GUIDELINES FOR THERMIT® WELDING WORK PERFORMED WITH THE ORGO-THERMIT® PROCESS

RULES AND PROCEDURES

SAFETY-PRODUCTIVITY-QUALITY

GENERAL NOTICE

RECOMMENDED GUIDELINES FOR THERMIT® WELDING WORK PERFORMED ON RAILROADS ARE:

SAFETY

A safe work environment should be provided for all employees

The safe performance of the job is more important than the job itself

Training, tools, and resources should be provided as required to ensure a safe and clean workplace

Employees must be responsible for performing their work activities in a safe manner

Employees should be empowered and required to discontinue any activity that involves the use of unsafe practices and tools.

QUALITY

The production of quality Thermit® welds depends on compliance with the rules and procedures published in this manual

Quality workmanship prevents unnecessary cost in the production and maintenance of Thermit® welds and associated track components as well as unnecessary delay of trains.

PRODUCTIVITY

Productivity results from good planning, organization, and efficient execution

Contents

0.0 INTRODUCTION

0.1 Definition

Thermit® Welding is a process that produces coalescence (or "fusion") of metals by heating them with superheated molten metal from an Aluminothermic (Thermit®) reaction between a metal oxide and Aluminum.
Filler metal is obtained from the liquid metal with a liquid slag following.

0.2 Discussion

One of the most common applications of the Thermit® Weld is the butt welding of railroad rail.

The objective of the Thermit® Welding of rail is to join two pieces of rail properly and permanently, end to end, with a butt weld. This is performed by casting molten steel into refractory molds that have been placed around the spacing between the two rails.

Preparatory work requires that the ends of the rail must be straight, and the correct welding gap established. The rail must be properly aligned, with 4 inches either side of the weld, top, sides and bottom of the rail, free of rust, dirt, and grease. Molds are applied and sealed with a sand/clay compound. The rails must then be preheated sufficiently (1600^0 to 1800^0 Fahrenheit) to provide conditions for full fusion between the molten steel and the base metal.

The reaction of the Thermit® material produces a maximum temperature of approximately 3600^0 Fahrenheit of the molten steel in the crucible prior to tapping into the molds. The Thermit® reaction is nonexplosive; however, the presence of any moisture will produce a defective weld and is also potentially dangerous to the welder.
Although it is called a welding process, Thermit® welding resembles a metal casting where proper gates and risers are required to:

- ✓ Compensate for volume shrinkage during solidification
- ✓ Eliminate typical defects that appear in castings.
- ✓ Provide proper flow of molten steel; and
- ✓ Avoid turbulence as the metal flows into the weld gap area.

It is critical to the success of the weld that no movement, shock, or vibration occurs in the rail during the solidification process of the molten steel. The weld metal and rail must cool to 700^0 Fahrenheit prior to allowing any traffic to cross the completed weld or to release a hydraulic rail puller.

Thermit® welders should be responsible and are expected to use good judgment in deciding when to Thermit® weld concerning weather and/or temperature condition.

1.0 APPROVED PROCESSES

1.1 The Orgo- Thermit SkV Thermit® welding processes have been approved for use on all the major railroads, although other manufacturers also exist.

1.2 Each process from the different weld manufacturers is mutually exclusive except as noted in this Manual.

This means that:

- Only Orgo-Thermit and approved Goldschmidt subsidiary materials (molds, portions, crucibles) and hardware are to be used when performing Orgo-Thermit welds.

1.3 The instructions and procedures issued by the manufacturer for the specific Thermit® Welding kit shall be followed, except where superseded by these instructions.

1.4 These instructions and procedures apply to the Orgo-Thermit SkV Thermit® Welding Processes for one (1) inch gap welds using Single Use or Degradable Crucibles where noted, for two piece or 3-piece mold application and 5-minute preheating systems.

1.5 When welding a lower tensile strength rail steel rail to a higher tensile strength rail steel, it is allowed to use either the welding portion for the lower tensile strength rail steel or a welding portion for the higher tensile strength rail steel.

1.6 The recommended welding process for rail steel with running surface hardness of 370 HB and greater is the Thermit® 2.0 portion kit

2.0 SAFETY AND RULES

2.1 GENERAL

- Thermit® Welding creates liquid steel in a crucible from basic elements through a chemical reaction that produces a great amount of super heat (approximately 3600^0 Fahrenheit). The process is properly designed to eliminate the danger of contact with materials at high temperatures if these rules and procedures are followed.

- The presence of moisture in the Thermit® portion or in the crucible can lead to the rapid formation of steam when the Thermit® reaction takes place. 1 part water per unit volume = 1000 parts of steam per unit volume. This may cause ejection of the molten metal from the crucible. Therefore, the Thermit® portion, crucible, and molds must be dry and moisture should not be allowed to enter the system before or during welding.
  (Crucible being Single Use or Degradable crucible)

22 WORK AREA.

Thermit® welders must produce Thermit® welds according to the requirements of the railroads Thermit® Welding Manual (current edition). Producing a Thermit® weld requires at least 45 minutes at the weld site.

A job briefing should be held and include all work groups associated with the performance of the task. It must be clearly established how the work will be performed, who will perform what work, all potential hazards should be identified and means for eliminating the hazards must be identified and implemented. It must be clearly communicated that the welding crew performing the weld oversees the work area and will control the work site.

All site preparations and job processes should be done as outlined in the Thermit® Welding Manual of the applicable Railroad. All employees welding and grinding should have a current copy in their possession.

The ballast section area where the weld is to be made must have ice and snow cleared away, as well as being heated with the preheating torch to eliminate as much moisture as possible.

All employees must stay 8 to 10 feet away from the Thermit® Welding crucible, from the time the portion has been ignited, until the molten metal has poured into the molds surrounding the rail.

If the mold starts to leak ***do not try to save it.***

Safety Rule-

Ensure the work area is free of combustible materials that may be ignited by sparks of small amounts of molten metal. The area must be free of standing water, ice, and/or snow.

Thermit® welding on open deck bridges.

Thermit® Welding on open deck bridges is permitted only when all safety requirements are met.

SAFETY

All employees must comply with bridge worker fall protection requirements. Job briefings that cover the nature of the work must be performed.

FIRE PREVENTION

Welding must not be attempted on or near badly decayed or weathered ties.
Welding or grinding must not be attempted during periods of high winds which would cause sparks to travel abnormal distances. It is suggested that the area be "pre-wet" prior to welding with a soap and water solution. Have water and firefighting equipment readily available. After finish grinding is complete, soak the area thoroughly with water. After welding is completed, a watchman should carefully observe the entire bridge for smoke for a minimum of one (1) hour conditions may require a longer watch.

PROCEDURES

Additional procedures should be used when Thermit® welding on open deck bridges; Ties each side of the joint should be moved to allow base plate and molds to be packed; do not cut or notch the ties.
A bridge gang may be required to space the ties prior to performing the welding operation.
Spike holes should be plugged before welding starts.
Use bags of Thermit® packing sand on top of bridge stringers as a cover.
It is recommended to place a "Wilson 3000 insulating blanket" on top of the packing sand and against the side of ties each side of the weld.
Place two (2) sheets of 1/2 inch plywood painted with a sanded coating between the rails to serve as a work platform.
Use care to prevent slag from dropping on the bridge.
Ensure to use spark guard devices when cutting or grinding the rails.
Do not drop or throw any HOT metal, molds or slag into water or combustibles under the bridge.

2.3 APPLICABLE RULES.

Thermit® weld installation shall comply with the applicable Rail Roads published rules and procedures, which should also include.

- Safety rules and procedures.
- Maintenance of Way rules.
- Track welding rules

2.4 PERSONAL PROTECTIVE EQUIPMENT.

2.4.1 Thermit® welders must wear appropriate protection from hot particles and sparks Including approved eye, hearing, and hand protection, hard hat, and protective footwear. Clothing should not have uncovered pockets or frayed cuffs that may catch hot particles and ignite. Preheating and observation of the weld pour should be performed, taking all safety precautions applicable, to the use of oxy-fuel gas equipment.

2.4.2 Thermit® welding requires the use of the following minimum approved personal protection equipment:

- Hard Hat.
- Face Shield.
- Safety Glasses with permanently attached side shields.
- Impact resistant goggles.
- Welding goggles or face shields equipped with filtered lens; +
    - When preheating, shades shall be equal to shade: # 5
    - Checking rail ends after preheating, shade: # 2.5
- Hand Protection, Gloves.
- Leggings, and
- Protective footwear.
- Welder's jacket or sleeves.

2.4.3 Hand Protection.
All leather, gauntlet-type gloves that have a cloth liner for insulation shall be worn when using a torch for heating, welding, or cutting, or handling hot tools and equipment.

❖ Non-insulated gloves are recommended when packing (sealing) Orgo-Thermit molds.

2.5 Respirators or air filters are not required for Thermit® welding work, however they should be provided to welders upon request.

2.6 Respirator Policy.
Normally Railroad's adopt their own respirator policies, to ensure the health and wellbeing of the welders, and to comply with Federal OSHA 29 CFR 1910.134 and various State OSHA Regulations:

a. Respirators should be worn to control exposures to contaminants, when engineering/ administrative controls are not feasible, or as an interim control until such controls are implemented.

b. Respirators shall not be worn when conditions prevent a continuing, effective, face piece to face seal. Facial hair (long sideburns and mustaches, greater than one day stubble growth), spectacle temples, skull caps, scars, excessive weight loss or gain, etc. which, interfere with the proper fit or function of the respirator, should not be allowed, while wearing a respirator.

Proper sizing, fitting, training, and certification, provided by a competent trainer, are required prior to a welder wearing a respirator into a hazardous atmosphere.

3.0 QUALIFICATION

3.1 Only welders that are qualified must be permitted to produce Thermit® welds. Qualified welders should have written authority from the respective Rail Road's Track Welding Supervisor.

3.2 Welders in training are normally permitted to produce a Thermit® weld under the **DIRECT** supervision of a qualified welder when authorized by the proper authority to do so.

3.3 Welders must be qualified in:

a. The appropriate railroads welding procedures.
b. The specific manufacturer's processes used.
c. The specific type(s) of preheating equipment used. (Gas, propane/air)
d. Straight Thermit® welds (2 piece or 3-piece molds)
e. Compromise Thermit® welds. (Off set base and different rail sizes)
f. Rail end gap preparation
g. Rail end alignment and proper preheating
h. Rough grinding; and
i. Finish grinding.

3.4 It is suggested that the qualification for Thermit® welding consists of a welder fulfilling four requirements.

a. Satisfactory completion of a minimum of twenty-five (25) Thermit® welds under the direct supervision of a Track Welding Supervisor, a Qualified Thermit® Welding Factory Representative or a Qualified Thermit Welder from the Railroad.

- ❖ The person requiring qualification should perform the preheating of each of these 25 welds.

b. Satisfactory completion of an additional four (4) Thermit® welds under the direct examination of the Railroads Track Welding Supervisor.

- ❖ The person requiring qualification should complete these welds from initial preparation through finish grinding and shall perform the preheating.

c. Satisfactory completion of a written rules' examination regarding correct Thermit® welding practices.

d Attendance and satisfactory completion of a Thermit® Welding Training course offered at a Railroad's College as scheduled and directed by the Track Welding Supervisor or at the manufacturers training center.

- Completion of this course should not preclude the satisfactory completion of Sections 3.4a, b and c.

3.5 It is suggested that welders be examined and have their qualification listing updated in the event of:

a. A change in any of the parameters identified in Section 3.3 occurs; or
b. The welder has not performed a Thermit® weld for a period of six months; or
c. There is sufficient reason to suggest the welder is not following proper procedures, as determined by a Track Welding Supervisor.

3.6 Examination of Thermit® welders for the conditions identified in Section 3.5 should require:

a. The satisfactory completion of ten (10) welds under the direct supervision of a Track Welding Supervisor, a Qualified Thermit® Welding Factory Representative or a Qualified Railroad Thermit® welder.
b. Satisfactory completion of an additional two (2) Thermit® welds under the direct examination of the Railroads Track Welding Supervisor.

3.7 Welders should be required to pass written rules examinations to ensure adequate knowledge in the existing Thermit® Welding Procedures and in the event of changes in equipment or procedures, or the introduction of a new Thermit® welding process.

4.0 GENERAL RESTRICTIONS/LIMITATIONS

4.1 Individual Thermit® welds should be the responsibility of the welder who performs the preheating of the rail ends.

4.2 It is recommended that Thermit® welds be prohibited and should not be installed when the following conditions exist.

- On rail ends with the end bolt holes drilled.
- Within 4-1/8 inches of the edge of any hole in the rail.
- Within 2 inches of a cad weld or copper bond wire installation, if this type of bond exists, remove any presence of copper by grinding. The rail ends must then be inspected and cleaned after the grinding is complete.
- Closer than 2 feet from an existing plant weld.
- Closer than 14 feet to an existing Thermit® weld. Closely spaced Thermit® welds, which are brittle by nature compared to rail and flash butt welds, have contributed to derailments. Fourteen feet is slightly longer than a three-axle locomotive.
- EXCEPTION: Thermit® welds can be placed closer than 14 feet but not less than 4 feet to existing Thermit® welds if the alternative is a rail joint, or if additional lengths of rail would have to be cut in to keep Thermit® welds at 14 feet apart. No bolt holes should exist between the 4-foot section of rail for Thermit® and 2-foot section for plant welds.
- On both ends of a rail "plug" simultaneously unless the rail is 24 feet long or more in length.
- On rail ends that have been repaired by electric arc welding.

4.3 The use of a rail puller is recommended for installing all closure welds.

5.0 TEMPERATURE RESTRICTIONS.

5.1 It is recommended to perform Thermit® welding at rail temperatures of 40^0 Fahrenheit and above.

5.2 Normally Thermit® welding is permitted when rail temperatures are below 40^0 Fahrenheit and above 0^0 Fahrenheit, providing additional welding procedures, as described in Table 6.1 is followed.

5.3 Thermit® welding is prohibited when the rail temperature is 0^0 Fahrenheit and below.

6.0 WEATHER CONDITIONS

6.1 It is strongly recommended that Thermit® welding be performed in dry weather conditions.

6.2 Thermit® welding in light moisture conditions is permitted, *if and only if,* the weld area, welding materials (portions, molds, and crucibles), and the finished weld can be positively protected from the moisture. The use of a welding umbrella or other covering device is recommended.

6.3 When welding in light moisture conditions, the Thermit® weld must be covered immediately after shearing until it cools below a temperature of 700^0 Fahrenheit. If the weld and the weld area cannot be protected from the moisture, welding operations should be suspended.

6.4 It is strictly prohibited to Thermit® weld in heavy moisture conditions such as heavy rain, sleet, and blowing snow.

6.5 Additional preheating and slow cooling requirements for working in adverse weather conditions are identified in Table 6.1

RAIL TEMPERATURE	WEATHER CONDITIONS	
	Clear	Wind, Rain, or Snow
≥ 40° F	• Air cool • A weld cooling cap is not required.	• Apply weld cooling cover* immediately after shearing • Leave cover in place until weld has cooled below 700° F (Approximately 35 minutes)
< 40° F and > 0° F	• Prior to the application of the molds, preheat rail head and base to hand warm temperature (110° F) for 3 feet on both sides of weld gap. • Complete weld and unmold normally. • Apply cooling cover* immediately after shearing • Leave weld cover in place until weld has cooled below 700° F (Approximately 35 minutes)	
≤ 0° F	• NO THERMITE WELDING PERMITTED	

> : Greater Than **≥ : Greater Than or Equal To** ***Welding Blanket or Full Cooling Box**

< : Less Than **≤ : Less Than or Equal To**

Thermite Welding Requirements for Adverse Weather Conditions

TABLE 6.1

7.0 RAIL REQUIREMENTS

7.1 It is recommended that the minimum length of rail to be Thermit® welded be:

a. 16 feet on tangent track; and
b. 18 feet in curves.

7.2 Glued bonded insulated joint assemblies are one unit length.

7.3 Rail should not be used that has poor rail conditions, such as:

1. Severe head checking and spalling.
2. Crushed heads.
3. Wheel burns.
4. Battered butt welds.
5. Welds kinked to field or gauge side.
6. Welds that are low or crowned outside of allowable tolerances; or
7. Any surface bends condition in the rail.

7.4 The actual length of a replacement rail should be determined by the specific location, and should follow the following guidelines:

a. The existing rail should be examined for poor rail conditions. (Section 7.3)
b. The length of replacement rail should be sufficient to remove these poor rail conditions.
c. Existing Thermit® welds should always be eliminated, where practical.
d. Rail should always be cut, where practical, such that the Thermit® weld will be performed in an existing tie crib and ties will not have to be moved; Where compromise Thermit® welds is required, the rail must be of sufficient length, such that the compromise welds are performed directly across each other in the same tie crib.

7.5 Replacement rail supplied to repair a defective weld or defective rail should:

a. Be the same rail section as the existing rail.
b. When rail must be added at a compromise weld location, the smaller rail section of the two should always be used.
c. Match as close as possible, the rail head contour of the existing rail.
d. Match as closely as possible, height and/or gage face wear of the existing rail.
e. (Maximum differentials are described in Section 7.7 and 7.10 and 7.11).
f. Be the same rail type as the existing rail; (Replace standard carbon rail with standard carbon rail, and replace premium rail with premium rail)
g. Be in good surface condition (Section 7.3)

7.6 It is not recommended to Thermit® weld a non-curve worn rail to a section of curve worn rail, especially on the high side of a curve.

7.7 The maximum difference in curve worn rail head width should not exceed one eight(1/8) inch on the gauge side of the rail head. A one sixteenth (1/16) inch maximum is recommended. This measurement for curve wear should be taken at the top of the rail head.

7.8 When large compromise welds (big off sets) exist on main and siding tracks, they should be replaced with a suitable transition rail.

7.9 Existing rail and replacement rail should be inspected for surface bend using a three-foot straight edge. Any surface bend condition must then be removed.

7.10 Thermit® welding of the same rail sections is permitted, *if and only if,* the appropriate standard or compromise welding molds are used within the height differentials outlined in Table 7.1. It is of utmost importance for the fatigue performance of the weld that the welders keep strictly to these laid down rail sections, height differentials and appropriate molds to be used. The approved sections and rail height differentials are:

RAIL	HEIGHT DIFFERENTIAL	MOLDS
112 RE to 112 RE or 115 RE to 115 RE	0 through 1/8	115 Standard 115 Head/Worn
	> 1/8 through 1/4	115 New to Worn
	> 1/4	Weld Prohibited
119 RE to 119 RE	0 through 1/8	119 Standard 119 Head/Worn
	> 1/8 through 1/4	119 New to Worn
	> 1/4	Weld Prohibited
132 RE to 132 RE	0 through 1/8	132 Standard 132 Head/Worn
	> 1/8 through 1/4	132 New to Worn
	> 1/4	Weld Prohibited
129 TR to 129 TR or 136 RE to 136 RE	0 through 1/8	136 Standard 136 Head/Worn
	> 1/8 through 1/4	140/136/132 Compromise 132 New to Worn
	> 1/4	Weld Prohibited

Standard Molds

TABLE 7.1

7.11 Thermit® welding of different rail sections is permitted, *if and only if,* the appropriate compromise welding kit is used within the height differentials outlined in Table 7.2. It is of utmost importance for the satisfactory fatigue performance of the weld that the welders keep strictly to these laid down rail sections, height differentials and appropriate molds to be used. The approved sections and height differentials are:

RAIL	HEIGHT DIFFERENTIAL	MOLDS
112 RE to 115 RE	0 through 1/8	115 Standard
	> 1/8 through 1/4	115 New to Worn 115/119 Compromise
	> 1/4	Weld Prohibited
112 TR to 115 RE	0 through 1/8	115 Standard
	> 1/8 through 1/4	115 New to Worn 115/119 Compromise
	> 1/4	Weld Prohibited
115 RE to 132 RE	1/4 through 1/2	115/132 Compromise
	> 1/2	Weld Prohibited
115 RE to 136 RE	1/4 through 1/2	115/136 Compromise
	> 1/2	Weld Prohibited
132 RE to 129 TR	0 through 1/8	132 Standard
	> 1/8 through 1/4	140/136/132 Compromise 132 New to Worn
	> 1/4	Weld Prohibited
129 TR to 136 RE	0 through 1/8	136 Standard
	> 1/8 through 1/4	140/136/132 Compromise 132 New to Worn
	> 1/4	Weld Prohibited
132 RE to 136 RE	0 through 1/8	132 Standard
	> 1/8 through 1/4	140/136/132 Compromise 132 New to Worn
	> 1/4	Weld Prohibited

Standard and Compromise Molds

TABLE 7.2

8.0 RAIL MOVEMENT & TRAFFIC RESTRICTIONS

8.1 Movement or vibration of the rail after alignment or after the molten weld metal pour has been completed is detrimental to the weld. Movement in the rail can:
Alter the welding gap width more than allowable tolerances. Alter the crown or alignment of the rail ends. Interrupt the solidification process creating a hot tear in the weld.

8.2 Upon beginning alignment of the rail ends, all potential sources of rail movement or vibration must be stopped in the immediate work area until after the Thermit® weld is completed and the head riser removed. Vibration source examples include, but are not limited to the application of spikes, anchors, concrete tie clips, and the tamping of ties.

8.3 Train traffic should be restricted from passing the welding location:
When working on double track, or any other location where train traffic is passing the work location on an adjacent track, or Vibration or rail movement is evident.
This restriction shall be maintained from the time the weld pours until after the Thermit® weld is completed and the head riser is removed.

8.4 When producing Thermit® welds at or near a road crossing and vibration is evident, all vehicle traffic should be stopped from crossing the rail at the road crossing:
From the time alignment of the rail begins, until after the Thermit® weld is completed and the head riser is removed.

8.5 Welders must observe the rail ends after the weld metal has poured for any movement. If the rails pull apart during this initial cooling phase, even the slightest amount, the weld should be considered defective and must then be replaced.

8.6 Train traffic, heavy pieces of work equipment, and hi-rail welding trucks should not be permitted across a completed Thermit® weld until:
The running surface and gauge face of the rail head are ground within fifty thousandths (0.050) of an inch of finish grinding tolerances.
The weld metal temperature is less than 700^0 Fahrenheit.
Crown and twist wedges have been removed; and
The weld is properly supported by a tamped tie on each side.

8.7 When a rail puller is used to position the rail for a Thermit® weld, the pressure shall be maintained until the weld temperature is below 700^0 Fahrenheit.
(*A temperature of 700^O F is generally reached approximately thirty to thirty-five minutes after the head riser is removed).*

9.0 CONCRETE TIES

9.1 Thermit® welders should ensure that concrete ties are not damaged in any manner when preparing or performing a Thermit® weld.

9.2 Concrete tie pads should be removed from the concrete ties prior to Thermit® welding production. Remove concrete tie pads from one tie on each side of the weld gap.

9.3 After completion of the Thermit® weld, polyurethane tie pads should be placed on each tie adjacent to a Thermit® weld.

a. When welding on tangent track or on curves less than 3^0 only the polyurethane pad is normally used.

b. When welding on curves greater than 3^0, the three (3) piece polyurethane pad should be used.

9.4 Polyurethane pads should not be placed, after welding, on ties adjacent to Thermit® welds until the temperature of the rail base, one (1) inch from the edge of the tie pad, has cooled below a temperature of 250^0 Fahrenheit.

9.5 If the standard EVA pad, (black, without shoulders) must be used after Thermit® welding on the ties adjacent to a Thermit® weld, the EVA pad should not be replaced until the rail base, one (1) inch from the edge of the tie pad, has cooled below a temperature of 150^0 Fahrenheit.

10.0 SWITCHES

10.1 When welding in switches, the switch points should be centered and square before welding. Normally panel switches are built with no gap between rail ends to allow for Thermit® welding. A one (1) inch gap must then be cut at all weld locations.

11.0 TRACKWORK PREPARATION

11.1 Permission to occupy the track should be secured as required by the Railroad instructions

11.2 Track at the Thermit® weld site should be in proper surface and line, prior to beginning a Thermit® weld installation.

11.3 Ties should be spaced, as required, to allow sufficient room for application and packing of the mold jackets. A minimum distance of four (4) inches is required from the edge of the tie to the end of the rail at the weld gap.

11.4 Notching of ties to allow room for installing a Thermit® weld is prohibited.

11.5 The welder in charge should check the rail surface of the joint to be welded

If the joint to be welded is low, it should be raised, and ties tamped prior to the removal of the joint bars.

11.6 All ties adjacent to the joint to be eliminated should be raised and tamped as required, so that they will not move during the welding process.

11.7 Rails to be welded should be inspected to ensure that:

a. The correct Thermit® Welding Kit is available for the size and type of rail to be welded.

b. The rail height and head width differential are within the allowable limits and the correct stepped molds are available for the rail height differential, if the differential is within the allowable limits

c. All surface bend condition has been removed; and

d. Rail surface condition is acceptable.

11.8 Rail spikes should be driven down, eight (8) ties on both sides of the joint to be eliminated

11.9 In normal operation, track spikes (or rail clips) should be removed from one (1) tie each side of weld crib if using a magnetic straight edge, two (2) ties each side of weld crib if using a standard straight edge.

11.10 Areas should be prepared for the un-molding operation. These areas are the locations where:

A. The hot used crucible will be placed after removal from the weld.

- ❖ This location shall be level and dry.

B. The slag pans will be placed to complete cooling after removal from the mold shoes.

- ❖ This location must be level and dry, free from any water, snow, or ice.
- ❖ The pathway to this location must be determined such that the employee has sound footing and cannot slip while carrying the slag pan.

12.0 RAIL END PREPARATION

12.1 All bolt holes should be eliminated, where practical.

12.2 If bolt holes are elongated, the bolt holes must be removed, or the rail should be rejected.

12.3 If bolt holes are left in the rail to the side of a Thermit® weld they should be reamed with the Rail Roads approved bolt hole reaming device.

- ❖ Each bolt hole should have a one thirty- second (1/32) of an inch bevel on each side of the bolt hole.
- ❖ The use of a one (1) inch grinding stone to bevel bolt holes is prohibited.

12.4 The underside of the base of both rail ends must be inspected for any broken area. If a broken out area is found; it must be completely removed.

12.5 On head worn rail where rail head flow exists, the flow (lip) must be removed by grinding through the mold application area (approximately four (4) inches from the rail end) prior to producing the weld.

12.6 On curve worn rail, rail flow can exist under the head of the rail. This flow must be removed by grinding for approximately twelve (12) inches from the rail end, prior to performing the weld. After grinding is completed the rail head should be checked to ensure the weld shearing machine will properly fit over the rail head.

12.7 Rail ends that exhibit any batter at one (1) inch from the end of the rail must not be welded.

12.8 Torch cutting is often required to remove expanded rail such that a welding gap can be achieved. Where tight rail conditions exist and a saw cut cannot be performed, remove only enough rail by torch cutting so that an additional one half (1/2) inch of rail will be removed in final gap preparation by rail saw cut from the torch cut end.

12.9 Torch cuts should be allowed to cool for two (2) to five (5) minutes prior initiating a saw cut on the same rail end. This is to minimize any saw blade warp due to heat.

12.10 If a rail end has been torch cut and thirty (30) minutes has elapsed since the torch cut was performed; a minimum of six (6) inches should be removed from the rail end.

12.11 Torch cutting of rail for final gap preparation is normally prohibited.

12.12 It is suggested that a saw cut be the ONLY acceptable type of cut for final gap preparation.

12.13 All rail ends must be checked after completion of final saw cuts to ensure the square-ness of the cut is within tolerance. The maximum out of square tolerance for rail ends is:

a. 1/8 inch in the vertical plane, and
b. 1/8 inch in the horizontal plane.

12.14 A correct welding gap must be established.

12.15 Welding gap width tolerances for Orgo- Thermit, 1 inch Thermit® welds are as follows: Strictly keep to the agreed gap, as small gaps can lead to possible shrinkage cavity defects, and gaps larger than the prescribed gap width can lead to possible lack of fusion defects.

WELD TYPE:	WELD GAP MINIMUM	WELD GAP MAXIMUM
SKV-F 1 inch gap weld.	1 inch.	1-1/8 inch.

12.16 The weld gap must be checked to ensure it meets established tolerances.
The welding gap must be checked at three locations:
Top center of the Rail Head.
Gauge Edge of Base; and
Field Edge of Base.

12.17 If the weld gap is not within tolerances, the rail should be repositioned or recut.

12.18 Rail ends to be welded should be cleaned with a wire brush for six (6) inches from the rail end until this area is FREE OF GREASE, RUST, DIRT AND OTHER FOREIGN MATERIALS. Particular attention must be paid to cleaning the underside of the base of the rail ends. The cleaner the work pieces are prior to welding; the better-quality weld will be installed. Grease is a hydrogen bearing compound and can lead to possible gas induced porosity.

12.19 All cutting fins or burrs shall be removed with a file. Particular attention must be paid to the removal of fins or burrs from the underside of the base of the rail ends.

12.20 After the proper weld gap has been established, the base of the rail and a spiked tie plate (or concrete tie clip) on both sides of the weld gap must be marked with a soapstone or crayon such that any longitudinal (lengthwise) movement of either rail is evident.

13.0 RAIL END ALIGNMENT

13.1 General Alignment.

a) The purpose of the alignment of the rail ends is to properly position the rail ends such that, after the weld has been completely cooled to ambient temperature, the rail through the weld area is perfectly flat and perfectly straight with no twist between the vertical axes of the rail ends.

b) The rail alignment must be checked visually, from approximately 39 feet from the weld in both the vertical and horizontal plane.

- ❖ Vertical alignment (crown) is checked by sighting under the ball of the rail to ensure that proper crown exists.
- ❖ To achieve vertical alignment if a flat plateau or concave surface exists, it may be necessary to set a jack approximately 15 feet from the joint on the low rail. Raise the rail up so that it is level with the higher rail, and then check the alignment at the joint.
- ❖ When welding two rails of different heights, (new/used or compromise welds) and a vertical offset exist, a jack on the smaller rail is needed.
- ❖ Horizontal alignment is checked by sighting along the top of the rail to ensure there is no horizontal kink.

c) Alignment of the rail ends is accomplished with aligning wedges and track spikes or with a special engineered rail alignment tool.

d) Alignment of the rail ends is performed with a straight edge and taper gauge.

- ❖ The head and web of the rail must be performed by using a 36- inch straight edge. A magnetic straight edge is preferable.
- ❖ If using a magnetic straight edge, it must be calibrated each day before use.
- ❖ An 18- or 24-inch straight edge may be substituted to align the base.

e) The standard routine for aligning rail ends uses the following procedure:

- ❖ Establish a rough crown.
- ❖ Align the gauge face of the base of the rail ends.
- ❖ Align the gauge face of the rail head by removing twist; and + Establish final crown.

f) Upon beginning the alignment of the rail ends:

- ❖ The entire Thermit® welding procedure should be completed prior to allowing any traffic to cross the joint. (Refer to Section 8.6); and
- ❖ All potential causes of shock or vibration to the rail must be eliminated until the head riser of the completed weld is removed. (Refer to Sections 8.2, 8.3, and 8.4)

13.2 Vertical alignment

a. Vertical alignment should provide for a smooth-running surface. Any difference in height should be in the base of the rails. Vertical alignment should be performed in the center of the head of the rail.

- ❖ Grinding a ramp on the rail head to adjust the height of the rail is prohibited.

b. The rail should be crowned such that no vertical offset exists and a gap of between 0.065 and 0.075 of an inch exists on each end of a 36- inch straight edge. These measurements should be within five (0.005) thousandths of each other. Adjustments should be made as required such that the rail is level after cooling; no droop should be accepted. (Figure 13.1)

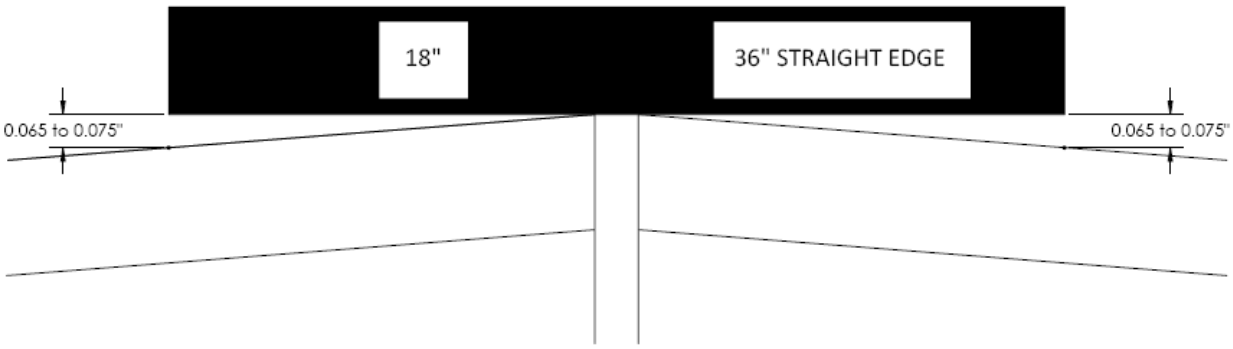


Figure 13.1

Location of Straight Edge and Crown

Balance Straight Edge
SIDE VIEW OF RAIL HEAD

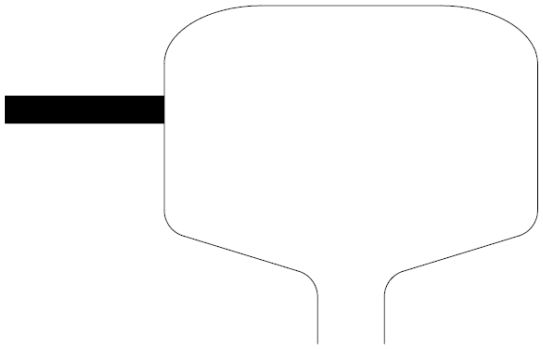


Fig. 13.2 No Gauge Face Wear

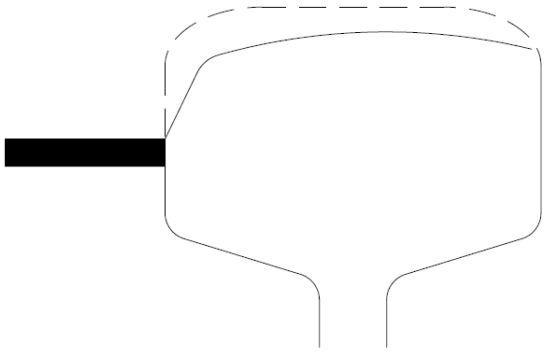


Fig. 13.3 Rail with Medium Gauge Face Wear

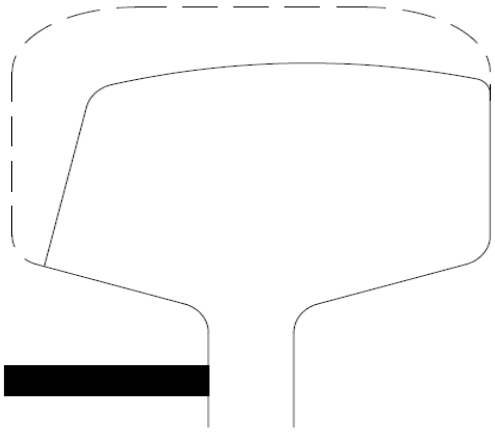


Fig. 13.4 Rail with Extreme Gauge Face Wear

Straight Edge Location for Gauge Face Wear

END VIEW OF RAIL HEAD

13.3 Horizontal Alignment.

a. Horizontal alignment of the head of rail of the same section should be performed on:

The gauge face of the rail head, if the rail exhibits no gauge face wear; (Figure 13.2)
The gauge face of the rail head below the worn section of the gauge face, when the rail is curve worn and an original portion of the gauge face exists; (Figure 13.3)
The web of the rail, when curve wear is so extreme on the gauge face, that the entire gauge face has experienced wear. (Figure 13.4)

b. Horizontal alignment of the head of rail of the same section should be performed on the gauge side of the head such that the rail is perfectly straight with no kink:

- For rail of equal head width, (within 1/16", excluding curve wear), no offset should exist along the entire length of the three (3) foot straight edge with the weld gap positioned at the midpoint. (Figure 13.5)

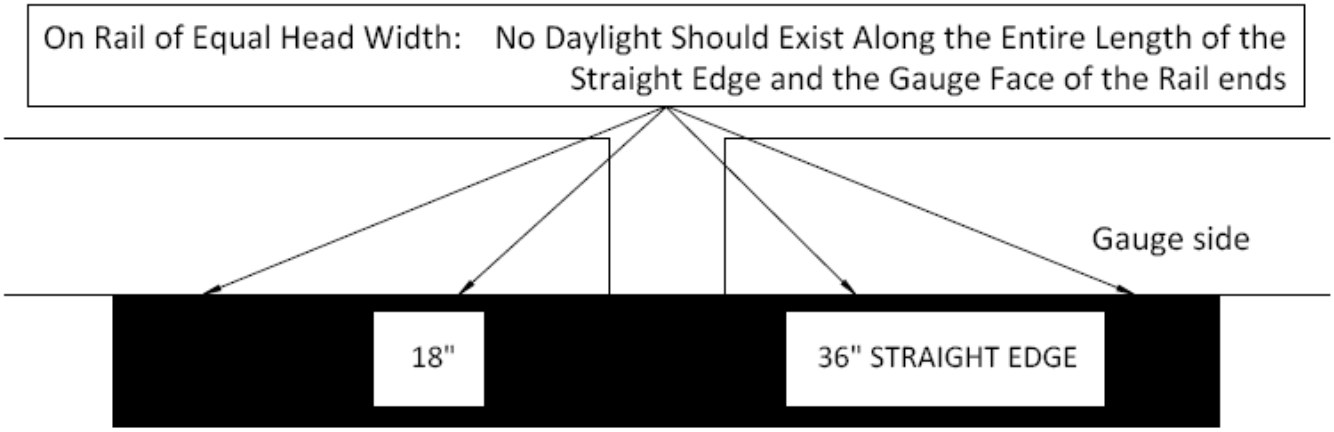


Fig 13.5

c. For rail of unequal head width, for example 132 lb. to 136 lb. (over 1/16" excluding curve wear), any difference in the width of the rail heads should be equally divided. The straight edge should be flush with the larger rail and the gap between the straight edge and the gauge face of the smaller rail must be uniform in width.
(Figure 13.6)
This alignment should be performed such that no twist exists between the rail ends.

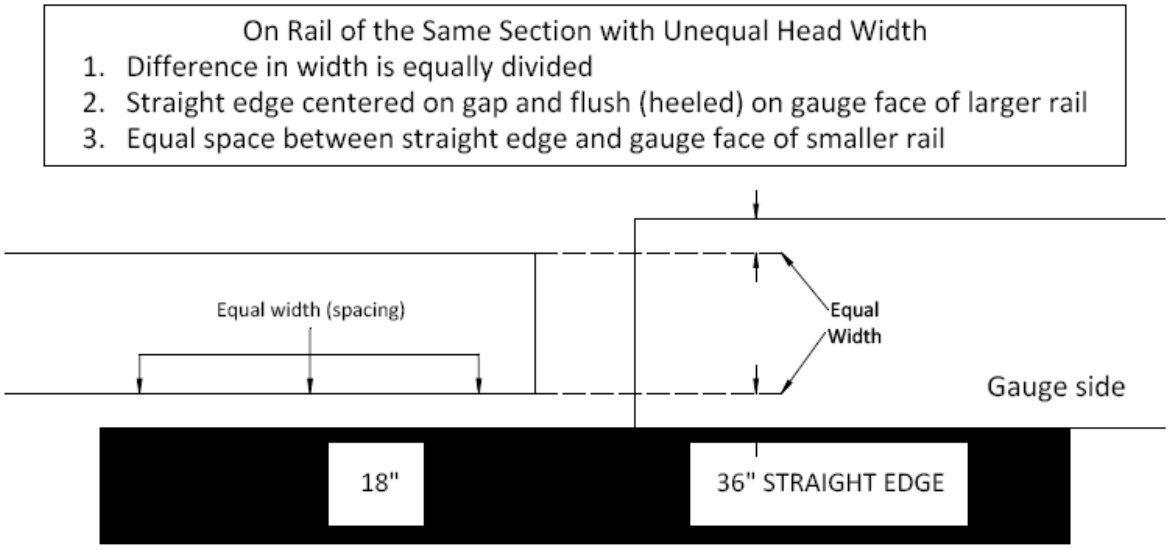


Fig. 13.6

Straight Edge Location for Rail Ends of Unequal head Width
TOP VIEW OF RAIL HEAD

d. Horizontal alignment of the base of rail of the same rail section should be done in such a manner that any difference in the width of the base of the rail ends is equally divided on both sides of the base such that true alignment of the webs of the rail ends is maintained.

13.4 Final alignment.

A visual alignment must be checked by eye from approximately 39 feet from the weld in both the vertical and horizontal plane.

Vertical alignment (crown) is checked by sighting under the ball of the rail to ensure that proper crown exists.

Horizontal alignment is checked by sighting along the top of the rail to ensure there is no horizontal kink.

13.5 Final gap check.

After completing the alignment of the rail ends, the weld gap must be checked to ensure it remains within tolerance.

13.6 Compromise Weld Alignment – Rail of Different Rail Sections.

- Vertical alignment of the compromise welds is performed in the same manner as straight welds.

- Horizontal alignment of the head of the rail, on rail ends of different sections, shall be performed on the gauge face such that the rail is perfectly straight, with no kinks. Any difference in width or offset occurs on the field side of the rail head. (Figure 13.7 shows the correct horizontal alignment of the rail head for a 115/132 # compromise weld).

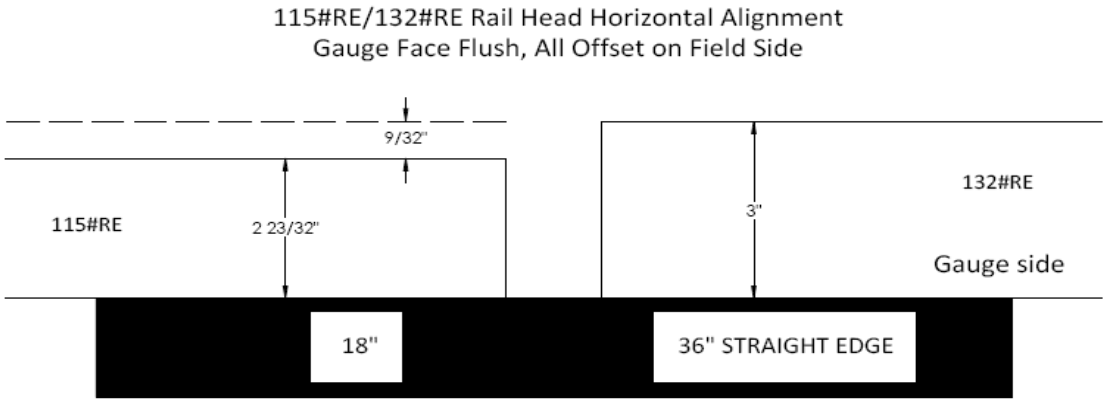


Fig. 13.7

Correct Alignment of Rail Head for 115/132 Compromise Weld
TOP VIEW OF RAIL HEAD

c. The gauge side of the base of the 115 # rail must be positioned at 1/8” in from the base of the 132# rail. This 1/8” offset on the gauge side of the base produces a parallel 1/8” offset in the vertical axes of both rails, such that no twist exists.

- ❖ A resulting 3/8” offset will occur between the 132# rail base and the 115 # rail base on the field side. (Figure 13.8)

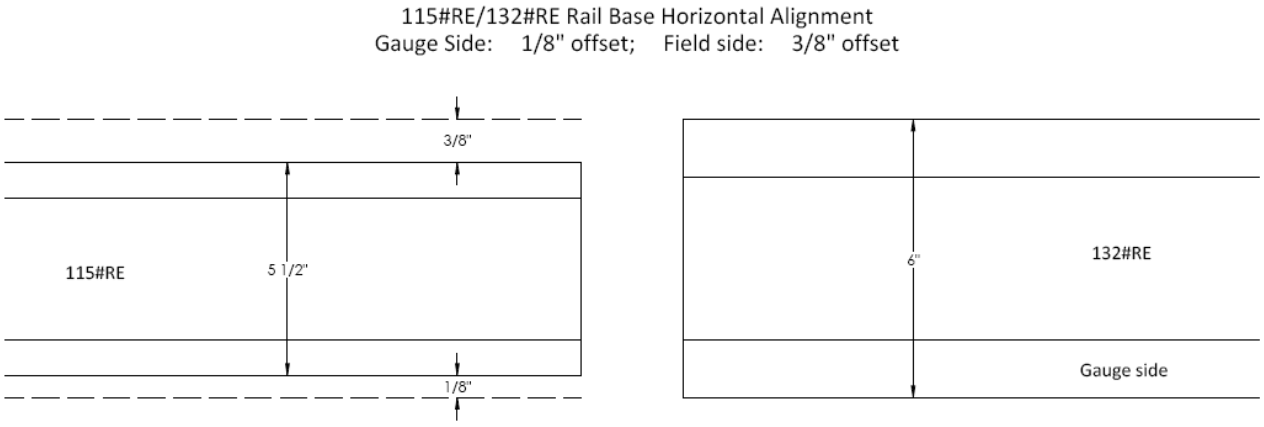


Fig 13.8

Correct Alignment of Rail Base for 115/132 Compromise Weld
TOP VIEW OF RAIL BASE

13.7 After completing the alignment of the rail ends, the alignment must be checked from approximately 39 feet from the weld in both the vertical and horizontal plane.

- A vertical alignment (crown) is checked by sighting under the ball of the rail to ensure that proper crown exists.
- Horizontal alignment is checked by sighting along the top of the rail to ensure there is no horizontal kink.

13.8 After completing the alignment of the rail ends, the weld gap must be checked to ensure it remains within tolerance.

14.0 UNIVERSAL CLAMP APPLICATION

14.1 When welding on a rail plug that is shorter than 20 feet, the setting gauge should be positioned such that the universal clamp will be positioned on the full-length rail or string – not the rail plug.

14.2 When welding on strings or rail longer than 20 feet, the setting gauge should be positioned such that the universal clamp is upwind of the welding gap.

14.3 Place the setting gauge in the welding gap on top of the rail in accordance with Section 14.1 and 14.2. for 2-piece molds. For 3-piece molds settings see 16.0.1.12

14.4 Position the Universal Clamp on the rail head such that it is:
Flush with the end of setting gauge, and
In a vertical position to the horizon.

14.5 After the Universal Clamp is correctly positioned, tighten the clamp firmly with a crescent wrench.

14.6 Torch height and square ness shall be checked prior to alignment of rail ends. (Refer to Section 23 Preheating, General)

15.0 MOLD SELECTION & PREPARATION. (2 piece or 3-piece mold application)

15.1 It is very important that the proper size molds be selected for the rail ends to be welded. Refer to Tables 7.1 and 7.2.

15.2 Each section of the mold pair must be inspected:

- Verify the molds are the correct size.
- Molds that are wet, or have evidence as having been wet, shall not be used. Report these molds as being unusable and dispose of properly.
- Molds that are broken, where pieces of the mold are missing, shall not be used. Report these molds as being unusable and dispose of properly.
- Molds that are cracked or broke, but are repairable, may be used if the crack is not severe
- Pouring channels and riser holes should be cleared of any obstructions or fins.

15.3 Place each mold in its mold shoe.
The sides of the mold shoe must fit tight.
If they do not fit tight, remove the mold, and adjust the mold shoe as necessary to achieve a tight fit.

15.4 Place the field side mold half on the rail, centered on the gap.
Check for fit and straightness.

15.5 Match the gauge side mold half to the field side mold.

15.6 Where filing is required to achieve proper fit:

Filing shall take place on the outer edges of the mold only.
Filing of the web collar is prohibited.
Molds may be filed on the outer edge of the ball to adjust for rail height and width differential.
Molds shall be filed on the landing area of the base only, to adjust for vertical straightness. (Figure 15.1)
Do not file more than 1/4” of mold material away.
NEVER OVER FILE A MOLD, THIS MAY LEAD TO EXCESSIVE FLASHING OR FIN and can disturb the solidification pattern of the weld.

15.7 Molds should fit vertically with relation to the rail.

15.8 Molds may be lightly rubbed longitudinally on the rail to obtain proper fit of the molds in the web of the rail.

15.9 Mold halves should not be rubbed at the same time or against each other.

15.10 Mold halves should fit tightly to the rail and to each other. Thermit® welders should ensure no large gaps exist between:

a. The web area of the mold and the web area of the rail; or

b. Between the two mold halves.

c. Between the mold and the base of the rails.

d. Between the mold and the base/web fillet area.

e. Between the mold and the crown/web fillet area.

A tight fit up of the molds to the rails, all around the rail profile, is very important for the satisfactory fatigue performance of the weld.

Where mold collars are filed away or are reduced in depth, these collar depths must be filed back into the mold, otherwise shrinkage cavity defects may form VERY IMPORTANT.

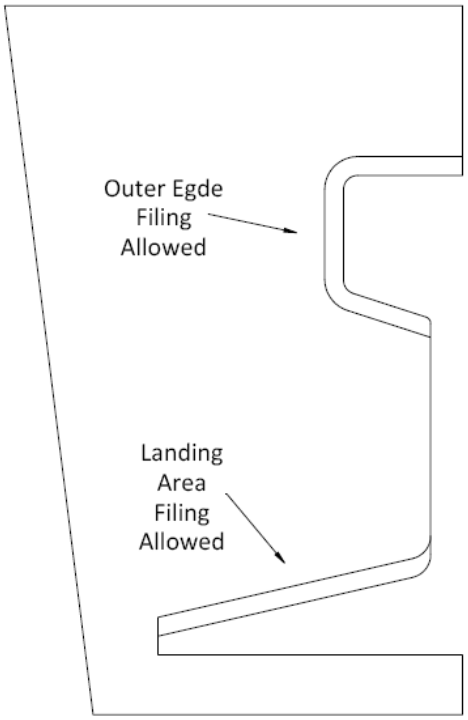


Fig. 15.1

Orgo-Thermit Mold Half
Allowed Mold Filing Locations
SIDE VIEW

16.0 TWO PIECE MOLD INSTALLATION

16.1 The field side mold half, in the mold shoe, is applied.

- ❖ It should be centered on the gap and the swivel arm screw of the universal clamp slightly tightened, while lifting upwards on the mold shoe.
- ❖ The swivel arm should be left in a horizontal position.
- ❖ The guidelines in the web of the molds (if present on the mold half), should be used to ensure that the mold is centered and vertically straight with the rail ends. Molds that are not centered and vertically straight can lead to possible lack of fusion defects in the rail base.

16.2 The gauge side mold half in the mold shoe is then applied.

- ❖ It is matched to the field side mold half at the base and at the top.
- ❖ The swivel arm screw is slightly tightened while lifting the mold shoe upwards.
- ❖ The swivel arm should be left in a horizontal position.

16.3 The bottom of the base of both mold shoes should be tapped lightly with a hammer.

- ❖ Recheck the mold position to ensure that they are flush at the top and bottom, fitting tightly together and to the rail.

16.4 Final alignment of the mold halves in relation to the rail ends and each other is performed by sighting down through the top of the molds. When properly aligned:

- ❖ The interior edges of the mold halves will be even.
- ❖ Equal lengths of each rail end will protrude from each side of the molds; and
- ❖ The web collars of each mold half will be vertical, parallel, and directly across from each other.

16.5 Upon achieving proper alignment of the molds, tighten each swivel arm screw no more than 1/2 turn.

- ❖ The swivel arm screws should be left in a horizontal position.
- ❖ Over tightening of the swivel arm screws can cause the molds to crack.

16.6 The fit of the diverting plug should then be checked.

16.7 When welding in a curve, the top or bottom of the diverting plug should be filed, such that it sits horizontal when installed. (Figure 16.1)

- ❖ This filing achieves uniform distribution of molten Thermit® Steel to each of the mold halves.

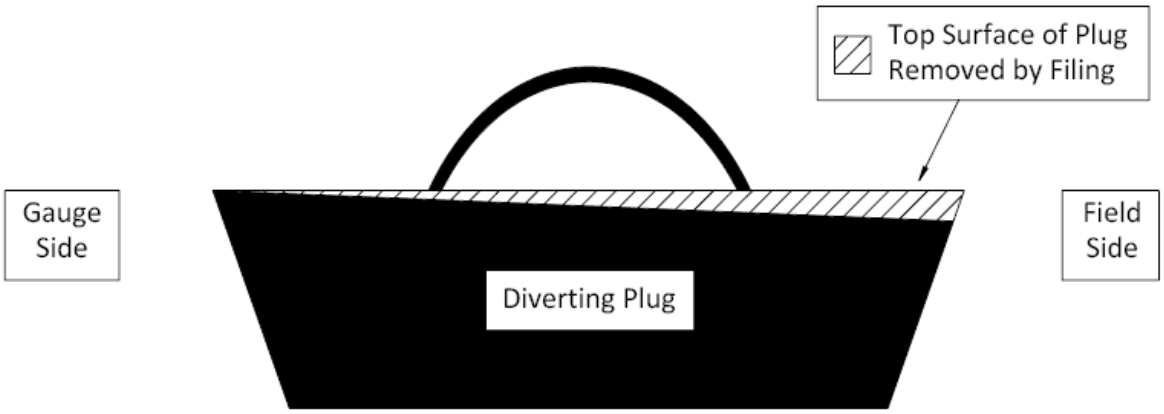


Fig. 16.1

Orgo-Thermit Mold Plug Filed (Top or Bottom) for High Rail Application
SIDE VIEW

16.8 The diverting plug should then be placed in the molds and the molds covered with cardboard from the mold box to ensure that no luting sand or any other foreign material is accidentally dropped into the molds.

16.9 Molds should remain covered until preheating begins.

16.0.1 3 PIECE MOLD INSTALLATION.

16.0.1.1 The Orgo-Thermit 3-piece mold weld requires the necessary hardware for the installation of the weld. The hardware consists of two (2) mold shoes for 3-piece mold application and a steel bottom tray. There is a bottom refractory that goes under the base of the joint and two side mold halve refractories.

16.0.1.2 All mold pieces must be centered on the axis of the joint or weld.

16.0.1.3 Any excrescences of the rail section (burrs) which may prevent correct installation of the mold must be eliminated by grinding.

16.0.1.4 The molds should never be placed near a bolt hole in the web of the rail. Refer to the rules from the railroad concerning bolt hole to mold minimum distances. Also see Section 4 page 12 concerning General Restrictions and Limitations. If rails had joint bars before, 2 cuts might be necessary to remove the crushed rail head ends.

16.0.1.5 To set the 3-piece molds up proceed as follow:

16.0.1.6 Rub the side mold halves in first on the rail. Remove all sand from the rail. Now, rub in the base refractory to ensure it fits flush to the bottom of the rail.

16.0.1.7 Place the bottom refractory inside the steel bottom tray. Make sure it stays on the steel **bottom tray correctly- no wobbling**.

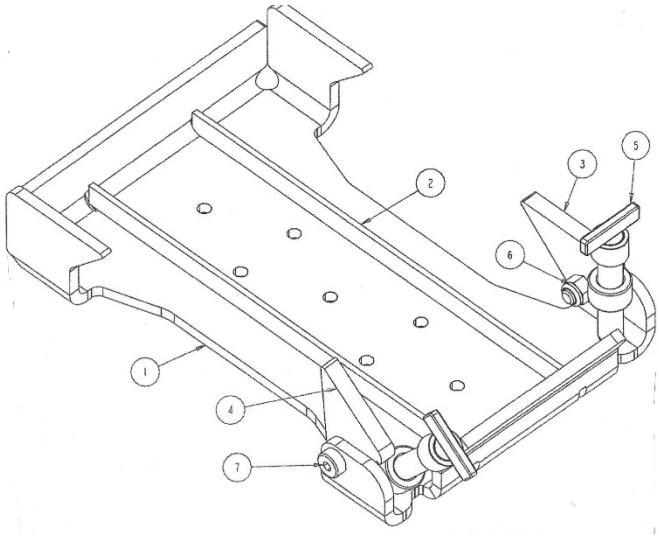
16.0.1.8 We do not recommend applying paste to the bottom refractory as it can find its way into the weld collar formation of the under base refractory if not applied carefully and this can cause a possible inclusion in the base of the weld.

16.0.1.9 Engage the steel bottom tray assembly on either side of the holding lugs; verify that the bottom refractory is perfectly centered to the gap**. Then hand tighten the nuts at the opposite side.**

16.0.1.10 Align the bottom refractory by sliding it in the steel bottom tray until the perfect position has been obtained. Tighten the nuts on both sides of the bottom tray tight now so that the steel bottom tray won't move. Take care not to crack the bottom refractory.

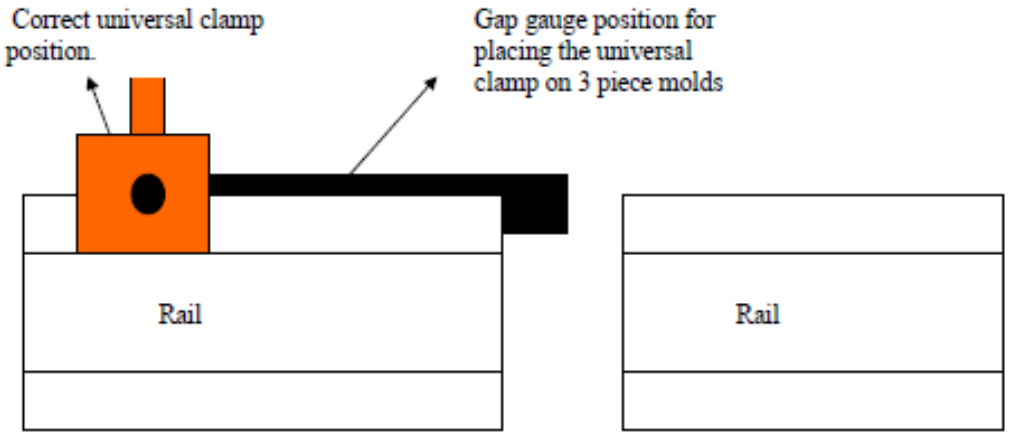
16.0.1.11 It is strongly recommended to check the alignment of the bottom refractory after having placed the steel bottom tray in place and having secured it to the rails. The bottom refractory must have equal lengths of mold collar protruding from each side of the rail ends, and the bottom refractory must be placed centrally to the gap width.

It is advisable to visually inspect the under base refractory fit to the rail to ensure no big gaps exist between the refractory and the rail, after the bottom tray has been secured to the rail.



Steel Bottom Tray

16.0.1.12 Place each mold shoe on the half molds.
Using the gap gage, the universal clamping device is placed on the rail ensuring the clamp arm screw nuts are in the center of the gap.



Ensure gap gauges is fitted as shown here in order to obtain the correct position of the universal clamping device arms.

16.0.1.13 The field side mold half in the mold shoe is applied.

- The mold half should be centered on the gap and the swivel arm screw of the universal clamp device slightly tightened, while pulling downwards on the mold shoe, to ensure that the lugs on top of the mold shoe are in contact with the top of the mold.

The fitted mold half should be visually checked to ensure it is centered and vertically straight with the rail ends.

♦Then

16.0.1.14 The gauge side mold half in the mold shoe is then applied.

It is matched to the field side mold half at the top.

The swivel arm screw is slightly tightened while pulling downwards on the mold shoe.

16.0.1.15 Recheck the mold position to ensure that they are flush at the top, fitting tightly together to the rail and bottom refractory.

16.0.1.16 Final alignment of the two mold halves in relation to the rail ends and each other is performed by sighting down through the top of the molds and the riser apertures.

When properly aligned:

The interior edges of the mold halves will be even

Equal lengths of each rail end will protrude from each side of the molds; and

The web collars of each mold half will be vertical, parallel, and directly across from each other.

16.0.11.17 Upon achieving proper alignment of the two side mold halves, tighten each swivel arm screw until the mold halves do not move at the top on the running surface.

The swivel arm screws should be left in a horizontal position so that the slag pans can fit without disturbance.

Over tightening of the swivel arm screws of the universal clamping device arms, can cause the molds to crack.

16.0.1.18 The fit of the diverting plug should then be checked.

16.0.1.19 When welding in a curve, the top or bottom of the diverting plug should be filed, such that it sits horizontal when installed. (Figure 16.1)

16.0.1.20 The diverting plug should then be placed in the molds and the molds covered with cardboard from the mold box to ensure that no foreign material is accidentally dropped into the molds.

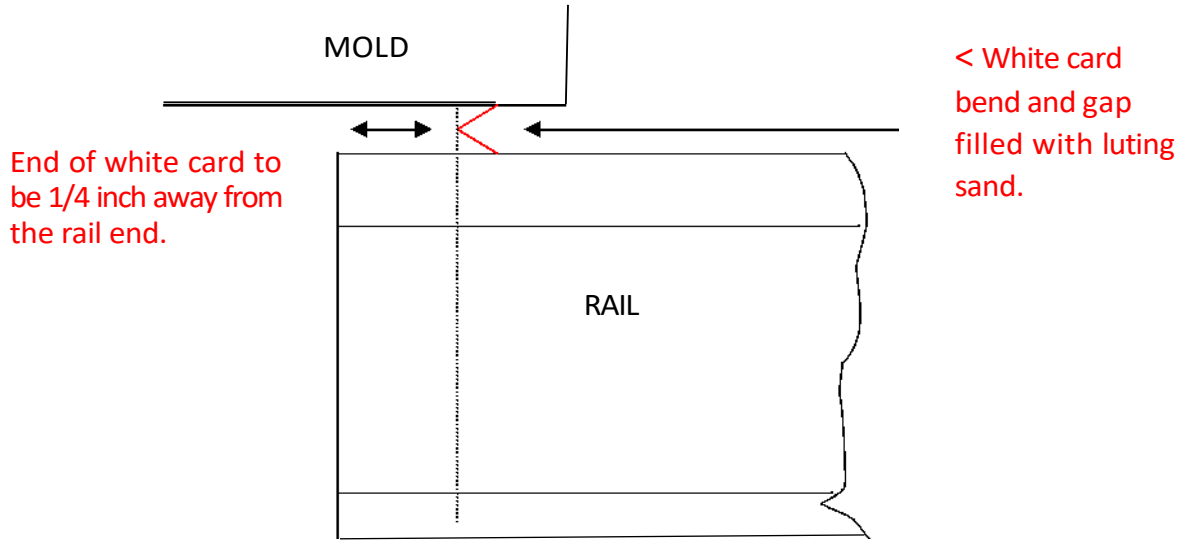
16.0.1.21 Proceed with the mold packing using luting sand as described in the next section.

17.0 MOLD PACKING USING LUTING SAND

171 When welding head worn rail, a relatively large gap may exist between the mold and the top or base of the rail. This gap shall be filled with the two white cards supplied with each pair of molds. The cards are to be placed one each side of the mold by bending in half each card and pushing through the aperture with the fingers, using the other hand as a stop, inside the mold head metal area.

IT IS VERY IMPORTANT THAT THE WELDER CHOOSE THE CORRECT MOLDS FOR THE PARTICULAR APPLICATION, IN ORDER TO HAVE THE SMALLEST GAP POSSIBLE BETWEEN THE MOLD AND RUNNING SURFACE, AND THE MOLD AND THE RAIL BASE.
MOLDS ARE AVAILABLE FOR NEW-TO-NEW RAIL, HEAD WORN TO HEAD WORN RAIL, NEW RAIL TO HEAD WORN RAIL GIVING 1/4" OFF SET BASE.

The cavity between the bent card is to be firmly packed with luting sand from the outside, whilst holding the card away from the rail end on the inside of the mold to ensure a clear exposure of approximately 1/4 inch of the rail end.



It is recommended that head worn molds are used where running surface wear is evident on both the rails to be welded.

17.2 When welding curve worn rail, relatively large gaps may exist between the mold and the gauge or field face of the rail. These gaps should be packed with dry tissue paper prior to beginning packing the molds.

17.3 Only one bag of premixed luting sand is required per weld.
The use of more than one bag of luting sand is unnecessary and wasteful

17.4 Orgo-Thermit welds should be packed with Orgo-Thermit premixed luting sand only

17.5 Premixed luting sand must be packed firmly into place to prevent any leakage of the molten weld steel when the weld steel pours from the crucible.

17.6 An established packing routine should be followed. The packing routine (luting) for Orgo-Thermit welds should be from the base to the top of the molds as follows:

- Install diverter plug and mold cover.
- Install base card or tissue paper if necessary.
- Base lip for two-piece molds only.
- Bottom of base.
- Remove mold cover and diverter plug, ensure alignment has been maintained, reinstall diverter plug and mold cover and continue.
- Install cardboard or tissue paper as needed.
- Top of base
- Web
- Rail Head
- Top of mold

17.7 With the mold cover and diverting plug removed from the top of the molds:

- Pack both sides of the base of the molds, ensuring the molds remain in a vertical position with an equal amount of each rail end visible when looking in the top of the molds.
- Place the diverting plug in the molds
- Place the cover on the molds; and
- Complete packing per Section 17.6.

17.8 Mold shoes should be firmly packed such that the luting flare is full.

17.9 After packing of the molds is complete, the welders who performed the packing should check each other's work to ensure that packing is proper and complete.

17.10 In the event luting sand or any other foreign material is dropped into the molds, the molds must be removed from the rails. The sand or foreign material should be cleaned from the molds and the molds then reapplied.

17.11 Preheating must begin within ten (10) minutes after the molds have been luted.

17.12 If preheating does not begin within ten (10) minutes after molds have been luted:

- The existing molds and luting sand should be removed from the rail ends.
- The molds shall be cleaned of existing luting sand, and
- Then the molds should be reinstalled and packed with "fresh" luting sand

18.0 CRUCIBLE TYPES AND THEIR PREPARATION.

18.1 Orgo-Thermit welding processes can be used with different types of refractory crucibles, namely.

- **Single Use Crucibles:** is a crucible in a tin can container with a handle designed for a once off reaction and subsequent Thermit® weld only. (Single Use)

- **Degradable Crucibles:** is a Single Use Crucible but without a tin can container and is designed for a once off reaction and needs a crucible removal tool to remove the crucible from the molds after pouring. The **Safe Start Crucible** additionally contains a cap with starter mixture that is ignited with the oxy/propane preheating burner to initiate the Thermit® reaction.

- Single-Use Crucibles and degradable crucibles requires the same mold shoes with tabs. The Single Use Crucible and all types of degradable crucibles are not preheated prior to use and has an automatic tapping system built into the crucible.

- All types of welding crucibles must be stored in a dry location with reasonable protection from damp and humid atmospheric conditions and must have complete protection from all other forms of moisture or water.

- NEVER ATTEMPT TO DRY OUT ANY TYPE OF THE CRUCIBLES THAT GOT WET – DISCARD THE CRUCIBLE IMMEDIATELY.
- WHEN USING A DEGRADABLE CRUCIBLE PLEASE ENSURE THE WELDERS HAVE A DEGRADABLE CRUCIBLE REMOVAL TOOL PRIOR TO USE OF SUCH A CRUCIBLE SYSTEM.

18.1. SINGLE USE CRUCIBLE AND ALL DEGRADABLE CRUCIBLE'S PREPARATION
FOLLOW THESE PROCEDURES IF YOU EMPLOY THE SINGLE USE CRUCIBLE OR ANY OF THE DEGRADABLE CRUCIBLE SYSTEMS.

GENERAL AND SAFETY.

The Single Use and all degradable Crucible have built in thimbles that require no installation.
See Sections 25.11 and 25.12 concerning details of tap time.
Never attempt to move a Single Use or degradable Crucible after ignition of the Thermit® powder and before it has tapped.
In the very unlikely event of a Single Use or degradable Crucible NOT TAPPING AT ALL, THE SINGLE USE or DEGRADABLE CRUCIBLE AND HOT STEEL INSIDE IT, MUST BE LEFT UNDISTURBED ON TOP OF THE MOLDS FOR A PERIOD OF NOT LESS THAN THIRTY (30) MINUTES.
Never use cracked or broken Single Use or Degradable Crucibles.

18.1. A.1 The Single Use Crucible lid is sealed at the clamping ring with a plastic anti tampering seal. Ensure that when you receive the Single Use Crucible the plastic seal is intact. Break the plastic seal by simply unclamping the clamping ring. By placing your hand on top of the Single Use Crucible lid, remove the lid. A can opening device is recommended to remove the lid with. Sometimes there can be a pressure difference between the Single Use Crucible and its surroundings. For the lid not to pop off with force, keep your hand always placed over the lid when opening the lid.

18.1. A.2 Remove the sand cap and protective cardboard insert from inside the Single Use or Degradable Crucible.

18.1. A.3 Turn the Single Use, all Degradable Crucibles upside down to remove any loose particles.

18.1. A.4 Make a visual inspection of:
The tapping hole and safety outlet, to ensure that all the tapping disc wafers are in position and did not became dislodged during transportation.

- The Single Use or Degradable Crucible lining and cap is not cracked or badly broken- dispose of properly if the Single Use or Degradable Crucible lining is cracked or broken- DO NOT USE BROKEN OR CRACKED SINGLE USE or DEGRADABLE CRUCIBLES.

18.1. A.5 Always place the Single Use or Degradable Crucible on a dry surface, preferably on the steel can lid or a folded open mold cardboard box.

18.1.A.6 The Single Use or Degradable Crucible shall be charged with the Thermit® portion prior to the preheating of the rail ends.
Make sure to level the surface of the portion and remove any portion powder from the top wall rim of the Single Use or Degradable Crucible.

18.1. A.7 Install the crucible cap. After installation the cap should remain in position.

18.1.A.8 Place the igniter in the crucible cap.

18.1.A.9 Ensure that a degradable crucible is removed from the molds after pouring using the degradable crucible removal tool. (Part number 55-10-120)

The Safe Start Crucible System is a degradable crucible that comes with a cap that contains a starter mix that is ignited with an oxygen/propane burner, this starter mix, after ignition, will automatically start the main Thermit® reaction. Instead of a conventional igniter being used, a Safe Start Crucible System can be used. The Starter mixture of the Safe Start Crucible is not classified as hazardous for transportation purposes and is not classified as explosive.

19.0 THERMIT® WELDING PORTIONS.

19.1 Thermit® welding portions are produced in different sizes (weights) for the rail size (lbs./yd) to be welded. The portions are a metallurgical powder mix of which the ingredients have been weighed out to near exact weights and to be appropriate for:

- The designed welding gap of the welding process
- The rail section(s) to be welded.

19.2 Thermit® welding portions are packaged in plastic bags. Applied to the bag is an identification sticker. This identification sticker contains the following information:

- Date of manufacture.
- Number of the individual portion produced in the lot.
- Portion size, meaning for which rail sizes the portion will be suitable for to fill the welding gap.
- Portion type meaning IH or Thermit® 2.0
- Operator code that checked the final check weight of the portion.

19.3 Thermit® Portion Hardness Identification.

General

For rail welding the hardness ranges are identified as:
Intermediate Hardness (IH) Portions (320 BHN plus minus 30 BHN)
Thermit® 2.0 portions (370 BHN plus minus 30 BHN)

Packaging.
The Thermit® welding portions are identified as follows when individually packaged:

Welding portions are individually packaged in clear plastic bags, with a peel off sticker label on the bag, and are packed with the molds

19.4 Thermit® welding portions should be used as follows:
The Thermit® welder must ensure that the Thermit® welding portion is the correct size for the rails to be welded.

19.5 Thermit® welding portions shall not be used:
If they are or have been wet/moistened: or

If the portion plastic bag has been punctured or broken open and any of the contents of the portion have been lost, or an opened bag have been dropped and a spillage of the contents occurred.

Report and record the unusable welding portion and then dispose of the portion properly.

19.6 Any welding portion bag that has been opened must be used the same day, or disposed of properly.

19.7 All the contents in the welding portion bag (s), for the process and rail size to be welded, must be used when completing the charging of the crucible.

19.8 It is not permitted to add any foreign materials (bolts, nuts etc.) to the welding portion, as this will influence the hardness and chemical composition of the resultant Thermit® Steel.

19.9 It is not permitted to add any additional amount of another portion to the welding portion(s), for the rail size and process it is designed for.

20.0 CRUCIBLE CHARGING

20.1 Single Use and Degradable crucibles should be charged as follows.

- The crucibles should be charged prior to beginning the preheating of the rail ends.
- The entire contents from the welding portion bag must be gently poured into the crucibles, leaving the top of the portion as level as possible.
- If the welding portion is clumped, it shall be considered wet/moist and must be rejected, as a very violent reaction can occur when using wet/moist portions.
- The crucibles should be covered with their respective caps.
- An igniter should be placed in the cap of the Single Use or Degradable Crucible, after charging has been completed. In the case of a Safe Start Crucible System an igniter is not used, the reaction is initiated by igniting the starter mixture in the cap with the oxygen/propane preheating burner.

21.0 SLAG PANS.

21.1 Two slag pans are required for all Orgo Thermit processes.

21.2 Slag pans should be dried with the preheating torch (burner) such that all moisture is removed.

21.3 The slag pans shall be fitted onto the mold shoe lugs prior to beginning the pre heat.

21.4 Always protect the slag overflow lug on the mold shoes with luting sand.

21.5 It is recommended to place a thin layer of completely dry silica sand on the bottom of the slag pan as this will increase the life of the slag pan and protect the slag pan from the intense heat of the slag. Never use wet/moist sand for this purpose.

22.0 PRE-HEATING EQUIPMENT

22.1 GENERAL

a. The Oxygen-Propane preheating process is the preferred pre-heating process for Orgo Thermit welds. Other pre heating processes can be used, after having obtained special instructions from Orgo Thermit Inc. on the recommended practices for these preheating processes.
b. It is essential that all pre heating equipment be in proper working order to successfully complete the pre heating of the rail ends.
c. The pre heating process is a critical important component in securing a sound weld and must be monitored from start to finish.
d. Preheating by means of a handheld torch (burner) is prohibited.
e. Flashback arrestors are required on the torch (burner) handle, as well as 3/8-inch I.D. inline pressure gauges, for both oxygen and propane.

22.2 REGULATORS

a. Regulators must be maintained in good condition. Any regulator not functioning properly should be removed from service.
b. Regulators are costly precision instruments and should be handled carefully to prevent damage.
c. Regulator pressure adjusting screws should be released when cylinder valves are closed and before they are opened.
d. Regulators must be removed when transporting oxygen and fuel gas cylinders.
e. Oxygen and propane regulators should be the single or multistage type, with pressure dial indicators.
f. Gaugeless regulators are prohibited from use for preheating Thermit® welds.
g. Propane regulators should range from 2 to 40 psi delivery pressure.
h. Oxygen regulators should range from 5 to 125 psi delivery pressure.

22.3 WELDING HOSE AND CONNECTORS

a. Hose type VD, Grade "T" is recommended.
b. Oxygen and Propane Welding Hose should be 3/8" twin diameter and 50 foot in length. The maximum length should not exceed 100 feet in length.
c. Quick disconnect systems are not recommended.

22.4 OXYGEN SUPPLY.

Oxygen supply should be provided from:
a. A high-pressure K or T type Oxygen Cylinder or
b. GP- Type Liquid Oxygen Cylinders
Minimum flow rate: 12 cubic meters per hour.

22.5 LIQUID OXYGEN CYLINDERS, CARE AND USE:

a. Liquid oxygen is put in a cylinder built like a thermos bottle. The temperature of the liquid oxygen is approximately -300^0 Fahrenheit.
b. It is in the liquid state until the gas "Use valve" is opened. Opening the "Use Valve" draws the liquid oxygen through coils, which allows the liquid to change to a gas.
c. Thermit® welders must always wear safety glasses or goggles and gloves when working with Liquid Oxygen Cylinders.
d. Liquid Oxygen Cylinders build up pressure as they sit. When the cylinder pressure reaches 250 psi, the cylinder will automatically start to release the pressure or bleed off. Cylinders that show the highest psi reading on the regulators should be used first.
e. Care must be taken not to drop liquid oxygen cylinders.
f. Liquid Oxygen cylinders must never be laid down.
g. If a liquid oxygen cylinder is dropped, tipped over, or unreasonably abused:

- Slowly raise it to its normal vertical position.
- Immediately open the vent to allow any excess pressure to be released. Leave the
- valve open.
- As soon as possible, remove the liquid product from the vessel.
- The cylinder must be inspected before returning to service.

Prior to applying the oxygen regulator to the liquid oxygen cylinder, slightly open the "Use" valves to clear the valve stem and then close.
a. Position the oxygen regulator on the "Use" valve and tighten. Since the "Use" valve stem is long, it must be supported with a gloved hand.
b. The "Use" valve may then be opened slowly for use.
c. Never open the liquid valve.

22.6 PRE-HEATING BURNERS AND OPERATING PRESSURES

Only approved pre heating equipment must be used.
Approved Orgo-Thermit Oxy-Propane preheating burners are identified in the Table 22.1 For propane air systems contact the OEM for details.

PREHEATING SYSTEM	Oxygen Propane Preheat burners		Propane Air	
PREHEATING EQUIPMENT	**ORGO-THERMIT**	**VICTOR**	**Propane /Air Blower**	
BURNER STEM **MANUFACTURER** **MODEL** **PART NUMBER**	HESA US THREAD 50-20-103	VICTOR HD 310 C	Propane pressure	As per OEM
PREHEATING BURNER **MANUFACTURER** **MODEL** **PART NUMBER**	ELECTRO-THERMIT SkV-2, 22 Orifice 50-20-101	VICTOR TWN-5	Air pressure	As per OEM
PREHEAT OPERATING PRESSURES MEASURED AT THE BURNER STEM* (psi)				
PROPANE **OXYGEN**	15 65	15 65	Propane Air	As per OEM

Approved Preheating Burners and Tips and Recommended Operating Pressures for the Orgo-Thermit Preheating System
TABLE 22.1

23.0 PREHEATING, GENERAL

23.1 Correct preheating of the rail ends is essential to the successful completion of the weld. Preheat is a timed process and must be monitored with a stopwatch.

23.2 Burner height, measured from the running top of the rail to the burner block, must be:
1 - 3/8 inches (-0 + 1/16 inches)

23.3 The burner height should be checked, at a minimum of once per day, prior to preheating the first weld. The correct burner height will ensure that the rail end base tips are preheated sufficiently to have good fusion.

23.4 Preheating equipment should be pre-aligned for each weld to ensure that it is centered along the rail and in the weld gap of the molds. The burner blockhead or tip should be aligned such that it is:
In line with the vertical axis of the rail (not pointing toward field or gauge).
And vertically straight (at a right angle to the base of the rail).

23.5 Proper preheating of the rail ends consists of fulfilling three (3) requirements:

a. Minimum preheating times must be adhered too.
b. Achieving uniform and proper color of the rail ends.
c. Observation of the entire preheating process to ensure that a rail end is not melted and there is no breakdown of the molds.

23.6 The proper preheating times are tabled below for the Oxygen/Propane preheating systems

Rail Weight	Weld Type	PREHEATING TIME		
		Minimum	Normal Range	Preheating gases
< **80#**	SkV – 1" Gap	3.0 minutes	3.0 to 5.0 minutes	Oxygen/Propane
80# - 101#	"	4.0 minutes	4.0 to 5.0 minutes	Oxygen/Propane
105# - 119#	"	4.0 minutes	5.0 to 6.0 minutes	Oxygen/Propane
122# - 132#	"	5.0 minutes	6.0 to 7.0 minutes	Oxygen/Propane
133# - 140#	"	6.0 minutes	6.0 to 7.0 minutes	Oxygen/Propane
152# - 155#	"	6.0 minutes	6.0 to 7.0 minutes	Oxygen/Propane

Preheating Times for Oxygen/Propane Preheating System
TABLE 23.1

23.7 The rail color at the center of the rail web and base must be a yellow/orange color after preheating.

23.8 When performing compromise welds on rail ends of two different rail sections, the preheating time should be the time required for the largest rail section.

23.9 *The welder performing the preheating must watch the entire preheating process of the rail ends to ensure yellow/orange rail end color.*

23.10 The preheating of the rail ends should be shielded from high wind during the preheating process.

23.11 In the event a rail end begins to melt, the weld must not be completed.
The molds shall be removed and disposed of properly; and
A minimum of 2 inches shall be cut off each melted rail end.

23.12 In the event that a gas cylinder becomes empty during preheating, the preheating process must be stopped, the empty gas cylinder must be replaced with a new gas cylinder, check the molds are not severely cracked, and the start the preheating process all over again from a zero time.

23.13 During the time the weld is being preheated, the diverting plug should be preheated for at least 30 seconds to ensure all moisture is removed.

24.0 PREHEATING PROCEDURE.

24.1 Prior to beginning the preheating of the rail ends, the oxygen and propane cylinders should be checked to ensure there is sufficient capacity to complete the weld.

24.2 The burner saddle assembly is placed on the universal clamping device. The preheating burner tip is placed in the molds and the burner stem is locked in the saddle. The preheating burner assembly is checked to ensure it is level and pointed directly down the molds. The saddle adjustment knobs are used to center the burner head over the rail gap. Once level and centered, the preheating burner (torch) and saddle assembly are removed as one unit.

24.3 The propane valve and oxygen valve should be opened approximately 1/4 turn. The burner is then lit with a gloved hand, and approved striker. After lighting, the propane and oxygen valves are adjusted until the oxygen valve is opened completely. The oxygen and propane pressure regulators must then be adjusted to the proper setting. The pressures should be checked for each weld performed. After the burner is adjusted, check the burner head to ensure there are no clogged orifices. If dirty, the burner must be shut off and cleaned, prior to proceeding with the preheat.

24.4 With the oxygen valve opened completely, the propane valve should be adjusted such that the blue flame tips or cones are even in length and 7/8 inches long. Recheck the oxygen and propane gas pressures on the regulators and adjust if necessary.

24.5 Once the correct flame has been established, the preheating burner nozzle or tip is carefully positioned in the molds and the burner saddle placed on the universal clamp.

24.6 The welder should check to ensure:
The burner saddle is touching the burner height adjustment ring.
The burner tip does not contact the sand mold (the sand mold can overheat, break off and fall into the molds); and
The preheating burner is centered and level; and
The inline pressure gauges show that the oxygen pressure is 65 psi, and the propane pressure is 15 psi at the burner stem of the preheating system.

24.7 The burner saddle clamp is then tightened.

24.8 Preheating time begins immediately after the burner is properly positioned in the molds and the burner saddle clamp is tightened. A stopwatch should be used to record all times.

24.9 The preheating time for the SkV/ TWN-5 Preheating system should be according to rail profile size as per Section 23.6

24.10 The welder is required to watch the entire preheating to ensure that:

a. Preheating is uniform on both rail-ends.
b. The rail does not melt; and
c. There is no mold breakdown.
d. The required preheating time is adhered too.

24.11 **Visual observation of the entire preheating period consists of:**

a. Rail ends and molds must heat evenly.

If one rail is heating faster than the other, the preheating burner is improperly aligned.
Adjust the preheating burner to achieve correct alignment.

b. The web of the rail ends should glow a bright yellow/orange with no signs of “sweat beads” or melting.
As heating progresses, the web of the rail may appear to soften or develop “sweat beads” on the rail face. If this condition appears, the flame must be softened by increasing the propane at the burner stem valve for a short time. This action will “cool” the rail ends. If no change in the flame is made, the rail will begin to melt. Always use a neutral to carburizing flame (more propane than oxygen), never an oxidizing flame (more oxygen than propane). This always means that, an excess of propane must be used over the oxygen.

c. The base should glow an orange color.

d. There must not be any melting of the rail ends.

24.12 In the event a portion of the rail head or rail face of either rail end is melted (even a tear drops), the weld must not be completed. The weld will be defective.

A minimum of two (2) inches should be removed from a melted rail end.

24.13 During the preheating process, an unusual occurrence may be a breakdown of the mold. This is when a piece of the mold may break off and fall into the weld cavity. If this happens the weld should not be poured, as a sand inclusion defect will arise from broken down mold. Stop the preheating operation, remove the molds, dispose of them properly and install new molds.

24.14 If the preheating process is stopped prior to completion of the minimum preheating time and restarted to complete the preheating, it is recommended to start the preheat from a zero time, alternatively, that the welder use good judgment in determining the correct amount of preheating time required to finish the preheating of the weld.

24.15 When the minimum preheating time has been achieved and the rail ends appear to be the correct color, the preheating burner and saddle should be removed. The rail ends must then be visually inspected to ensure the correct rail end color has been achieved.

True color of the rail ends can only be observed with the preheating tip removed from the molds.

24.16 If the rail ends have not achieved the proper color after the preheating burner is removed, the preheating burner must be replaced for additional preheating until the correct color is achieved by visual inspection. (Center of the rail web and base must be a yellow/orange color).

24.17 If the proper color cannot be achieved upon reaching the maximum preheating time, there is a problem with the preheating equipment. Preheating must be stopped, and the problem solved. (Check for a blocked burner head nozzle, faulty flashback arrestors, faulty diaphragm on regulators, too long hose lengths, faulty regulators, empty gas bottles). New molds will have to be installed and the preheating reinitiated.

24.18 Upon achieving the minimum preheating time and the correct color in the rail ends, the preheating burner and saddle are removed from the molds.

24.19 While preheating of the rail ends, the diverting plug should be dried before placing it in the molds.

24.20 Drying the diverter plug should be performed during the final preheating of the rail ends. The diverter plug should be held:

- With the fire tongs.
- Over the flame coming out of the large riser hole.
- 6 to 12 inches above the mold; and
- For a minimum of 30 seconds.

25.0 IGNITION AND POUR.

25.1 Welding crew members must be protected during the ignition of the welding portion and pouring of the molten steel by wearing:
Welding gloves, and Eye protection with filter lens (Minimum shade no.5)

25.2 The welding portion must be ignited soon after the preheating burner has been removed. For ignition of the portion an igniter, an Electronic Ignition System or the Safe Start Crucible may be used. For the Safe Start Crucible ignition the starter mixture in the crucible cap is ignited with the oxy/propane preheating burner only.

25.3 After preheating has been completed, the diverting plug is carefully and squarely placed into the top of the molds.

25.4 The diverting plug should be firmly pushed into place. The diverting plug must not be tapped.
Tapping the diverting plug may cause pieces of mold sand to fall into the weld cavity.
By not placing the diverting plug into its position at all, will lead to the rail head being full of slag.

25.5 After completion of the rail end preheat.

FOR SINGLE-USE-CRUCIBLE USE: Place the charged Single Use Crucible on top of the mold shoes, with the handle facing in the direction of the slag pans and lock the crucible handle over the alignment tabs on the mold shoes for 1 inch gap welds. Alignment of the Single Use Crucible is achieved if the handles of the Single Use Crucible face in the direction of the slag pans.
The degradable crucible carry handles must be parallel with the running direction of the rail so that the locating lugs at the bottom of the crucible fit into the top of the mold shoes.

25.6 The igniter is lit using the preheating burner, or the riser aperture hole for the processes where this procedure is required.

25.7 The lit igniter is placed through the cap. NOTE: DO NOT PUSH THE IGNITER DEEP INTO THE PORTION OR LET IGNITER JUST TOUCH THE TOP SURFACE OF THE PORTION, INSERT THE IGNITER LIGHTLY INTO THE PORTION UNTIL RESISTENCE IS FELT, THIS RESISTENCE IS NORMALLY FELT AT AN IGNITER DEPTH OF 1 TO 1-1/2” INTO THE PORTION.

25.8 A predetermined, designated welding crew member should note the tapping time of the weld.

Tapping time is defined as the total time, from when the portion ignites (intense flame visible), until the molten weld metal begins to pour.
Tapping times should be recorded using a stopwatch.

25.9 During the initial active phase of the reaction ALL welding crew members must stand clear.

25.10 When the Thermit® reaction is complete, the crucible automatically releases the charge at the correct moment through the tapping hole.

25.11 In the event the tapping time is less than 15 seconds the weld should be considered defective and removed immediately as the Thermit® reaction has not been completed.

25.12 In the unlikely event the weld metal does not tap at all within 60 seconds, the crucible (Single Use or Degradable) should not be moved until the weld finally taps or until the steel and slag are completely solidified in the crucible. In the event the tap time is so prolonged that the Single Use or Degradable crucible tap through the emergency by-pass the weld should be considered defective and removed immediately.

25.13 If any of the crucibles fail to tap, the crucible should be disposed of properly.

26.0 UNMOLDING

26.1 Prior to beginning the unmolding process, the welder in charge and the crew members that will perform the unmolding operation should review prepared locations where:

- The hot crucible must be placed after removal from the weld
- The slag pans must be placed to complete cooling after removal from the mold shoes, and
- The used mold material, slag and steel risers must be placed in the used Single Use Crucible.

26.2 After the weld has completed pouring, the crucible (Single Use or Degradable) should be left in place for 3 (three) minutes.

The Single Use Crucibles should be gently lifted straight up from the weld and moved to the prepared dry and level location.

For Degradable crucible removal from the molds, the Degradable crucible removal tool (Part number 55-10-120) must be used.

26.3 Four (4) minutes after the time the weld metal has completed pouring, the slag pans are to be removed and carefully carried to their prepared cooling location.

- Ensure that you have gloves on and use either, a Tommy bar, a fork or a slag pan removal tool that is on the demolder, to remove the slag pans.
- Slag pans are not to be emptied for a minimum of five (5) minutes after the weld has poured.

26.4 Four and one half (4 1/2) minutes after the weld has completed pouring:

Remove the Universal Clamping Device.

26.5 Five (5) minutes after the weld has completed pouring:

Carefully remove the mold shoes. Watch the molds for any molten metal leaks; then
Clean excess luting material from the edges of the molds; and
Carefully score the molds, 1 1/2 inches above the rail head surface.

26.6 Six (6) minutes after the weld has completed pouring:
Place a shovel on top of the rail on one side of the molds. Then from the opposite side, gently tap on the top portion of the molds with a sledgehammer until the top portion of the mold has cracked; alternatively use demolding tool.
If there is any indication that the weld metal is still liquid (leaking) allow the top of the mold to come back and cover the weld for an additional 15 to 30 seconds. Continue this process until the weld metal has solidified; then
Push the top portion of the mold off onto the shovel. The top portion of the mold is to be discarded in the prepared disposal location.
This whole process can also be performed in a similar manner with a demolding tool, instead of using the shovel and hammer option.

26.7 Removal of the head riser should begin when the head riser has solidified, and the tips have started to turn grey. This occurs at approximately seven (7) minutes plus minus 30 seconds after the pour.

26.8 It is extremely important that no molten weld metal is lost during the unmolding process and that a full head riser remains for proper weld metal solidification.

26.9 Clean the excess mold material from the sides of the head riser prior to head riser removal. Use the hot cut chisel with a horizontal pushing motion, never a striking motion.

27.0 RISER REMOVAL.

27.1 It is recommended that the head riser be removed by an approved hydraulic rail shearing device.

27.2 Shearing the head riser through the mold is prohibited, as it can cause a hot tear in the rail head, or a loss of Thermit® Steel.

27.3 Removal of the head riser using a hot cut chisel is permitted.

27.4 When the head riser must be removed with a hot cut chisel:

- The top of the head riser should be removed first and then the sides of the head riser should be separated.
- The top of the head riser should be cut approximately halfway through from one side. The remainder of the cut should then be completed from the opposite side.
- The hot cut chisel must be indexed (worked) across the width of the head riser as the cutting operation progresses.
- This is to prevent hot tearing in the top of the weld.
- Care should be exercised such that the weld is not gouged or any of the parent rail nicked.

27.5 If the parent rail is nicked or gouged in the head, web, or base and cannot be repaired by:

- Welding or grinding the running surface of the head; or
- Grinding only, in the web or the base.
- The weld should be considered defective and replaced.

27.6 After removal of the head riser, and if the ambient temperature is above 40^0 F, the base risers may be bent out to allow rough grinding of the ball. The risers should be bent to approximately a right angle to the rail.
If the ambient temperature is below 40^0 F, the risers must be left in the upright position and the weld covered with a cooling blanket or box until the weld has reached 900^0 F. After the weld has reached 900^0 F, the base plate, molding sand, and base risers should be removed.
Finish grinding the weld, starting with the base riser area, moving to the web and then the ball.
All grinding should be completed before the weld reaches 600^0 F. If the weld cools below 600^0 F no bluing of the weld is allowed.

27.7 Crowning wedges or alignment plates should be removed at 20 minutes after the weld pour has been completed.

27.8 Mold sand should be left on the web and base of the weld until the weld has cooled to 900^0 F.

27.9 Wedges or spikes used for horizontal alignment of rail in curves should be left in position until the weld has cooled to 700^0 F or below.

27.10 Base risers may be removed after they have cooled below 900^0 F.
Caution: Do not use excessive force to remove base risers.
Standing on the opposite side of the rail, tap the risers with a hammer from left to right until the riser is removed. Repeat for the riser on the other side of the rail.

27.11 Base risers must be removed before re-spiking the rail.

28.0 ROUGH GRINDING.

28.1 Rough grinding of the rail head portion of the Thermit® weld may be performed after the head riser is removed.

28.2 Rough grinding of the rail head should be performed with an approved profile grinder.

28.3 Rough grinding is completed when the excess weld material is reduced to approximately fifty (0.050) thousandths of an inch.

28.4 After the rail head has been rough ground, the gauge and field faces may be finish ground using the profile grinder.

28.5 After the weld has reached a temperature of 900° F the base risers should be removed and the area where the riser was broken off should be smoothened.

28.6 Upon completion of the riser break off base area smoothening, the running surface should be finish ground.
When finish grinding, the weld should be left five (0.005) thousandths high as measured with a straight edge and taper gauge.
Measure the weld at the heat line on each side of the weld.

28.7 When the surface of the weld is above 600^0 F, it is permitted to “blue” the weld steel. When the surface is equal to or less than 600^0F, “bluing” of the rail steel is not permitted.

28.8 During rough grinding, grinding of the running surface parent rail steel on either side of the weld is prohibited.

28.9 Grinding the required taper of the gauge and field faces should be completed. The Faces are being ground on welds that contain a horizontal offset or mismatch.

29.0 FINISH GRINDING

29.1 GENERAL.

a. Finish grinding of the weld should be performed after the weld has cooled below 900^0F.
"Bluing" of the rail or weld surface should not be permitted at any location on or near the Thermit® weld, after the temperature of the weld reaches 600^0 F or below.

b. It is important that Thermit® welders and grinder operators understand that the vertical crown measurement of the weld will continue to reduce until the Thermit® weld has cooled to ambient temperature.

Welds that are ground flush to a 36-inch straight edge at a weld/rail temperature of 600^0 F will continue to reduce in the combined vertical crown and offset measurement until completely cooled and therefore result in a low weld.

Finish grinding of the running surface of the weld prior to the weld completely cooling to ambient temperature must compensate for this reduction by being left high enough, so that when the alignment inspection of the weld is performed with the weld at ambient temperature, all alignment and finish grinding specifications are met.

29.2 FINISH GRINDING OF THE RUNNING SURFACE AND THE RAIL HEAD BELOW 600^0 F.

a. "Bluing" of the rail steel is <u>not</u> prohibited below 600^0 F. Do not grind off weld prior to inspecting weld using an approved straight edge.

b. The running surface of the weld should be ground flush with the parent rail head surface at ambient temperature.

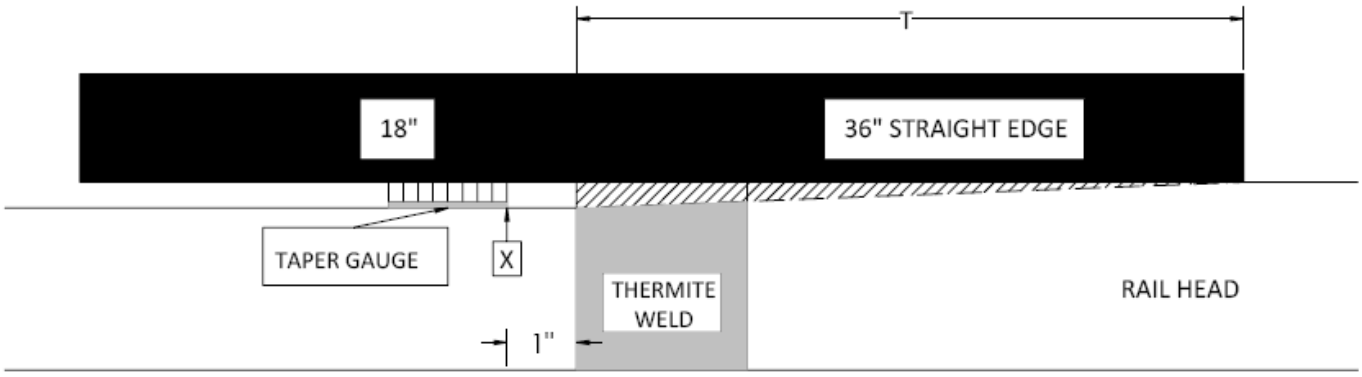
c. When finish grinding the weld and the weld temperature is less than 600^0 F, but greater than ambient temperature, leaves the weld approximately 0.015 of an inch high and lightly tie in the weld/rail interface.

d. All finish grinding of the running surface of the rail should be performed with an approved profile grinding attachment.

e. The running surface of the weld should be ground to exactly match the contour of the existing rail. A radius is to be applied to the gauge and field faces such that no sharp edges remain. (Sharp edges are fatigue initiation points)

f. Determine if a vertical offset condition exists in the completed Thermit® weld. (See Figure 29.1)

- Place a 36-inch Straight Edge in the center of the top surface of the rail with the weld at midpoint.
- Heel the straight edge.
- Insert the taper gauge between the rail head and the straight edge, approximately one (1) inch from the weld fusion line; and
- Measure the vertical offset.
- Determine the length of taper required from the chart in Figure 29.1



X: Offset Measured
T: Length of Taper

VERTICAL OFFSET (X)	TAPER LENGTH (T)
0.010	6"
0.011-0.020	12"
0.021-0.030	18"
0.031-0.040	24"
0.041-0.050	30"
0.051-0.060	36"

Material to be Removed by Grinding: ▨

Fig. 29.1 Vertical Offset Rail Taper Length Requirements

Side View of Railhead

g. Where an allowable vertical offset condition exists, the surface of the head of the rail must be tapered back to provide for a smooth transition.

The rail should be ground such that:

- When a 36-inch straight edge is placed on the top surface of the rail at the interface between the weld and the low rail (Figure 29.2)
- The weld should be flush with the low rail and taper back the distance specified in Figure 29.1, up to a maximum of three (3) feet; and
- The requirements of Section 29.2 h are met.
- (See Figure 29.2, 29.3 & 29.4)

h. Where no vertical offset condition exists, the surface of the head of the rail through the weld area should be ground such that:

- When a 36-inch straight edge is placed on the top surface of the rail with the weld at the midpoint,
- The maximum distance between the rail head and any point along the entire length of the straight edge should be less than fifteen thousandths (.015) of an inch. (Figure 29.4)

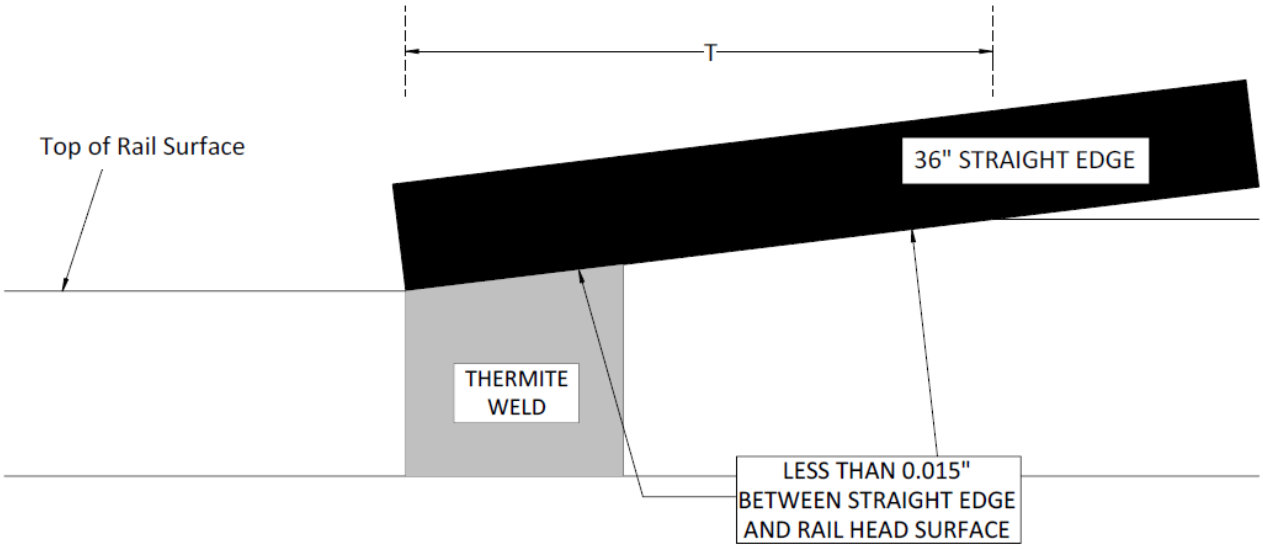


Fig. 29.2

Straight Edge Location to Inspect Finish Grinding on Thermit® Welds with Vertical Offset
Side View of Railhead

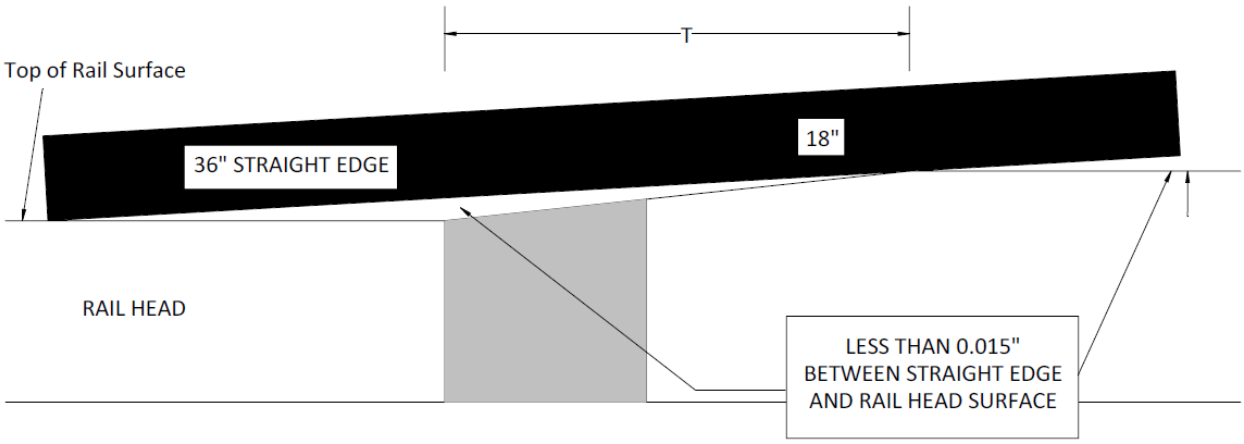


Fig. 29.3

Straight Edge Location to Inspect Finish Grinding on Thermit® Welds with Vertical Offset
Side view of Rail Head

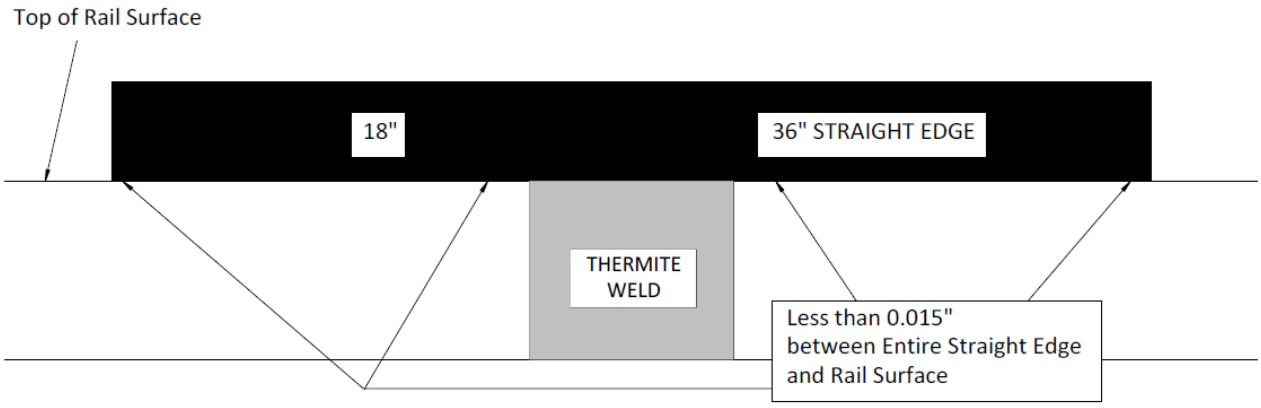


Fig. 29.4

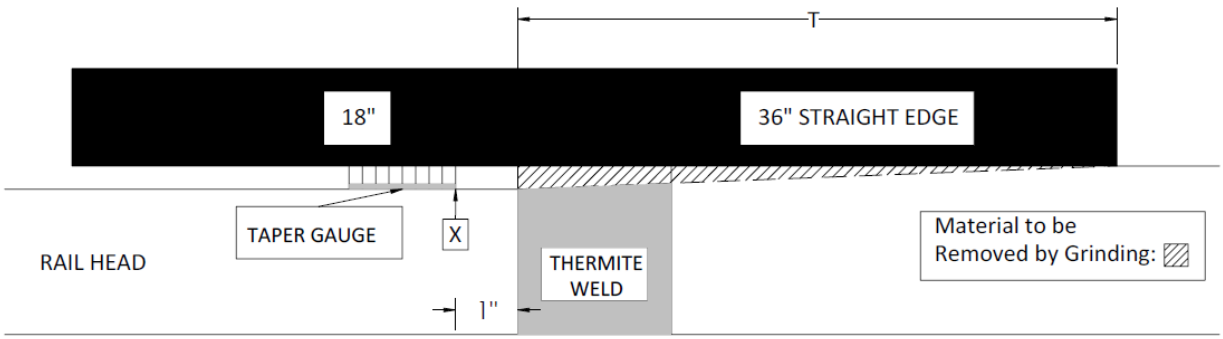
Straight Edge Location to Inspect Finish Grinding on Thermit® Welds with Vertical Offset
Side View of Rail Head

29.3 FINISH GRINDING THE GAUGE SIDE OF THE RAIL HEAD.

a. The gauge face of the weld should be ground flush with the gauge face of the parent rail head surface.

b. Determine if a horizontal offset condition exists on the gauge face of the completed Thermit® weld due to rail manufacturing variance, misalignment, or curve wear differential. (See Figure 29.5)

- ❖ Place a 36 “straight edge on the gauge face of the rail with the weld at midpoint.
- ❖ Heel the straight edge.
- ❖ Insert the taper gauge between the rail head and the straight edge, approximately one (1) inch from the weld fusion line.
- ❖ Measure the horizontal offset; and
- ❖ Determine the length of taper required from the chart in Figure 29.5



OFFSET (X)	TAPER LENGTH (T)
0.010	6"
0.011-0.020	12"
0.021-0.030	18"

OFFSET (X)	TAPER LENGTH (T)
0.031-0.040	24"
0.041-0.050	30"
0.051-0.060	36"

Fig. 29.5

Gauge Side – Horizontal Offset Taper – Requirements
TOP VIEW OF RAIL HEAD

C. Where an allowable horizontal offset condition exists, the gauge face of the rail must be tapered back to provide for a smooth transition. The rail should be ground such that:

- When a 36” straight edge is placed on the gauge face of the rail, at the interface between the weld and the low rail (Figure 29.6)
- The weld should be flush with the low rail and taper back the distance specified in Figure 29.5, up to a maximum of three (3) feet; and
- The requirements of Section 29.3d are met.
  (See figure 29.6, 29.7 & 29.8)

d. Where no horizontal offset condition exists, the surface of the rail head through the weld area should be ground such that:
When a 36” straight edge is placed on the gauge face of the rail with the weld at midpoint, The maximum distance between the rail head and any point along the entire length of the straight edge should be less than fifteen thousandths (.015) of an inch. (Figure 29.8)

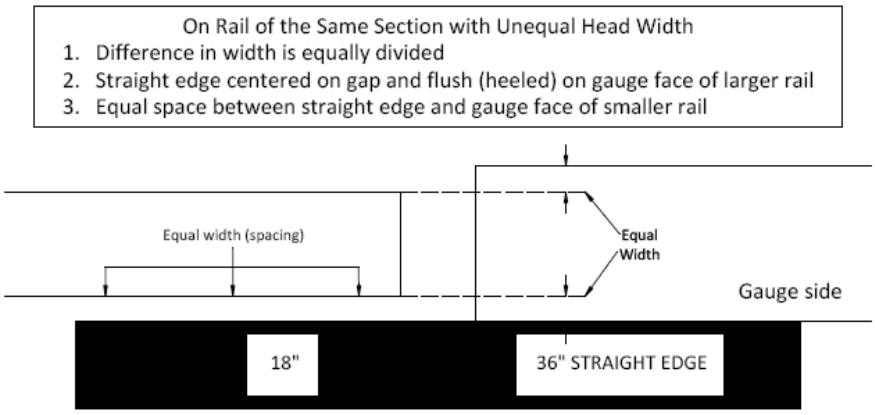


Fig. 29.6

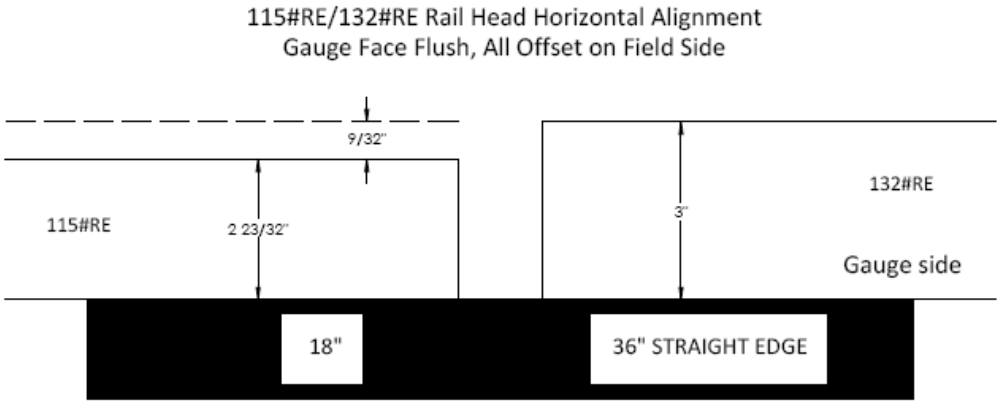


Fig 29.7

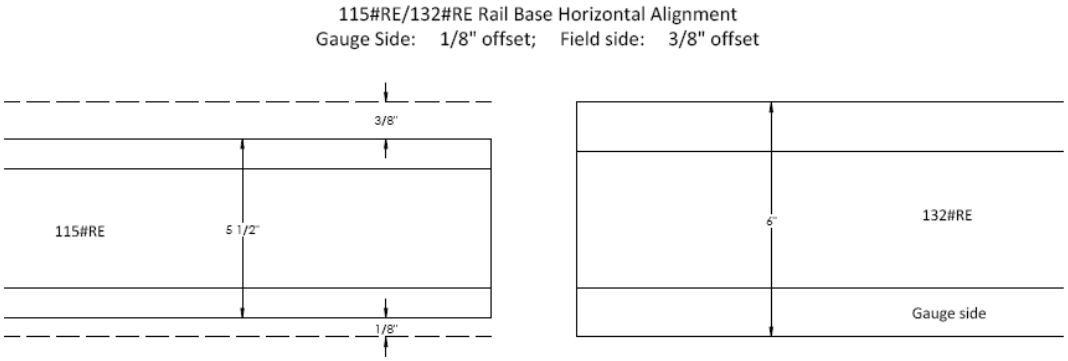


Fig 29.8

e. On head worn rail where the rail head flow has been removed on the gauge side to produce a Thermit® weld (Figure 29.9), the flow must be tapered back to provide a smooth transition

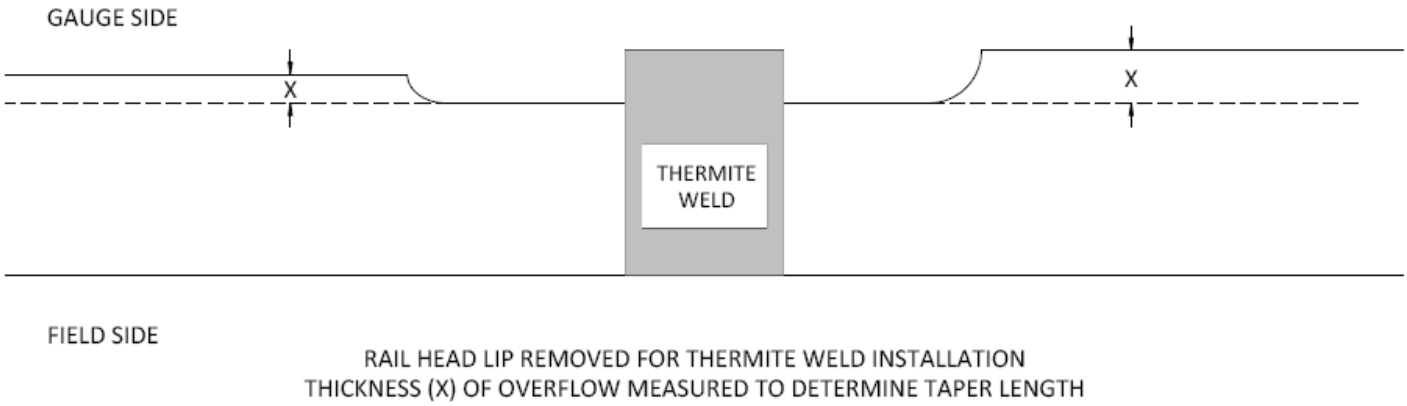
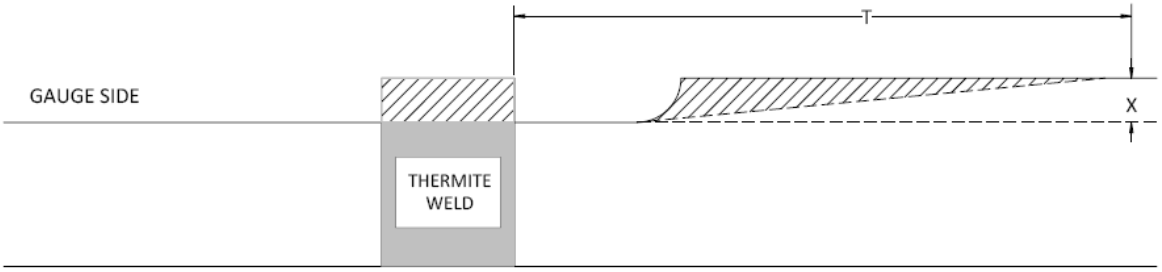


Fig. 29.9

f. Measure the amount of overflow with a taper gauge or tape measure and determine the length of taper required from the chart in Figure 29.10.



X	TAPER LENGTH (T)
0.010	6"
0.011-0.020	12"
0.021-0.030	18"

X	TAPER LENGTH (T)
0.031-0.040	24"
0.041-0.050	30"
0.051-0.060	36"

Fig.29.10

g The gauge face of the head of the rail should be ground such that:

- When a 36” straight edge is placed on the overflow on the gauge face of the rail, at the interface between the weld and the rail (Figure 29.6),
- The weld should be flush with the rail.
- The flow (x) shall taper back the distance specified in Figure 29.10, up to a maximum of three (3) feet; and
- The requirements of Section 29.3c are met. (Figure 29.6, 29.7 & 29.8)

29.4 FINISH GRINDING THE FIELD SIDE OF THE RAIL HEAD.

a. The field side of the rail head should be ground such that the weld is flush with the field faces of the parent rail sections.

b. Horizontal offset may exist on the field face of the completed Thermit® weld due to:
Rail manufacturing variance or misalignment, curve wear differential. (See fig. 29.5),

Compromise welds where an offset exists on the field side due to alignment requirements, or

Rail head flow (lip) has been removed on the field side to allow for Thermit® welding.

c. Determine if horizontal offset exists on the field face of the completed weld. (See Figure 29.11)

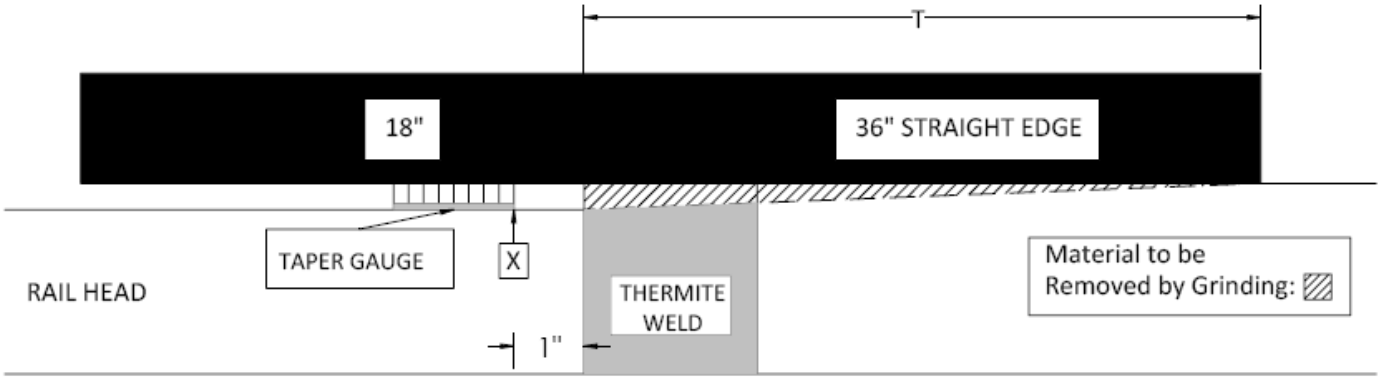
Place a 36" straight edge on the field face of the rail with the weld at midpoint

Heel the straight edge

Insert a taper gauge between the rail head and the straight edge at approximately one (1) inch from the weld fusion line, or if the gap is large, use a tape measure

Measure the horizontal offset; and

Determine the length of taper required from the chart in Figure 29.11



OFFSET (X)	TAPER LENGTH (T)
0.010-0.125	6"
0.126-0.250	12"
0.251-0.375	18"
0.376-0.500	24"

Fig. 29.11

d Where an allowable horizontal offset condition exists, and the rail will not be subject to transposal at a later date, the field face of the rail must be tapered back to provide for a smooth transition. The rail should be ground such that:

When a 36" straight edge is placed on the field face of the rail, at the interface between the weld and the low rail (Figure 29.12),

The weld shall be flush with the narrow rail and taper back the distance specified in Figure 29.11, up to a maximum of three (3) feet; and

The maximum distance between the rail head and any point along the length of the straight edge should be less than fifteen thousandths (.015) of an inch. (Figure 29.12)

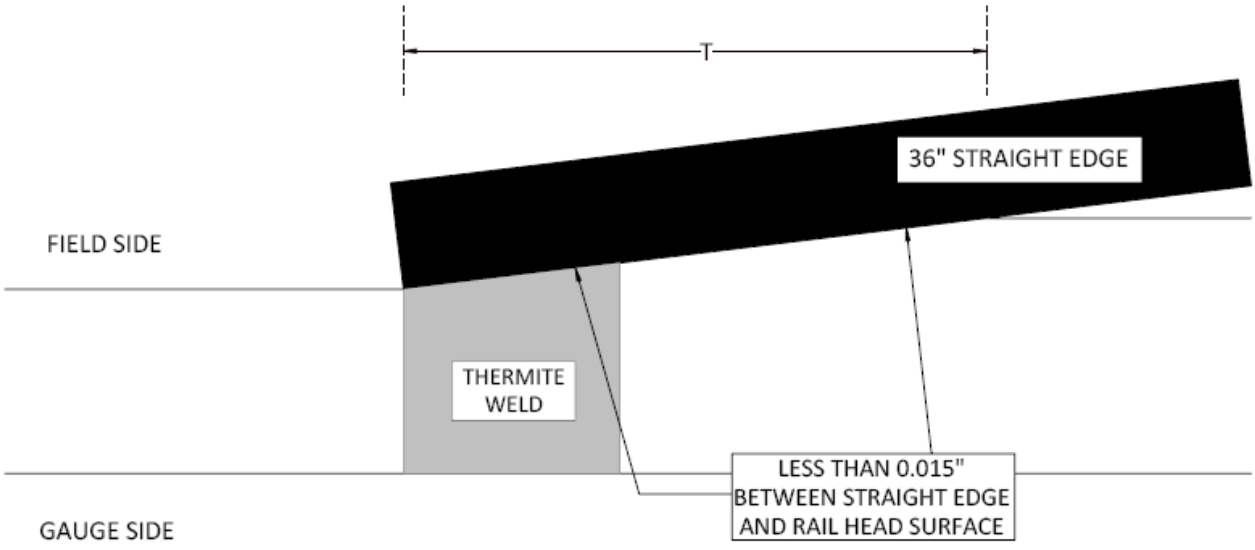


Fig. 29.12

e Where no horizontal offset condition exists and where the rail may be subject to transposal at a later date, the field face of the rail head should also be ground such that: When a 36” straight edge is placed on the field face of the rail with the weld at the midpoint; and The maximum distance between the rail head and any point along the entire length of the straight edge should be less than fifteen thousandths (.015) of an inch. (Figure 29.13)

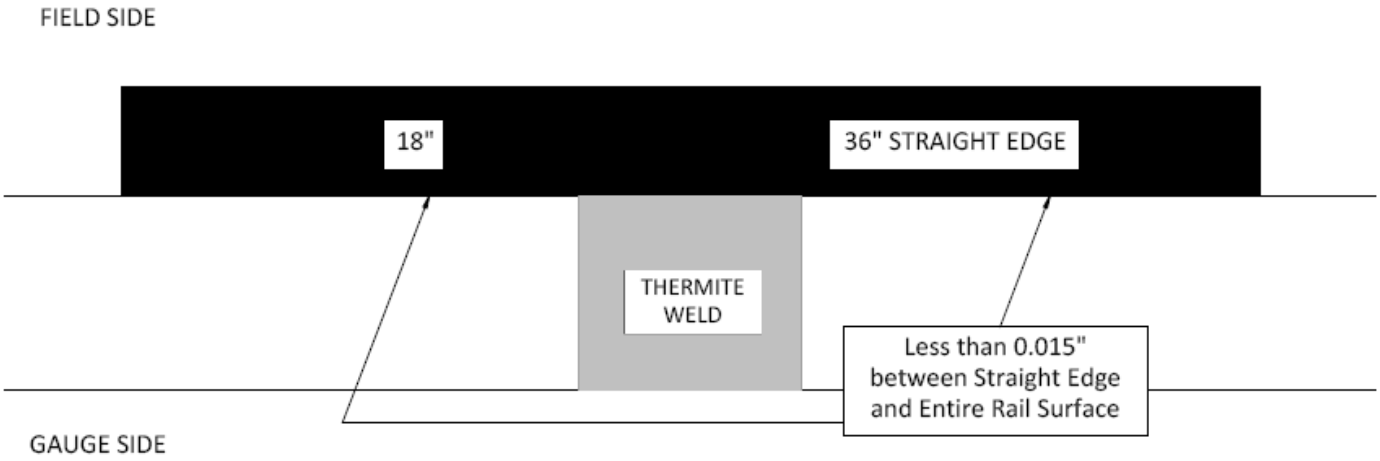


Fig. 29.13

Straight Edge Location for Inspection Field Side of Thermit® Welds with no Horizontal offset
TOP VIEW OF RAILHEAD

29.5 A summary of required taper lengths is provided in Table 29.14 below, for:

- ❖ Vertical offsets on the top of the rail; and
- ❖ Horizontal offsets on the field and gauge faces.

Table 29.14

OFFSET		TAPER LENGTH (T) INCHES			
		VERTICAL OFFSET	HORIZONTAL OFFSET		
			GAUGE		FIELD
X (inches)	Approximate Fractional Equivalent for Maximum		FACE	CURVE WEAR, FLOW LIP	FACE, CURVE WEAR, FLOW LIP
0.010		6	6	6	6
0.011 – 0.020		12	12	12	6
0.021 – 0.030	1/32	18	18	18	6
0.031 – 0.040		24	24	24	6
0.041 – 0.050		30	30	30	6
0.051 – 0.060	1/16	36	36	36	6
0.061 – 0.125	1/8	OUT OF TOLERANCE		36	6
0.126 – 0.188	3/16				12
0.189 – 0.250	¼				12
0.251 – 0.313	5/16				18
0.314 – 0.375	3/8				18
0.376 – 0.500	½				24

REQUIRED TAPER LENGTH SUMMARY FOR VERTICAL AND HORIZONTAL OFFSETS

29.6 FINISH GRINDING THE WEB COLLAR AND BASE.

a. No “bluing” of the weld should take place when finish grinding the web and base of the Thermit® weld.

b. Risers should be ground flush with the weld collar.

c. If a sand inclusion is in the web or base area, it must be removed by grinding (mold scabbing shall not be removed). A gentle taper must be ground such that no sharp edges or angles remain.

d. If a sand inclusion remains in the weld after grinding down to the parent metal depth, the weld should be considered defective and removed from the track.

e. If slag inclusions are found, the weld should be considered defective and removed from track.

f. The mold collar of the weld on both base faces should be ground in a half moon shape. A slight (1/16”) radius should be applied to both the top and bottom of the face so no sharp edge remains. No nicks or notches must be grinded into the rail or weld, as these notches will act as severe stress raisers and cause premature fatigue failure.

30.0 FINAL MISALIGNMENT TOLERANCES.

30.1 Surface Misalignment Tolerances at Ambient Temperature (measured with a 36" straight edge, weld at midpoint)

a. No dip camber should be allowed. (Figure 30.1)

b. Vertical offset should not exceed sixty thousandths (0.060) of an inch (Figure 30.2) Goal: 0.000"

c. Combined vertical offset and crown should not exceed sixty thousandths (0.060) of an inch. (Figure 30.3) Goal: Less than 0.000"

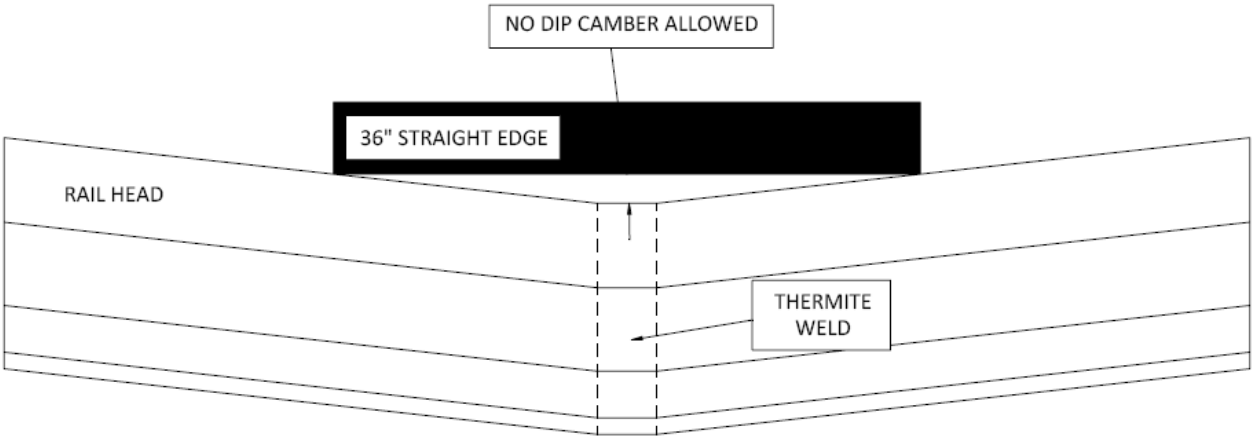


Fig. 30.1

Dip Chamber
Side View of Rail

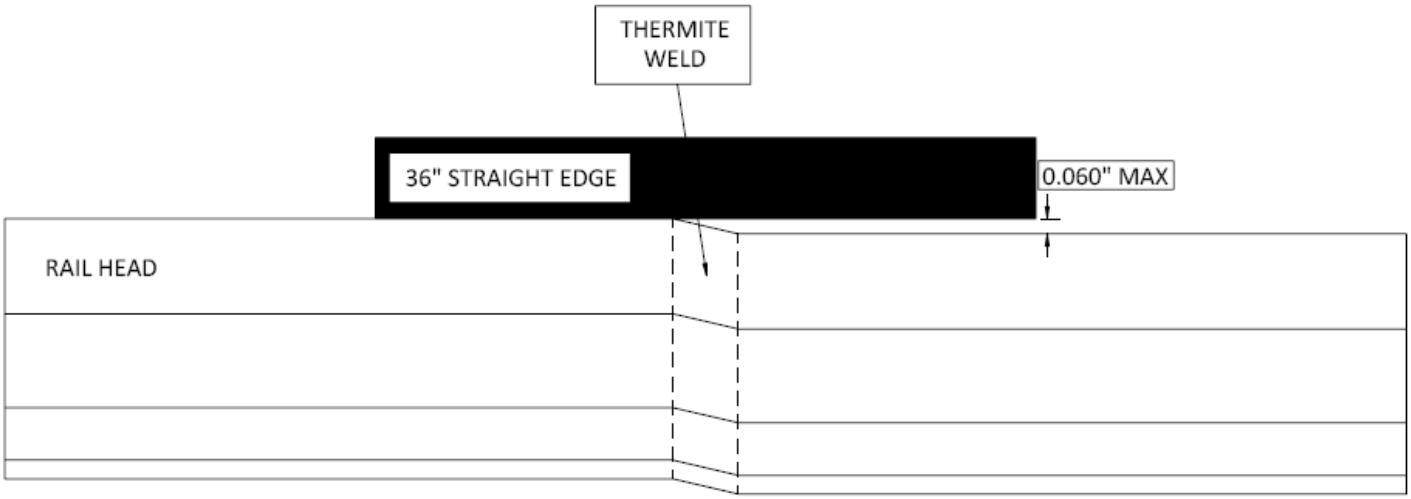


Fig. 30.2

Vertical Offset

Side View of Rail

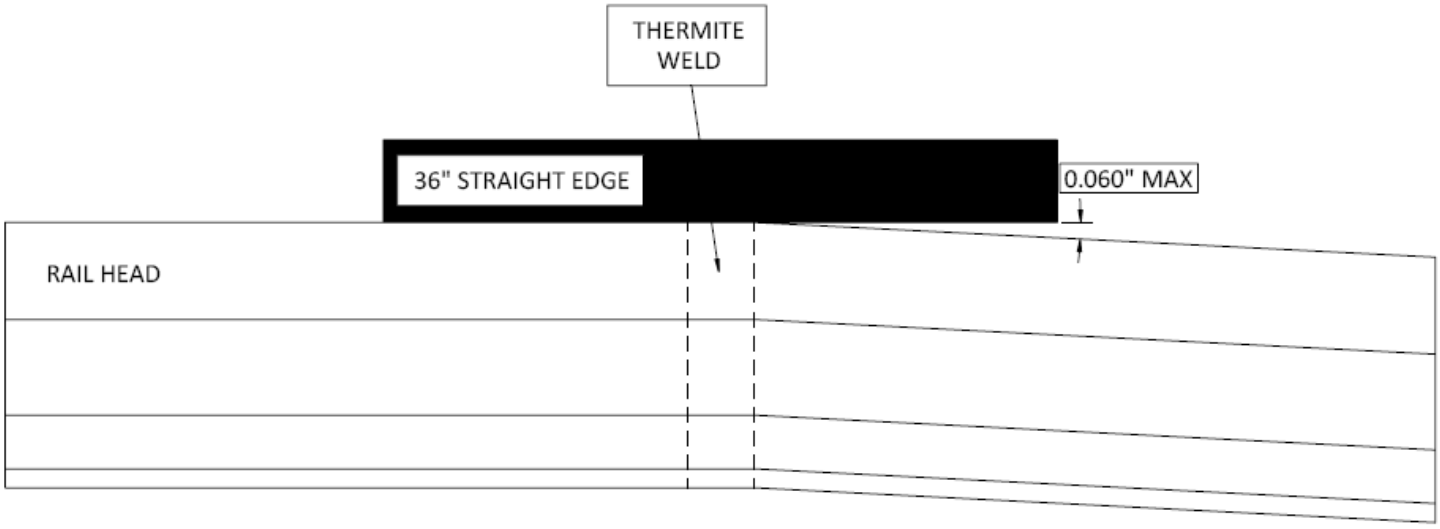


Fig. 30.3

Combined Vertical offset and Crown

Side View of Rail

30.2 HORIZONTAL MISALIGNMENT TOLERANCES AT AMBIENT TEMPERATURE.

(Measured with a 36" straight edge, weld at midpoint)

a. Horizontal offset should not exceed thirty thousandths (0.030) of an inch on the gauge side of the head. (Figure 30.4.)

b. Combined horizontal offset and kink should not exceed thirty thousandths (0.030) of an inch on the gauge side of the head when kinked to gauge. (Figure 30.5).

c. Combined horizontal offset and kink should not exceed fifteen thousandths (0.015) of an inch on the gauge side when kinked to field. (Figure 30.6.)

d. Horizontal offset should not exceed sixty thousandths (0.060) of an inch in the base.

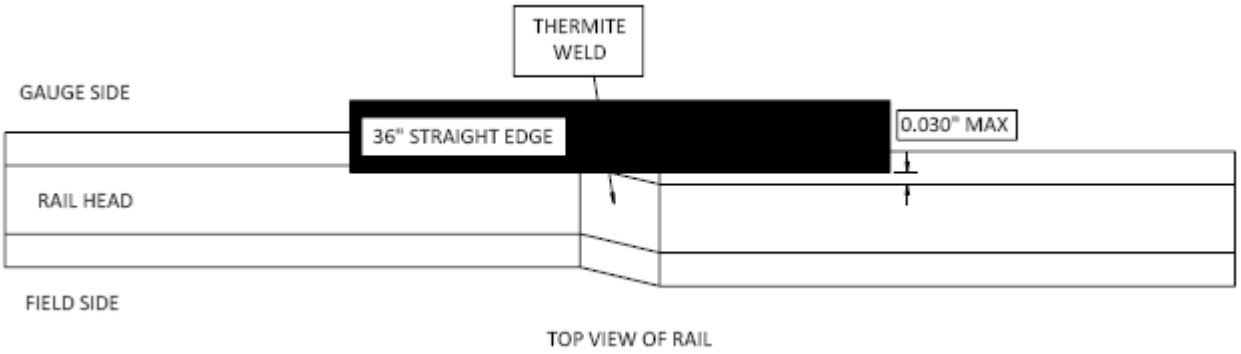


Fig. 30.4 - Horizontal Offset

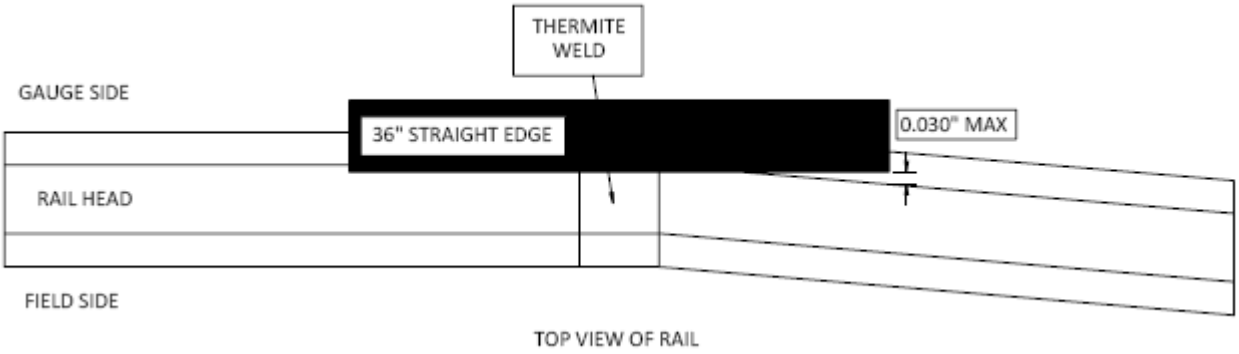


Fig. 30.5 - Horizontal Offset & Kink to Gauge

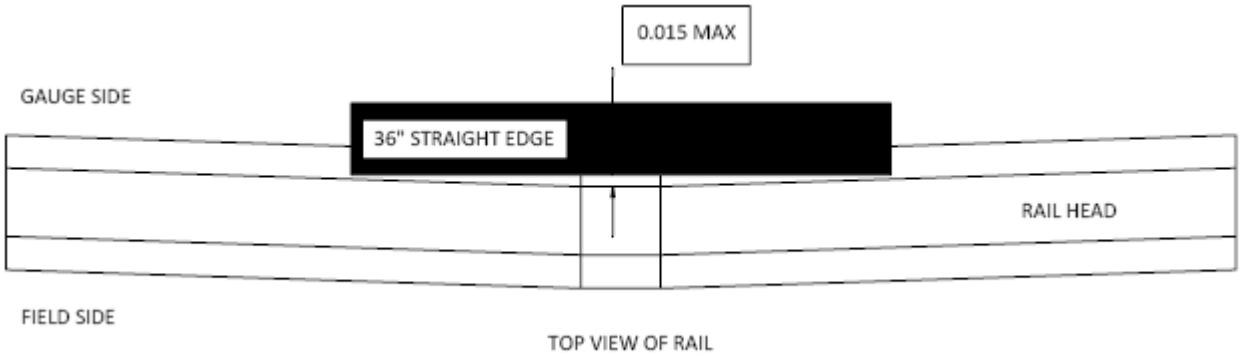


Fig. 30.6 - Horizontal Offset & Kink to Field

31.0 TRACKWORK COMPLETION REQUIRED.

31.1 Completed Thermit® welds should not be:

- Placed over or on a tie; or
- Placed in or on a tie plate.

31.2 Ties should be straightened, spaced, and spiked (or clipped in the case of concrete ties) as required, to conform to the existing Railroad's standard for the track where work is performed.

31.3 All ties should be tamped through the weld area, including those under the rail plug or insulated joint assembly when installed.

31.4 Anchors should be applied (or reapplied) to conform with the existing Railroad's standard.

31.5 Anchors must not be placed closer than one (1) inch from the edge of a completed Thermit® weld. (Figure 31.1)

- Reposition the tie, where necessary.
- If the tie cannot be repositioned the anchor should not be applied.

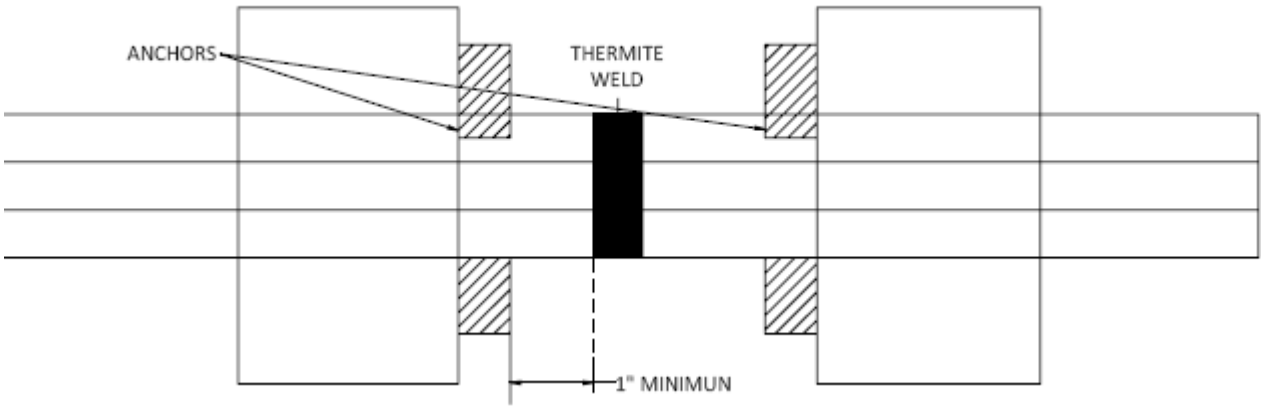


Fig. 31.1 Minimum Anchor Distance from Tie

32.0 MARKING OF COMPLETED THERMIT® WELDS

It is recommended that:

32.1 The employee in charge of the welding crew should be responsible to ensure that the correct marking and identification of completed Thermit® welds is performed.

32.2 Each completed Thermit® weld should be identified using a ball point paint stick with the following information:

- Welder's initials (the welder who performs the preheat
- Weld number completed (each qualified welder begins each year with Weld "#1
- Date (month, day, and year)
- Rail temperature at time of pour, and
- Amount of rail added (in inches). This information should be printed legibly. It should be printed in the order and at the locations specified in Fig. 32.1

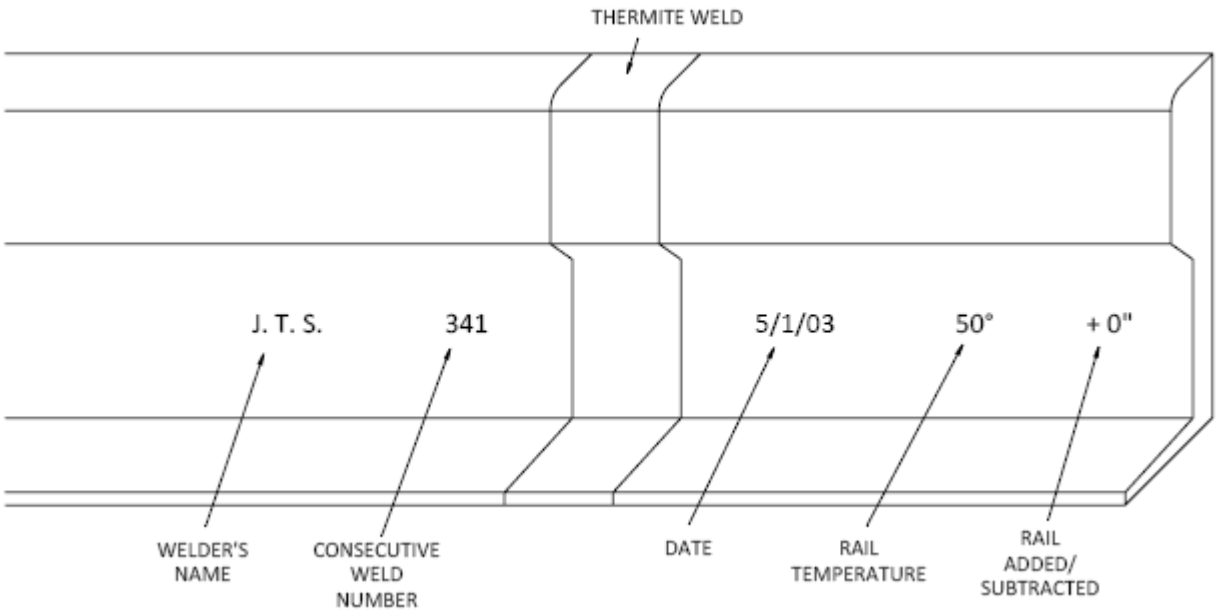


Fig. 32.1 Thermit® Weld Identification

Field Side of View of Rail

33.0 CLEAN UP DEBRIS.

33.1 The used mold material, slag, and risers are to be properly disposed of.
It is suggested that.

- Mold, slag, and degradable crucible material should be buried at the toe of the ballast section and should be at least ten (10) to twelve (12) inches deep.
- The risers from the weld should be taken to a metal dumpster; and
- The cardboard and plastic should be taken to a trash dumpster.

34.0 REPORTING.

34.1 Each welder should keep a record of each weld produced as required by the particular Railroad.
Additional recorded information for each weld is suggested as follows:

a. Weld number
b. Date
c. Division
d. Subdivision
e. Line Segment
f. Track
g. Milepost
h. Rail (North or South)
i. Rail size and rail type (Standard, Intermediate, High Strength, etc.)
j. Curve or Tangent
k. Rail Temperature
l. Weld kit Manufacturer and welding process
m. Weld Gap
n. Tap Time
o. Rail added or subtracted (inches)
p. Welder in Charge

34.2 Defective or unusable material must be reported to the relevant Railroad authority when found. The following information is required:

a. Mold, Portion and Crucibles.
b. Size and/or Type
c. Lot number/Date of Manufacture
d. Reason for being classed as defective or unusable.

35.0 QUALITY CONTROL SPECIFICATIONS.

35.1 It is highly recommended that a Track Welding Supervisor performs formal Quality Assurance inspection of each welder on a continuing basis to verify whether the welder is familiar with the various welding codes and practices for all the processes he uses, railroad safety aspects and other railroad regulations and laws, and whether his vehicle and welding equipment is in a serviceable condition.
Should a welder not satisfy the requirements he should be retrained or given a refresher course to be totally updated with the necessary practices and standards as required by the relevant rail roads.

The quality of the execution of the weld by the welder, will determine the satisfactory performance of the weld under service conditions.

The Track Welding Supervisor should ensure the final grinded and cleaned weld is inspected and documented for; final grinding tolerance acceptance, indications of any porosities, inclusions, or other defects, under base collar mismatches, vertical collar alignment, notches, and sharp corners, and verify whether the correct molds for an upset base weld was employed.

Continuous inspection and monitoring of completed welds will determine welder proficiency.

36.0 STORAGE AND HANDLING.

36.1 ALL THERMIT® WELDING MATERIALS.

a. Thermit® welding material, molds, welding portions, all types of crucibles, thimbles, igniters, and luting sand must be stored in a dry location.
b. It is advisable to store Thermit® Welding materials in an orderly manner, off the floor of the storage location.
c. Thermit® welding material should be inspected when delivered. Any material that has evidence of mishandling should be rejected.
d. Thermit® welding molds are fragile and together with the portions should be handled with care in order to prevent mold breakage or any damage to the sealed portion bags.
e. Thermit® Welding molds, portions, crucibles, and luting sand must be used on a rotating basis, with the oldest material being used first.
f. Boxes or Thermit® welding kits containing the preformed molds and/or portions should not be stacked more than 5 boxes high to prevent possible crushing and damage to the fragile refractory molds.
g. The recommended shelf life of the Thermit® welding molds are three (3) years provided they are stored in a dry and well-ventilated area however some rail roads may have their own internal rules pertaining to the shelf life of their welding kits.
h. Any material that has exceeded the stipulated shelf life shall not be used.
    - Send a sample of the material to Orgo Thermit Inc. who would test the material for fitness.
    - Contact your Track Welding Supervisor.
i. Igniters must be stored separately from the Thermit® welding portions. (Either placed in the riser aperture of the mold, or separate from both portion and mold)

36.2 PREHEATING BURNERS AND GAS EQUIPMENT.

The preheating nozzle tip should be cleaned, at regular intervals, with the proper tip cleaner. (Suggest once a week).
Damaged burners, regulators, and flash back arrestors must not be used and must be repaired only by an authorized technician.
Preheating burners must be placed carefully in the toolbox after each day's use.

36.3 Hydraulic Rail Shearing Machines.

Shear blades with overflow lips can tear the weld. Shear blade cutting edges should be sharpened by light hand grinding when an overflow lip develops. Use only approved rail shears and shearing blades.
After having sharpened the shear blade tip and having removed all existing overflow lip, place the shear blade onto the rail shearing machine. Operate the machine so that the shear blades open and close check for proper alignment and fit of the blades on a section of rail.

36.4 HOT CUT CHISELS.

Hot cut chisels should be kept sharp and in a good condition.
Hot cut chisels should be sharpened by hand filing only.
Grinding on the cutting edge of hot cut chisels is prohibited.
The struck end of the hot cut chisels should be protected by a rubber hose.
The struck end of a hot cut chisel should be beveled. No overflow or lip must be present.
Hot cut chisels should be struck with a sledgehammer only.
Maximum weight: 12 pounds.
Hot cut chisels must be cooled in water after the cutting operation has been completed.

365 WELDING HARDWARE.

It is very important that the welder always keeps all of his welding hardware in good working order.
Periodic maintenance should be performed on all welding hardware, and adjustment screws should be lightly oiled and move freely.

36.6 ALIGNMENT TOOLS.

Lining wedges or specially engineered rail alignment tools must be kept in good working order.
Straight edges should be kept in their original boxes or containers that afford protection.
When not in use, they must be laid on a flat surface.

37.0 THERMIT® WELD REPAIR WELDING.

37.1 If rail end batter exists on the rail ends to be Thermit® welded, the batter should be corrected by welding or removed prior to performing the Thermit® weld.
Only the oxy-acetylene welding process should be used to make the repair weld.

37.2 If the weld batter develops in the rail head portion of a Thermit® weld, the repair can be performed using:
The oxy-acetylene welding process; or
The electric welding processes.
ONLY with the approved procedures and approved welding electrodes or wire.

37.3 Welding repairs are prohibited in the web and base areas of Thermit® welds.