

THERMITE WELDING

**\*\*From Castleton-West Rutland/Castleton AC STP 2705(1)/2908(1)/2909(1)**

- xx. DESCRIPTION. This work shall consist of performing thermite welding for track as required in the Plans and as directed by the Engineer.
- xx. SUBMITTAL REQUIREMENTS. The Contractor shall submit the following to the Engineer for approval prior to beginning any welding:
- (1) Type and manufacture of weld kits.
  - (2) Detailed specifications showing proposed quick preheat, self-tapping thermite weld kit, and method and procedure for thermite welding. Specifications submitted shall comply with these provisions and those of the weld kit manufacturer.
  - (3) Qualification certification for each supervisor and field welder who will perform work under this Contract. Weld supervisors and welders shall be required, upon request of the Engineer, to submit their qualification certificates throughout the duration of the project.
  - (4) Name of independent testing contractor and certification that testing laboratory and persons who shall perform ultrasonic testing of field welds have previously tested a minimum of 250 welds.
  - (5) Documentation that sample thermite welds have been tested and that welds meet or exceed the requirements of this Section.
  - (6) Complete thermite weld kits conforming to these provisions.

Certified ultrasonic inspection results shall be submitted for field welds on all tracks.

- xx. CONSTRUCTION REQUIREMENTS.
- (a) Quality Control. The thermite welding process can only be successful if it is carried out by thoroughly trained and well disciplined personnel. It will be the responsibility of the Contractor to organize and coordinate all preparation and training activities for its personnel, including participation by the welding kit supplier as required. The Contractor is also responsible for documenting the preparation and training activities for submittal to the Engineer.

- (1) General. Perform sample weld testing and inspection at no additional cost to the Agency.

Sample weld testing and inspection shall be performed by an approved certified independent testing laboratory. The Engineer may audit operations to ensure that inspection and tests are being performed in accordance with approved procedures and in compliance with these provisions.

To be accepted, sample welds must fulfill the requirements of these provisions.

- (2) Field Weld Qualification Inspection and Testing. Prior to field welding, welds and each welding crew shall be qualified as specified below. Welding crews shall prepare, in accordance with method and procedure for thermite field welding submitted to and approved by the Engineer, at least three samples of a thermite weld. Each welding crew shall perform at least one of each type of sample weld. Sample welds shall join two pieces of each type of running rail a minimum of 30 inches and a maximum of 36 inches in length each.

The Contractor shall test three sample welds as follows:

- a. Perform Manual Ultrasonic Test specified in this Section on all sample welds from each type of rail.
- b. Inspect sample welds ultrasonically in accordance with recommendations of the Nov. 29-30, 1983 Proceedings of Association of American Railroads (AAR) entitled "Railroad Rail Welding," Pages 191-205. Acceptance criteria for this test shall be as specified herein.

Approval of weld kit, welding process, and welding crews will depend upon all sample welds satisfying the specified requirements. Should any sample weld fail to satisfy the specified requirements, the welding process, the welding crew, or both, will not be qualified for the work.

Employ a supervisor for each welding crew who has been trained and certified for performing thermite field welding by the manufacturer supplying weld kits. Should the supervisor of the welding crew be replaced during the work, the welding crew shall be re-qualified under the new supervisor.

Prior to performing welds in specified work, satisfactorily qualify welds and welding crew as specified herein.

If Contractor changes supplier of welding kits or welders during the job, repeat all of above sample weld testing.

- (3) Preparation and Training for Field Welding. Prior to making sample welds and prior to field welding, coordinate the following with the welding kit manufacturer at no additional cost to the Agency.

Provide a detailed list of tools, equipment, and supplies required to make field welds. Copies shall be delivered to the Contractor and the Engineer and shall be kept onsite with welders at all times.

Provide a detailed procedure for making field welds, consistent with Engineer requirements. Field welds shall

be made with approved kits. If there are different types of welds in the Contract (e.g., different sizes or types of rail, compromise joints, etc.), a procedure shall be provided for each. Copies of procedures shall be delivered to the Contractor and the Engineer and shall be kept onsite with welders at all times.

Qualified welders will receive a dated Certification Card, signed by a Supplier Representative, approved by the Engineer, which must be available for inspection at any time and be on call to assist the Contractor and the Engineer in case any unusual problems arise in the field. Supplier should be prepared to provide for laboratory testing needed to solve a problem, and should have the capability of tracking their kit materials backward through the chain of production.

Make random inspections of the welding work in progress, at least every three months, to ensure that proper tools, equipment, and supplies are being used, and that their procedures are being followed.

- (4) Field Weld Record. Provide the Engineer with a complete and up to date record of all welds, welders, and welding kits. This record shall be submitted on the approved project standard form which includes, but is not limited to, the following information for each weld:
- a. Weld number, location by track designation and station, and date and time weld made. Rail identification including section, heat number, and date rolled.
  - b. Kit manufacturer and identity of each mold and portion.
  - c. Weather conditions, and air and rail temperatures.
  - d. Rail gap.
  - e. Name of welder, Contractor's foreman, and Engineer's representative on the job.
- (5) Field Weld In-Track Testing. During field welding, hand test and inspect all field welds as specified herein to ensure compliance of welds to the requirements of these provisions.

Thermite welds shall be visually and dimensionally inspected as soon as the weld has been completed regardless of whether track has been designated as "in revenue service" or "out of revenue service."

Manual ultrasonic testing of thermite welds in track designated as "in-revenue service" shall be completed within 24 hours of weld completion.

Manual ultrasonic testing of thermite welds in track designated as "out-of-revenue service" shall be completed within 30 days from date of welding but in all cases prior to the resumption of train operations.

It shall be the responsibility of the Contractor to follow the above criteria and ensure that all welds are properly inspected and tested at no additional cost to the Agency.

The Ultrasonic testing organization shall submit to the Engineer detailed test procedure and description of test equipment including calibration blocks that will be utilized in the testing process. Calibration process shall be able to permit detection of defects of size, type, and location described under acceptance criteria. Test procedure and equipment shall include, but not be limited to the following:

a. Calibration.

1. Calibrate when starting work and at least every hour.
2. Recalibrate if there is a change in probes or cables.
3. Use 1.1.W. Type 1 and Type B-1 steel test blocks for calibration. A rail with drilled holes may be used in addition. If a rail is used, a duplicate shall be provided to the Engineer.

b. Web Test.

1. Use two 45 degree probes placed on top of rail in pitch-catch configuration.
2. Scan from top to bottom of weld with both probes.
3. Scan top and bottom edges of weld with a single probe.
4. Scan from both sides of weld.

c. Head Test.

1. Use two 45 degree probes placed on sides of the rail head in pitch catch configuration.
2. Scan across weld with both probes, angling them up and down to cover entire cross-section of weld.
3. Scan each vertical edge of weld with a single probe.

4. Scan from both sides of weld.

d. Base Test.

1. Use a 70 degree probe.
2. Place probe on top of base far enough back from center of weld so that beam is following the "3/4 W" path.
3. Move toward and away from weld, angling probe from side to side.
4. Scan both sides of base and from both sides of weld.
5. Test crew shall fully document their findings on an approved project standard form. This form shall include, but is not limited to, identification of test equipment used, calibration, weld number and location, members of test crew, date and time of test, description of defects, and recommendation to accept or reject weld.

e. Acceptance Criteria - Ultrasonic.

1. No defect in the weld of any size will be accepted in the head, web, or base of rail.
2. The Engineer may perform random manual ultrasonic tests of field welds.

f. Physical Inspection.

1. Visually and dimensionally inspect each field weld to determine conformance with alignment and finishing tolerances specified herein.
2. When weld is made and molds and risers removed, weld shall be checked for obvious failures such as an incomplete weld.
3. Once weld has been ground and weld temperature is less than 200°F, physical inspections shall be made to verify acceptance criteria.

g. Acceptance Criteria - Physical.

1. There should be no visible voids, rat holes, nicks, or gouges in surfaces which have been ground.
2. Weld collar in web zone and base of rail should not be ground except to remove notches created by upset conditions. Sharp protrusions and gouges should be blended into rail and weld

collar contour to eliminate possible stress risers.

3. Combined vertical offset and crown camber at top of rail, at rail temperature of 200°F or less, shall not exceed 0.060 inch. No Dip Camber shall be allowed.
  4. Combined horizontal offset and horizontal kink camber at side of rail head, at rail temperature of 200°F or less, shall not exceed 0.060 inch.
  5. A finished deviation of not more than plus 0.010 inch or minus 0.00 inch from parent section of rail head surface shall be allowed.
  6. Weld straightness tolerances shall be as shown in AREMA Chapter 4.
- h. Defective Welds. Defective welds shall be cut out and replaced with a 19 foot-6 inch section of new or like relay rail, and welded in place, at no additional cost to the Agency.
- i. Final Ultrasonic Testing. Final ultrasonic testing shall be performed by an on track detector car.

(b) Thermite Welding.

- (1) General. Thermite field welds shall be made to join jointed rail or continuous welded rail (CWR). Field welds will be required in turnouts and in areas of asphalt crossings to eliminate rail joints.

Ends of rails to be welded shall be saw cut. Torch cutting of rails will not be allowed.

Do not locate field welds within the following locations in standard track work:

- a. Within 8 feet of the center of any bolted, bonded, or insulated joint.
- b. Within 2 feet of a thermite weld in the opposite rail.
- c. Within 6 inches of any hole drilled in rail.
- d. Within 9 inches of a weld which has been cut out.
- e. Over a tie plate.

In the case of special trackwork, some exceptions to above will be allowed with approval of the Engineer.

If plug rails are required to meet requirements specified above, or to replace a defective weld, minimum length of plug rail is 19 feet-6 inches.

Thermite welding process generates extremely high temperature (up to 5,000°F) accompanied by flames, sparks, hot molten metal, and slag. Extreme caution shall be observed by welders and others in the vicinity. The following precautions must be observed:

- a. During welding process, prevent hot molten metal and slag from contacting water, snow, or ice, as an explosion could occur.
  - b. Properly dispose of hot slag, slag pans, top and side risers, or other hot scrap. Be sure that this material is not left where it could be stepped on, causing serious injury.
  - c. Wear welding goggles or safety glasses and other safety equipment as appropriate.
  - d. During and after welding, avoid burning or damaging ties and timbers, or setting fire to wayside areas. A fire extinguisher shall be required at the weld site (2½ gallon water type extinguisher).
  - e. Keep welding tanks, hoses, and other flammables a safe distance from the weld site.
  - f. Do not make field welds on open deck bridges or timber structures.
  - g. Unused thermite material must be kept in an approved secure, dry, weather tight location, consistent with applicable fire regulations so that it will not be accessible to unauthorized persons.
  - h. When welding rails in track on lines in service, ensure that rail fastenings and anchors are properly installed prior to restoration of service.
- (2) Weld Quality. Weld quality shall be as specified in these provisions.

The Contractor shall be responsible for the integrity of the field welds for a minimum of two years from the date the track is put in service for train traffic.

- (3) Welding Requirements. Use approved kits that are self-tapping and require minimum preheating.

Saw cut rail ends at right angles to rail. Clean the surface of rail for a length of approximately 6 inches from each end, free of all grease, dirt, loose oxide, scale, and moisture. Remove burrs and lipped metal which would interfere with the proper fit of molds.

At time of field welding, rails shall be aligned to produce a weld which, with respect to alignment, shall be in accordance with these provisions.

Proper rail end alignment shall be achieved by use of an approved alignment device designed and manufactured for this purpose. In no case will use of track jacks or track spikes be allowed for rail end alignment.

Striking of rail with blunt tools, such as a maul, is prohibited.

Contractor shall assure that rail ends are secured against longitudinal, vertical, lateral, or twisting movement during and immediately after the welding process. Rail puller/expanders shall be used to prevent movement. Rail clips or anchors shall be installed if there is a chance of longitudinal movement.

At time of field welding, rail gap shall be as specified by the manufacturer of the weld kit.

The following restrictions limit when field welds can be made, and specify special procedures required under certain environmental conditions:

- a. Field welds shall not be made when the ambient temperature is below 32°F and during inclement weather such as rain, mist, sleet, and snow unless approved by the Engineer.
- b. It is important that weld is not subjected to a sudden strain by releasing hydraulic pressure too quickly. The rail puller/expander shall be left in place until rail has cooled to below 500°F. Any movement of rail before weld has cooled to at least 500°F may result in failure of weld.
- c. Hydraulic rail puller/expander shall be used to establish the proper rail end gap at all thermite weld locations.
- d. When welding rail in track on lines in service, allow sufficient time to complete weld so that surface finish and temperature of welded joint will permit safe operation of scheduled trains without delay to service. Temperature of welded joint should be 200°F or less before rail traffic is allowed to pass over weld.
- e. Thermite field welds shall be made in accordance with and shall not deviate from manufacturer's recommendations and AREMA Chapter 4. Short-cuts in the recommended pre-heating process are prohibited.

Trim and grind weld to meet the following requirements and as otherwise specified by the manufacturer:

- a. Finish weld to the tolerances specified in these provisions.
- b. A rail shear, specifically designed for the purpose, shall be utilized to remove weld upset. Use of a saw, cutting torch, or other hand held devices is prohibited.
- c. A rail profile grinder specifically designed for the purpose shall be utilized to finish grind top and sides of weld. Use of hand held grinder is prohibited.
- d. As specified in these provisions, weld collar in the web zone and base of rail should not be ground except to remove notches created by upset conditions, sharp protrusions, and gouges. These should be blended into the rail and weld collar contour to eliminate possible stress risers. Remove, by grinding, defects visible to the unaided eye. If removal by grinding cannot be accomplished without damaging rail, remove the weld. Take precautions to avoid excessive pressure during grinding of weld in order to prevent overheating of rail surface.
- e. Finish grinding shall be done only when weld temperature is less than 200°F.
- f. Overheating rail when grinding must be avoided. Since weld has cooled to below 200°F prior to grinding, the temperature rise due to grinding should not exceed this level.
- g. Finish rail grinding on top and sides of weld shall be completed prior to operation of trains over weld.

- (4) Weld Identification. Mark weld identification on field side of rail using a permanent metal marker and record required information in conformance with these provisions.
- (5) Weld Cleanup. Clean up and remove waste material such as paper and plastic containers, scraps of metal, slag, and molds.

Move all joint bars to project material storage area.

xx. METHOD OF MEASUREMENT. The quantity of Special Provision (Thermite Welding) to be measured for payment will be the number of welds installed in the complete and accepted work.

xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (Thermite Welding) will be paid for at the Contract unit price per each. Payment will be full compensation for furnishing, transporting, handling, and

placing the materials specified, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The costs for all preparation and training activity will not be paid separately, but will be considered incidental to Special Provision (Thermite Welding).

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
900.620 Special Provision (Thermite Welding)	Each