1.0 PURPOSE

The following guideline addresses the minimum requirements to successfully thermite weld. This is not meant to supersede the thermite kit manufacturer’s procedure / methodology.

2.0 THERMITE WELDING

Thermite welding is a process that produces coalescence of metals by heating them with superheated molten metal from an aluminothermic reaction between a metal oxide and aluminum. Thermite welding resembles metal casting, whereas a mold is installed around the weld joint, and torches placed inside mold to preheat. A refractory-lined crucible containing the charge is positioned above the mold and after the charge is ignited, molten metal is poured in the mold and the cavity between the rails. The slag remains on top and solidifies. When molds are removed, excess material is removed by grinding.

ANSI / AWS D15.2 states “welding procedure including preheating techniques, method of ignition, rate of cooling, and mold removal techniques will vary somewhat based on the instructions of the manufacturer of the specific thermite kit being employed and the type, size and chemistry of the rail being welded.” Therefore, a detailed procedure to be specific for the given project shall be submitted for review prior to work starting.

2.1 WELD PROCEDURE

Limited / quick preheat thermite weld process is not permitted.

A detailed weld procedure including step-by-step methods to be employed in making the welds shall be submitted for Owner’s approval. The procedure shall be developed with the kit manufacturer. Include, at minimum, complete description of the following items:

   a. Manufacturer’s kit to be used.
   b. Method for cutting / cleaning the rail ends.
   c. Minimum and maximum allowable gap between rail ends prior to welding.
   d. Method used for preheating including time and temperature.
   e. Method used for removing the upset material and finishing the weld to the final contour, including a description of special tools and equipment.
   f. Method for post weld cooling including time and temperature.
   g. Quality control procedures to be followed.
   h. Welder qualifications / certifications and list of prior projects.
   i. Sample welding test record sheet.

Procedure shall be qualified by performing a thermite weld on a minimum of two test pieces in the range of 104 to 135 lb rails, and performing the following tests:

   1. Slow bend test in accordance with AWS D15.2 Clause 5 and Annex D. The weld joint shall be capable of meeting the minimum requirements as defined in AWS D15.2 table 2 for the grade of rail being installed.
2. Brinell hardness test of weld metal shall be within +/- 30 HB of the manufacturer’s specified hardness for the specified kit being used. Refer to AWS D15.2 table 2.

2.2 WELDER QUALIFICATIONS

Welder operators shall receive training by kit manufacturer. The qualification shall be valid for the specific thermite kit used and grade / size of rail. Welder operator shall have performed thermite welding within the last 6 months.

2.3 MATERIALS

The following thermite weld kits are approved:
- Calorite, limited or standard preheat, by Calorite Inc
- Boutet, distributed by Railtech
- Orgo-Thermit, by Orgo-Thermit, Inc

Each charge kit should have proper identification label stating:
- Expiry date
- Rail weight and preheat type
- Rail grade
- Process (i.e.: one shot process)
- Manufacturer’s control or identification number

If label is illegible or kit is past expiry date, do not use.

Crucibles and ignition fuses shall be stored in area free of moisture / humidity. Store in a manner which will not cause kits to be crushed (max 5 kits high).

2.4 RAIL END PREPARATION

Clean the rails to be welded of grease, oil, dirt, loose scale, and moisture to a minimum of 6 inches back from the rail ends, including the railhead surface. Use a wire brush to completely remove dirt and loose oxide, and use oxygen / acetylene torch to remove grease, oil and moisture.

Use a power grinder with an abrasive wheel to remove scale, rust, burrs, lipped metal and mill brands which would interfere with the fit of the mold for four (4) inches on each side of the ends. Rail ends shall show no steel defects, dents, or porosity before welding.

No drilled holes in rail web shall be within 4 inches from rail end. Rail weld area is defined as 18 in on either side of gap and cannot have been previously arc welded. Thermite joints shall be located no closer than 3 feet from adjacent thermite welds.

Cut rail square using approved rail saws.
2.5 RAIL END ALIGNMENT

The minimum and maximum spacing between rail ends shall be as specified by the rail welding kit manufacturer and the approved procedure specification. Wide gap welds will not be permitted unless approved by the Engineer. Align the rail ends using a rail beam specifically designed for this purpose or a 36-inch straight edge.

When aligning the rail ends, the following steps must be completed in this order:

1. **Gap:**
   a. Measure gap at both sides of rail head and base. All measurements shall be within manufacturer’s tolerances.

2. **Peak (Vertical Alignment):** Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.
   a. All measurements shall be within manufacturer’s tolerances.

3. **Horizontal Alignment:** Horizontal alignment shall be done in such a manner that any difference in the width of heads of rails shall occur on the field side.
   a. All measurements shall be within manufacturer’s tolerances.

4. **Unequal cant between rails:**
   a. All measurements shall be within manufacturer’s tolerances.

Once gap / alignment is completed, hold the rail gap and alignment without change during the complete welding cycle.

2.6 MOLD PREPARATION

Mold shall be installed in accordance with manufacturer’s instructions. Special precautions must take place to ensure mold cavity is free of moisture / foreign matter by covering mold opening with cardboard during sealing operations.

2.7 CHARGE PREPARATION

Set up crucible in dry location and verify charge bag for signs of punctures or moisture. Prepare charge in accordance with manufacturer’s recommendations.

2.8 PREHEATING THE RAIL ENDS

Preheat the rail ends prior to welding to the temperature and for the time specified in the approved Weld Procedure to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.

Confirm preheat temperatures using tempil-sticks, or with a temperature gun and log temperatures and time in weld test record sheet. Preheating time only starts after the flame is properly adjusted. The flame should be directed straight down into the mold and not just above the mold gates.
2.9 IGNITION AND POURING OF THERMITE STEEL

Following preheating, remove the burner nozzle should be from the mold, place the charge in the crucible and ignite in accordance with the manufacturer’s instructions and Weld Procedure. Ignition fuses should be placed at an angle. Ensure crucible cover is replaced the instant the fuse is placed. As soon as slag stops pouring, start stop watch to ensure proper de-molding time.

2.10 COOLING

Leave the molds in place, after tapping for a sufficient time to permit complete solidification of the molten metal, in order to allow proper slow cooling in order to prevent cracking and to provide a complete weld with proper hardness and ductility.

2.11 DEMOLDING / SHEARING OF EXCESS HEAD METAL

Crucible shall be removed at interval set by manufacturer / weld procedure. Time starts immediately after slag stops pouring.

Base plate retaining mechanism and mold clamp screws shall be removed at interval set by manufacturer / weld procedure. Time starts immediately after slag stops pouring.

Immediately after mold has been broken away, cut off surplus metal on rail head using method recommended by manufacture / weld procedure.

2.12 HOT GRINDING

When hot grinding, it is important to leave enough material on the running surface above the rail steel as weld will shrink during cooling / solidification.

2.13 COLD GRINDING

Bring welded joints in the finished track to a true surface and align by means of an approved grinding or planning machine (shear). Use a hand grinder for the final smoothing and for areas not accessible to a track grinder. Perform finish grinding with an approved grinder operated by a skilled workman. Take care to grind evenly and leave the joints in a satisfactory condition. Complete the completed weld by mechanically controlled grinding in conformance with the following requirements. A finishing deviation of not more than plus or minus 1/100 inches of parent section of the rail will be allowed.

2.14 QUALITY CONTROL

During welding, a manufacturer’s representative is required to witness / perform quality control on, at minimum, the first 4 welds of each welder operator.
Visually inspect and check welds in accordance with approved procedures to ensure there are no surface defects such as cracks and to verify that the welds conform to the alignment and finishing tolerances specified in this Section. Visually inspect all welds at the time of welding and during the grinding operation. Prior to completion of welding operation, visually inspect all welds to verify the base riser break off area has been smoothed.

Each completed field weld shall be marked with the date, name of welder, air temperature, and rail temperature or with date, name, and “free weld” for welds not used to control CWR thermal adjustment.

Verify that each completed weld has full penetration and complete fusion and is entirely free of cracks or fissures.

Perform the following tests on all welds:

1. Leeb rebound test taken on running surface at the center of the weld fusion zone. Hardness of weld metal shall be within +/- 30 BHN points of manufacturer’s specified hardness for the specific kit being used.
2. Ultrasonic testing shall be performed after the weld has been ground and finished to specified tolerances. All personnel performing Ultrasonic Inspection shall be qualified to CGSB (Canadian General Standards Board) 48.9712 Level 2 or 3 and use CSA W59.1 acceptance criteria.
3. Magnetic particle test shall be performed minimum 48 hrs after welding has occurred. All personnel performing Ultrasonic Inspection shall be qualified to CGSB (Canadian General Standards Board) 48.9712 Level 2 or 3 and use CSA W59.1 acceptance criteria.

2.15 DEFECTIVE WELDS

Welds made outside of the track which the Owner determines to be unacceptable prior to rail installation shall be cut out, rails pulled together to the indicated rail gap, and re-welded.

Cut unacceptable welds and replace with a section of rail and 2 new welds. The minimum length of the new rail used shall be 15 feet.

Saw cuts shall be made at least 6 inches from the centerline of the faulty weld.

In-track welds shall be made in accordance with the requirements specified in this Section.

UT and MT the replacement welds as specified 2.14

3.0 REFERENCE DOCUMENTATION

The following documents are related to this Guideline:

| ASTM E164 | Standard Practice for Ultrasonic Contact Examination of Weldments |
| ASTM E709 | Standard Guide for Magnetic Particle Examination |
AWS D15.2 | ANSI / AWS D15.2 Recommended Practices for the Welding of Rails and Rail Related Components for Use by Rail Vehicles
AWS Volume 2 | AWS Volume 2, Chapter 29, Other Welding Process: Thermit Welding
CSA W59.1 | Welded Steel Construction – Metal Arc Welding
4.0  REVISION AND TRANSITION NOTES

Revision notes describe: what was changed, and if applicable, why it was changed, and the plan to implement the change, including whether changes are retroactive.

Note: The revision notes are a summary of the changes and may not necessarily be a complete list.

A risk code is entered for each revision and if applicable, the revision notes will describe how risk was addressed for the revision.

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<td>C</td>
<td>For this revision, a PHR or other risk management tool has been used to address risk and minimize hazards. This risk assessment has been documented and is available through Central Engineering.</td>
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