="checkbox"/>
2. Conformity of equipment and welding materials	2.1. Equipment and welding materials selected correctly	<input type="checkbox"/>	<input type="checkbox"/>
	2.2. Pre-heating burner unbent and fit for use	<input type="checkbox"/>	<input type="checkbox"/>
3. Gap and rail alignment	3.1. Track cutting machines in working order and used correctly	<input type="checkbox"/>	<input type="checkbox"/>
	3.2. The welding gap is perpendicular and the size meets the requirements specified no grooves more than 3 mm deep	<input type="checkbox"/>	<input type="checkbox"/>
	3.3. Track ends are cleaned	<input type="checkbox"/>	<input type="checkbox"/>
	3.4. Rail clips are removed	<input type="checkbox"/>	<input type="checkbox"/>
	3.5. Rail alignment: lifting, inner edge of the rail head and the rail sole properly aligned	<input type="checkbox"/>	<input type="checkbox"/>
4. Preparation of materials and equipment before welding	4.1. The burner height is set correctly	<input type="checkbox"/>	<input type="checkbox"/>
	4.2. The axis of the moulds coincides with the centre of the gap	<input type="checkbox"/>	<input type="checkbox"/>
	4.3. The cardboard used to cover the rail head	<input type="checkbox"/>	<input type="checkbox"/>
	4.4. The moisture content of the sand used for sealing complies with the specified requirements	<input type="checkbox"/>	<input type="checkbox"/>
	4.5. Sealing is done correctly	<input type="checkbox"/>	<input type="checkbox"/>
	4.6. Correct handling of the crucible (disposable)	<input type="checkbox"/>	<input type="checkbox"/>
	4.7. The distance from the crucible is set correctly	<input type="checkbox"/>	<input type="checkbox"/>
5. Pre-heating of rails	5.1. The gas pressure gauge readings are correct	<input type="checkbox"/>	<input type="checkbox"/>
	5.2. The burner flame is correctly adjusted	<input type="checkbox"/>	<input type="checkbox"/>
	5.3. Burner anchored through the centre of the weld joint	<input type="checkbox"/>	<input type="checkbox"/>
	5.4. Adequate pre-heating time	<input type="checkbox"/>	<input type="checkbox"/>
6. Performing the welding	6.1. Crucible built through the centre of the moulds	<input type="checkbox"/>	<input type="checkbox"/>
	6.2. Correct use of thermite-portion ignition matches	<input type="checkbox"/>	<input type="checkbox"/>
7. Final works	7.1. The time after liquid metal injection is correctly maintained	<input type="checkbox"/>	<input type="checkbox"/>
	7.2. Rough grinding is done correctly	<input type="checkbox"/>	<input type="checkbox"/>
	7.3. Final grinding tolerances meet the specified requirements	<input type="checkbox"/>	<input type="checkbox"/>
	7.4. Weld joint cleaned of mould residues, the rail is secured and sleeper lining is carried out in the joint area	<input type="checkbox"/>	<input type="checkbox"/>
	7.5. The joint marking has been carried out correctly	<input type="checkbox"/>	<input type="checkbox"/>
8. Comments			

Responsible welder _____
 (first name and surname, code, signature)

Welder(s) _____
 (first name and surname, code, signature)

Verified by _____
 (position, name and surname, signature)

THERMITE WELDING COMPANY INSPECTION REPORT

Welding company _____ audit _____ date: _____
(company name) (company address)

Rating scale (0-5):

- 5 – Fully compliant with all requirements, no comments;
- 4 – Meets the requirements, minor comments;
- 3 – Minor infringements that do not require a non-compliance record;
- 2 – Significant infringement, correction required;
- 1 – Serious non-compliance, rectify immediately;
- 0 – Critical violation/safety hazard/no action taken.

Company audit evaluation table:

Aspect to be checked	Standard/source reference	Rating (0-5)	Comments
1. Existence and compliance with welding procedures	EN 14730-1: 5.1, Goldschmidt Code		
2. Staff qualification documents and certificates	EN 14730-1: 7, EN 14730-2		
3. Condition of equipment in use and inspection marking	EN 14730-1: 5.1		
4. Traceability and storage of capsules and materials	EN 14730-1: 5.2.2		
5. Quality control documentation	EN 14730-2		
6. Compliance with health and safety requirements	EN 14730-1: 7		

Inspection conclusion:

The results of the inspection are assessed as Positive / Negative.
(delete as appropriate)

Company's
representative

(position, first name and surname, signature)

Inspector

(position, first name and surname, signature)

(position, first name and surname, signature)

(position, first name and surname, signature)

REPORT OF INSPECTION OF WORKERS PERFORMING THERMITE WELDING OPERATIONS

Welding crew _____ inspection _____ date: _____
(name of welding company) (welding location)

Rating scale (0-5):

- 5 – Fully compliant with all requirements, no comments;
4 – Meets the requirements, minor comments;
3 – Minor infringements that do not require a non-compliance record;
2 – Significant infringement, correction required;
1 – Serious non-compliance, rectify immediately;
0 – Critical violation/safety hazard/no action taken.

Employee assessment table:

Action to be checked	Standard/source reference	Rating (0-5)	Comments
1. Track end preparation: cleanliness, oxide removal	EN 14730-1: 5.2.1		
2. Fitting of moulds and centre in accordance with the SKV procedures	Goldschmidt Code		
3. Capsule insertion, burner ignition	EN 14730-1: 5.3.3		
4. Response monitoring and time recording	EN 14730-1: 5.3.4		
5. Cooling cycle compliance (by model)	Goldschmidt Code		
6. Removal of moulds and disposal of residues	EN 14730-1: 5.3.6		
7. Surface treatment and visual inspection	EN 14730-1: 6.2		
8. Use of personal protective equipment	EN 14730-1: 7		
9. Filing documentation after works	EN 14730-1: 6.3		

Inspection conclusion:

The results of the inspection are assessed as Positive / Negative
(delete as appropriate)

Responsible welder _____
 (first name and surname, code, signature)

Welder(s) _____
 (first name and surname, code, signature)

Verified by _____

LTGI K/114 Rules for Thermite Welding
of Rails and Switch Elements

(position, first name and surname, signature)